

**GEOTECHNICAL CONDITIONS ON PLOT 1890
BOEGOEBERG SETTLEMENT AND THE
REMAINDERS OF FARMS 142 AND 144: A REPORT
FOR THE EXPANSION AND FORMALISATION OF
BOEGOEBERG COMMUNITY**

2020/J09/MCP_01



ON BEHALF OF : MACROPLAN

P O BOX 987

UPINGTON

8800

TEL: 054 332 3642

PREPARED BY : CEDARLAND GEOTECHNICAL
CONSULT (PTY) LTD

PO BOX 607

CERES

6835

TEL: 082 570 2767

EXECUTIVE SUMMARY

1 INTRODUCTION

It is envisaged to develop some 49 hectare of land on Plot 1890 of Boegoeberg Settlement and the Remainders of Farms 142 and 144 for an expansion and formalization of the existing Boegoeberg community. For this purpose Cedar Land Geotechnical Consult (Pty) Ltd was appointed as sub consultant to to conduct a geotechnical investigation on the property.

2 TERMS OF REFERENCE

The requirements of the following documents were adhered to in the conduct of the investigation and reporting of the project :

- The document Geotechnical Site Investigations for Housing Developments (Generic Specification GFSH-2), issued by the National Department of Housing in September 2002.*
- The document SANS 634-1 : Geotechnical Investigations for Township Development, issued by SABS in February 2012.*

3 SITE DESCRIPTION

3.1 Site Location

The village of Boegoeberg is located directly to the west of the Orange River and in an apex of a triangle formed by two gravel roads – one leading to Boegoeberg Dam and the other to Marydale in the Northern Cape. It is some 15 km southeast of Groblershoop. The area of investigation consisting of Plot 1890 of Boegoeberg Settlement and the Remainders of Farms 142 and 144. The size of the property is 49 hectare.

3.2 Topography and Drainage

The land investigated is located between 876,0mamsl and 896,0mamsl. Topographical it can be described as a undulating landscaping consisting of localized low rises, but generally sloping virtually due south to north at 1,6%. Drainage takes place by means of surface sheetwash. The sheetwash is disposed of towards the east through two non-perennial streams. The drainage courses are contained in narrow, steeply sloping and well defined gullies following courses through the area of investigation and the existing village.

3.3 Vegetation and Landscape

the area of investigation is referred to as Bushmanland Arid Grassland. The landscape features are described as consisting of extensive to irregular plains on a slightly sloping plateau sparsely vegetated by grassland dominated by white grasses giving this vegetation type the character of semi-desert steppe. In places low shrubs change the vegetation structure. In years of abundant rainfall rich displays of annual herbs can be expected.

3.4 Climatic Conditions

The area is located in a summer-rainfall region with mean annual precipitation between 70mm to 200mm ; mean maximum summer temperature of 38°C and mean minimum winter temperature of -0,6°C. Frost incidence varies between 10 and 35 days per year. The Thornthwaite moisture index is less than -40 ; and the Weinert N value approximately 35. The climate can thus be described as arid.

3.5 Existing Facilities

Water purification works are present on the southeastern perimeter of the site. An unused, non-functional oxidation pond is present on the western perimeter of the site. Localized stockpiles of waste material, consisting of domestic waste, stockpiles of gravels and human waste are present close to the water purification works. Electricity is provided by an overhead reticulation system via overhead lines.

Informal housing consisting of galvanized iron structures and some reed structures is present in the eastern and northern parts of the site, directly adjacent to the existing village. Some residents have created small vegetable and flower gardens on the stands. Vacant, undeveloped land extends from the existing village to the limits of the area of investigation in all wind directions.

4 NATURE OF INVESTIGATION

4.1 Test Pitting

In compliance with the requirements of SANS 634 and GFSH-2 test pitting was conducted to provide applicable geotechnical information. On 10 and 11 July 2020 32 test pits were excavated with a Bell 315SK TLB on hire from ALS Plant Rentals. The TLB was equipped with a 600mm wide bucket. All test pits were excavated to refusal. The test pits were profiled by a professionally registered geotechnical engineer.

4.2 Materials Testing

Soil testing consisted of the following :

- Conductivity and pH determinations on five samples of the in-situ materials to determine the corrosivity thereof.
- Foundation indicator testing on ten samples of the in-situ materials to determine possible conditions of heave or settlement.
- CBR and road indicator testing on three samples to determine the suitability of the in-situ materials to be utilized as road layerworks.

5 GEOLOGY, SOIL PROFILES AND GROUNDWATER

5.1 Stratigraphy

The available information shows that the area of investigation is located on a subduction zone dating approximately 1000 million years old. The zone is located between the lithology of the Kaapvaal Craton and the Namaqua-Natal mobile belt. The remains of the original geology in the area are referred to as the Kaaien Terrane and the site is located on the Groblershoop Formation of the Brulpan Group.

Bedrock on site consists of the following :

5.1.1 Quartz-sericite Schist

The quartz-sericite schist is described as yellow-green, unweathered, hard rock, weathering to light grey-green, very closely jointed, very fine grained, very intensely laminated, slightly weathered, medium hard rock. Dark grey, needle like crystals of amphibole are present in the schist. Joints are open and filled with white, fine, calcareous sand.

5.1.2 Quartzite

A very prominent outcrop of quartzite was encountered close to the southern perimeter of the site. It is present as a band of light grey speckled black, medium jointed, fine grained, unweathered, very hard rock, striking east-west and dipping almost vertically. The discontinuities in the quartzite are closed, smooth and clean.

5.2 Soil Profile

5.2.1 River Terrace Gravels

It is described as abundant clast supported, coarse, rounded gravels of banded ironstone and quartz in a matrix of light red brown, fine sand. The consistency of the terrace gravels is medium dense and the thickness of the horizon varies between 100mm and 800mm, but usually less than 400mm in the test pits.

5.2.2 Alluvium

The alluvium is described as light red fine sand of medium dense consistency. The horizon extended to a maximum depth of 800mm in the test pits.

5.2.3 Mokalanen Formation

Calcrete of the Mokalanen Formation, Kalahari Group, is present as an ubiquitous surface duricrust on site, in virtually a continuous cover over the Groblershoop Formation, with the schist and quartzite outcropping occasionally only in limited areas of localized extent. The calcrete is present as very dense hardpan calcrete. It underlies the terrace gravels and alluvium, occurring from depths between 100mm and 800mm minimum, extending to 200mm to 900mm maximum, at which stage refusal of excavation occurred. Minor outcrops of calcrete are present randomly across the site.

5.2.4 Fill

Areas of stockpiled material were encountered in the area, but surface rubble were distributed widely over the site. The fill consists mostly of household waste. Such waste is also present on the surface over a widespread area.

5.2.5 Residual Quartzite

Residual quartzite is described as light red brown fine sand with a variable content of cobbles of quartzite. The consistency of the residual quartzite is medium dense and it extended to a depth of 300mm in both test pits.

5.3 Groundwater

Perched groundwater was not encountered in any of the test pits excavated for this investigation. It is anticipated that perched water will generally not prove problematic on the site. The probability for drilling successfully for water in the area is between 40% and 60%, and the probability that such a borehole

will yield more than 2l/s is between 10% and 20%. Groundwater is expected to occur at depths less than 15 meters in compact, argillaceous strata.

6 CONDITIONS OF EXCAVATION

On average over the entire site bedrock or refusal of excavation on very dense hardpan calcrete or bedrock of quartzite and quartz-sericite schist was encountered at depths between 200mm minimum and 900mm maximum, averaging 450mm deep. The implication of this is that should trenches require excavated depths to 1000mm, 55% of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 70% of the excavation may be classified as hard.

7 SITE CLASS DESIGNATION

7.1 Geotechnical Zone I

The zone is classed as R. The distribution thereof encompasses 48% of the proposed area for development. Slope across the land is approximately between 2% and 6%. The use of slab-on-the-ground foundations will require additional works in the form of the construction of an engineered fill or cutting to establish a level platform for construction. The more viable foundation alternative therefore remains founding by conventional strip foundations.

7.2 Geotechnical Zone II

The zone is classed as R. The distribution thereof encompasses 50% of the proposed area for development. Slope across the land is less than 2%. Considering the limited slope and the favourable geotechnical site classification, two foundation design alternatives are applicable to the zone, namely conventional strip foundations or slab-on-the-ground foundations placed directly on bedrock or very dense pedocrete.

7.3 Geotechnical Zone III

The zone is classed as S. The distribution thereof encompasses 2% of the proposed area for development. Slope across the land is less than 2%. Considering the limited slope and the favourable geotechnical site classification, two foundation design alternatives are applicable to the zone, namely conventional strip foundations or slab-on-the-ground foundations placed directly on medium dense terrace gravels.

8 LAND SLOPE

The average slope across 48% of the land is between 2% and 6%. In Geotechnical Zones II and III is the slope less than 2%, that is over 52% of the site. This slope of less than 2% has a detrimental influence on especially the design of a stormwater disposal system depending on gravity to dissipate of the surface water due to downpours.

9 AREAS SUBJECT TO FLOODING

The non-perennial water courses on site are contained in well-defined, narrow gullies and may be regarded as being of lesser importance, requiring no additional precautionary measures to ensure the safety of the population against flooding. The effects of the gully draining from the old oxidation dam into the village need to be addressed should the oxidation dam be commissioned again.

10 MATERIALS UTILIZATION

- *Trench Backfilling : None of the materials are suitable for selected fill or pipe bedding. With exception of the hardpan calcrete all materials can be used for normal backfill.*
- *Layerworks for Paved or Segmental Block Paving : The in-situ materials are suitable for the construction of selected layerworks for lightly trafficked access roads in townships, and with selection it may be used as material for the construction of subbase and base course material.*
- *Wearing Course for Gravel Roads in Urban Areas : None of the soil materials are 100% suitable for this purpose. The use of these materials will generally result in a road surface subject to raveling and corrugations.*

11 OTHER CONSIDERATIONS

- *Undermining : The area is not subject to undermining.*
- *Seismic Activity : The Peak Ground Acceleration expected in 50 years is 0,10g. A low risk for the development of earth tremors therefore exist.*
- *Soil Corrosivity : The in-situ soils and pedocretes are not corrosive due to acidic properties. All soil materials can be regarded as corrosive due to high soluble salt contents.*
- *Dolomite : The area of investigation is not subject to any restrictions due to the presence of dolomite. Bedrock of dolomite does not occur in the area of investigation.*

12 FACTORS INFLUENCING DEVELOPMENT DETRIMENTALLY

- *The presence of hard rock and very dense hardpan calcrete close to the surface. The presence thereof will result in conditions of hard excavation.*

- *The limited slope of less than 2% in Geotechnical Zones II and III will have a detrimental influence on the design of stormwater disposal systems and sewerage reticulation.*
- *The presence of waste material need to be addressed.*
- *The issue of the vandalized oxidation dam need to be clarified.*

**GEOTECHNICAL CONDITIONS ON PLOT 1890
BOEGOEBERG SETTLEMENT AND THE REMAINDERS
OF FARMS 142 AND 144: A REPORT FOR THE
EXPANSION AND FORMALISATION OF BOEGOEBERG
COMMUNITY**

2020/J09/MCP_01

INDEX

		PAGES
1	INTRODUCTION	1
2	TERMS OF REFERENCE	1
3	AVAILABLE INFORMATION	1
4	SITE DESCRIPTION	2
5	NATURE OF INVESTIGATION	4
6	SITE GEOLOGY AND GEOHYDROLOGY	6
7	GEOTECHNICAL EVALUATION	17
8	SITE CLASS DESIGNATIONS	26
9	FOUNDATION RECOMMENDATIONS AND SOLUTIONS	30
10	DRAINAGE	34
11	SPECIAL PRECAUTIONARY MEASURES	34
12	CONCLUSIONS	34
13	RECOMMENDATIONS	40
14	SOURCES OF REFERENCE	42
15	ADDENDUM A: TEST PIT PROFILES	
16	ADDENDUM B: RESULTS OF MATERIALS TESTING	

Cedar Land Geotechnical Consult (Pty) Ltd retains the copyright in all intellectual property and documents prepared in terms of this appointment for the project covered by the appointment. The client may use the documents for the sole purpose of their intended use on this project only, subject to all invoices being paid timeously. Use for any other purpose, whether the report has been paid for constitute an infringement of copyright



*Cedar Land
Geotechnical
Consult (Pty) Ltd*

PO Box 607

Ceres

6835

Reg no 2015/423890/07

VAT no 4810272098

Tel : 0825702767 or 0823732146

E-mail : cedarland.frans@breede.co.za

or cedarland.mariette@breede.co.za

**GEOTECHNICAL CONDITIONS ON PLOT 1890 BOEGOEBERG SETTLEMENT AND THE
REMAINDERS OF FARMS 142 AND 144 : A REPORT FOR THE EXPANSION AND
FORMALISATION OF BOEGOEBERG COMMUNITY**

1 INTRODUCTION

It is envisaged to develop some 49 hectare of land on Plot 1890 of Boegoeberg Settlement and the Remainders of Farms 142 and 144 for an expansion and formalization of the existing Boegoeberg community. For this purpose Cedar Land Geotechnical Consult (Pty) Ltd was appointed as sub consultant to Macroplan as per the minutes of the start-up meeting of the project held in the offices of Macroplan on 20 May 2020 to conduct a geotechnical investigation on the property.

2 TERMS OF REFERENCE

The requirements of the following documents were adhered to in the conduct of the investigation and reporting of the project :

- The document *Geotechnical Site Investigations for Housing Developments (Generic Specification GFSS-2)*, issued by the National Department of Housing in September 2002.
- The document *SANS 634-1 : Geotechnical Investigations for Township Development*, issued by SABS in February 2012.

3 AVAILABLE INFORMATION

Regional or site specific data regarding geotechnical conditions at Boegoeberg settlement are not readily available.

Directors : FJ Breytenbach (Pr Eng) B Eng (Civ) NDT (Geology); M Breytenbach M Sc (Mathematical Statistics)

4 SITE DESCRIPTION

4.1 Site Location

The village of Boegoeberg is located directly to the west of the Orange River and in an apex of a triangle formed by two gravel roads – one leading to Boegoeberg Dam and the other to Marydale in the Northern Cape. It is some 15 km southeast of Groblershoop. The area of investigation consisting of Plot 1890 of Boegoeberg Settlement and the Reminders of Farms 142 and 144. The area of investigation is located to the north and west of the existing village, but includes some existing informal housing directly to the west of Boegoeberg. The size of the property is 49 hectare.

Refer to the attached Figure 1 : Locality Plan.

4.2 Topography and Drainage

The land investigated is located between 876,0mamsl and 896,0mamsl. Topographical it can be described as a undulating landscaping consisting of localized low rises, but generally sloping virtually due south to north at 1,6%.

Drainage takes place by means of surface sheetwash. The sheetwash is disposed of towards the east through two non-perennial streams. The drainage courses are contained in narrow, steeply sloping and well defined gullies following courses through the area of investigation and the existing village.

4.3 Vegetation and Landscape

Based on the work done by Mucina^{Reference 14.1} the area of investigation is referred to as Bushmanland Arid Grassland. The landscape features are described as consisting of extensive to irregular plains on a slightly sloping plateau sparsely vegetated by grassland dominated by white grasses giving this vegetation type the character of semi-desert steppe. In places low shrubs change the vegetation structure. In years of abundant rainfall rich displays of annual herbs can be expected. On site it was found that in the areas where natural vegetation is present it consists of a sparse stand of *Acacia melliflora* and *prosopis glandula*.

4.4 Climatic Conditions

The area is located in a summer-rainfall region with mean annual precipitation between 70mm to 200mm ; mean maximum summer temperature of 38°C and mean minimum winter temperature of -0,6°C. Frost incidence varies between 10 and 35 days per year. The

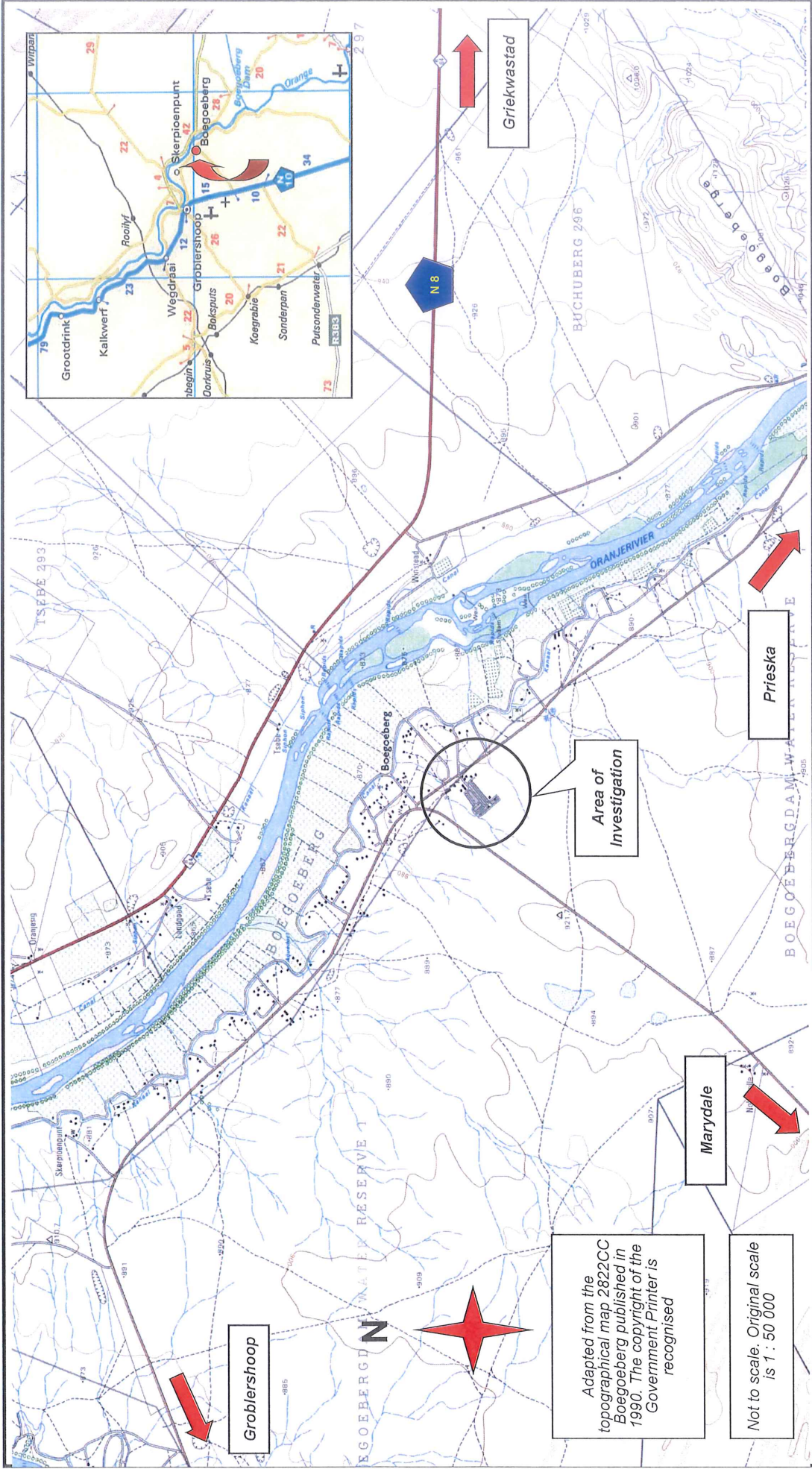


FIGURE 1

LOCALITY PLAN



development of whirl winds are common on hot summer days. The Thornthwaithe moisture index is less than -40 ; and the Weinert N value approximately 35. The climate can thus be described as arid. The importance of this is that mechanical breakdown of bedrock will take place rather than chemical decomposition, limiting the formation of secondary minerals such as expansive montmorillonite clay.

4.5 Existing Facilities

Site conditions are illustrated on Photo 1 : Site Conditions. Water purification works are present on the southeastern perimeter of the site. An underground pipeline originating from the facility follows a course due west through the area of investigation. An unused, non-functional oxidation pond is present on the western perimeter of the site. Localized stockpiles of waste material, consisting of domestic waste, stockpiles of gravels and human waste are present close to the water purification works. Electricity is provided by an overhead reticulation system via overhead lines.

The area can be divided into two zones as follows :

4.5.1 Informal Housing

Informal housing consisting of galvanized iron structures and some reed structures is present in the eastern and northern parts of the site, directly adjacent to the existing village. Electricity is provided by overhead power lines. Some residents have created small vegetable and flower gardens on the stands.

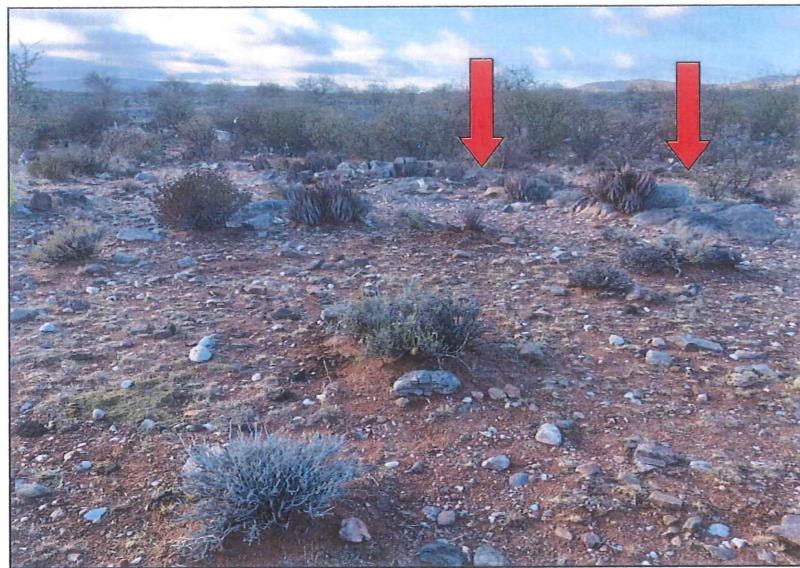
4.5.2 Vacant Land

Vacant, undeveloped land extends from the existing village to the limits of the area of investigation in all wind directions.

5 NATURE OF INVESTIGATION

5.1 Test Pitting

In compliance with the requirements of SANS 634 and GFSH-2 test pitting was conducted to provide applicable geotechnical information. On 10 and 11 July 2020 32 test pits were excavated with a Bell 315SK TLB on hire from ALS Plant Rentals. The TLB was equipped with a 600mm wide bucket. All test pits were excavated to refusal.



OUTCROPS OF VERY HARD ROCK, QUARTZITE



NATURAL CONDITIONS NORTHWEST OF THE VILLAGE



GULLY TO THE NORTHWEST OF THE VILLAGE



STOCKPILES OF WASTE CALCRETE AND HOUSEHOLD WASTE



CONDITIONS IN THE VILLAGE



WELL DEVELOPED TERRACE GRAVELS OF QUARTZ AND BANDED IRONSTONE



CONDITIONS IN BOEGOEBERG VILLAGE

The test pits were profiled by a professionally registered geotechnical engineer. For the benefit of the non-geotechnical reader of this document, the guidelines for test pit profiling are summarized in the attached Table 1 : Soil Profiling Parameters. The profiles of the test pits may be found in Addendum A to this report. The positions of the test pits are indicated on the attached Figure 2 : Site Plan. Provisional co-ordinates for property beacons A to V are indicated on this figure.

5.2 Materials Testing

Soil testing was undertaken by Roadlab in Upington. As a matter of quality control duplicate samples were sent to the Roadlab branch in Germiston for independent testing to verify the results. Due to general limited vertical extent of the soil profile and coarse nature thereof, it was not feasible to retrieve undisturbed samples to determine properties of settlement or collapse fairly accurately.

Soil testing consisted of the following :

- Conductivity and pH determinations on five samples of the in-situ materials to determine the corrosivity thereof.
- Foundation indicator testing on ten samples of the in-situ materials to determine possible conditions of heave or settlement.
- CBR and road indicator testing on three samples to determine the suitability of the in-situ materials to be utilized as road layerworks.

The results of the soil testing may be found in Addendum B. However, for easy reference, these results are summarized in the attached Table 2 : Summary of Soil Testing. The data sheets contained in Addendum B are copies of the originals, which are available from Roadlab.

6 SITE GEOLOGY AND GEOHYDROLOGY

The geology of the area between Upington and Groblershoop appears to consist of granitoid rock in the north, grading into metamorphic rocks towards Groblershoop, but it is in fact highly complex and from a stratigraphical viewpoint provides complicated formation. As a background to the site geology an effort is made in this subparagraph to provide a simplified explanation of the regional geology of the area. For this purpose publications by McCarthy^{Reference 14.2}, Cornell^{Reference 14.3} and Moen^{Reference 14.4} were consulted. Of these three references, the latter two can be regarded as site specific. However, there is disagreement between the two sources regarding the stratigraphic classification of the major

TABLE 1 : SOIL PROFILING PARAMETERS

CONSISTENCY : GRANULAR SOILS

CONSISTENCY : COHESIVE SOILS

SPT N	GRAVELS & SANDS Generally free draining soils		DRY DENSITY (kg/m ³)	SPT N	SILTS & CLAYS and combinations with SANDS Generally slow draining soils		UCS (kPa)
<4	Very loose	Crumbles very easily when scraped with geological pick. Requires power tools for excavation.	<1450	<2	Very soft	Pick point easily pushed in 100mm. Easily moulded by fingers.	<50
4-10	Loose	Small resistance to penetration by sharp pick point. requires many blows by pick point	1450-1600	2-4	Soft	Pick point easily pushed in 30mm to 40mm. Moulded by fingers with some pressure.	50-125
10-30	Medium dense	Considerable resistance to penetration by sharp pick point.	1600-1750	4-8	Firm	Pick point penetrates to 10mm. Very difficult to mould with fingers.	125-250
30-50	Dense	Very high resistance to penetration by sharp pick point. Requires many blows by pick point for excavation.	1750-1925	8-15	Stiff	Slight indentation by pick point. Cannot be moulded by fingers. Penetrated by thumb nail.	250-500
>50	Very dense	High resistance to repeated blows of geological pick. Requires power tools for excavation.	>1925	15-30	Very stiff	Slight indentation by blow of pick point. Requires power tools for excavation.	500-1000

SOIL TYPE

SOIL TYPE	PARTICLE SIZE(mm)
Clay	<0,002
Silt	0,002-0,06
Sand	0,06-2,0
Gravel	2,0-60,0
Cobbles	60,0-200,0
Boulders	>200,0

MOISTURE CONDITION

Dry	No water detectable
Slightly moist	Water just discernable
Moist	Water easily discernable
Very moist	Water can be squeezed out
Wet	Generally below water table

SOIL STRUCTURE

COLOUR		Intact	No structure present.
Speckled	Very small patches of colour <2mm	Fissured	Presence of discontinuities, possibly cemented.
Mottled	Irregular patches of colour 2-6mm	Slickensided	Very smooth, glossy, often striated discontinuity planes.
Blotched	Large irregular patches 6-20mm	Shattered	Presence of open fissures. Soil break into gravel size blocks.
Banded	Approximately parallel bands of varying colours	Micro shattered	Small scale shattering, very closely spaced open fissures. Soil breaks into sand size crumbs.
Streaked	Randomly orientated streaks of colour	Residual structures	Residual bedding, laminations, foliations etc.
Stained	Local colour variations : Associated with discontinuity surfaces		

ORIGIN

Transported	Alluvium, hillwash, talus etc.
Residual	Weathered from parent rock, eg residual granite
Pedocretes	Emcrete, sicrete, calccrete etc.

DEGREE OF CEMENTATION OF PEDOCRETES

TERM	DESCRIPTION	UCS (MPa)
Very weakly cemented	Some material can be crumbled between finger and thumb. Disintegrates under knife blade to a friable state.	0,1-0,5
Weakly cemented	Cannot be crumbled between strong fingers. Some material can be crumbled by strong pressure between thumb and hard surface. Under light hammer blows disintegrate to a friable state.	0,5-2,0
Cemented	Material crumbles under firm blows of sharp pick point. Grains can be dislodged with some difficulty by a knife blade.	2,0-5,0
Strongly cemented	Firm blows of sharp pick point on hand-held specimen show 1-3mm indentations. Grains cannot be dislodged by knife blade.	5,0-10,0
Very strongly cemented	Hand-held specimen can be broken by single firm blow of hammer head. Similar appearance to concrete.	10,0-25

subdivisions of the Namaqua-Natal province. As the work produced by Cornell is regarded as the reference document, his approach is adopted for this report.

Some concepts must be identified :

- *Craton* : A craton is a block of ancient crust, formed 3000 million years ago and its rocks have essentially remained unchanged. Cratons form the larger parts of the land-building mass.
- *Province* : A tectono-stratigraphic province is defined as a large area of contiguous structural fabric with well-defined boundaries which formed during a particular, geochronologically defined, tectono-metamorphic event. A province is further subdivided in sub-provinces and sub-provinces into terranes.

COORDINATES – BOEGOEBERG		
System: WGS84 GW21		
Point	Y	X
A	86130.263	3201985.821
B	85564.856	3201176.796
C	85520.786	3201090.491
D	85496.243	3201016.226
E	85476.715	3200910.834
F	85473.190	3200843.903
G	85454.182	3200823.712
H	85431.175	3200821.983
J	85349.874	3200902.399
K	85200.000	3201143.777
L	85409.688	3201327.421
M	85677.145	3201561.938
N	85658.655	3201583.287
P	85719.196	3201637.562
Q	85544.703	3201833.961
R	85582.353	3201866.891
S	85455.099	3202010.506
T	85525.077	3202118.560
U	85464.649	3202175.231
V	85748.108	3202426.331

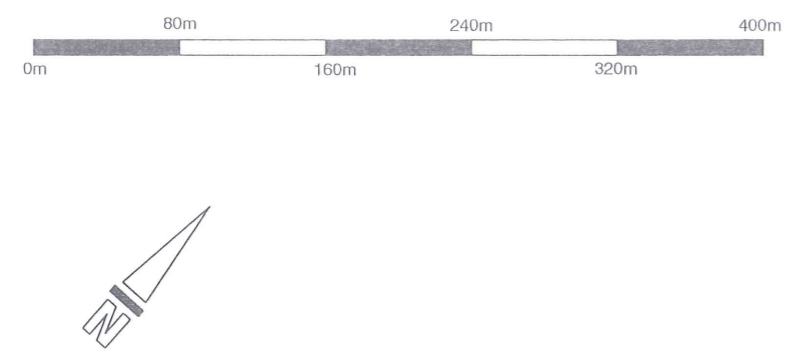
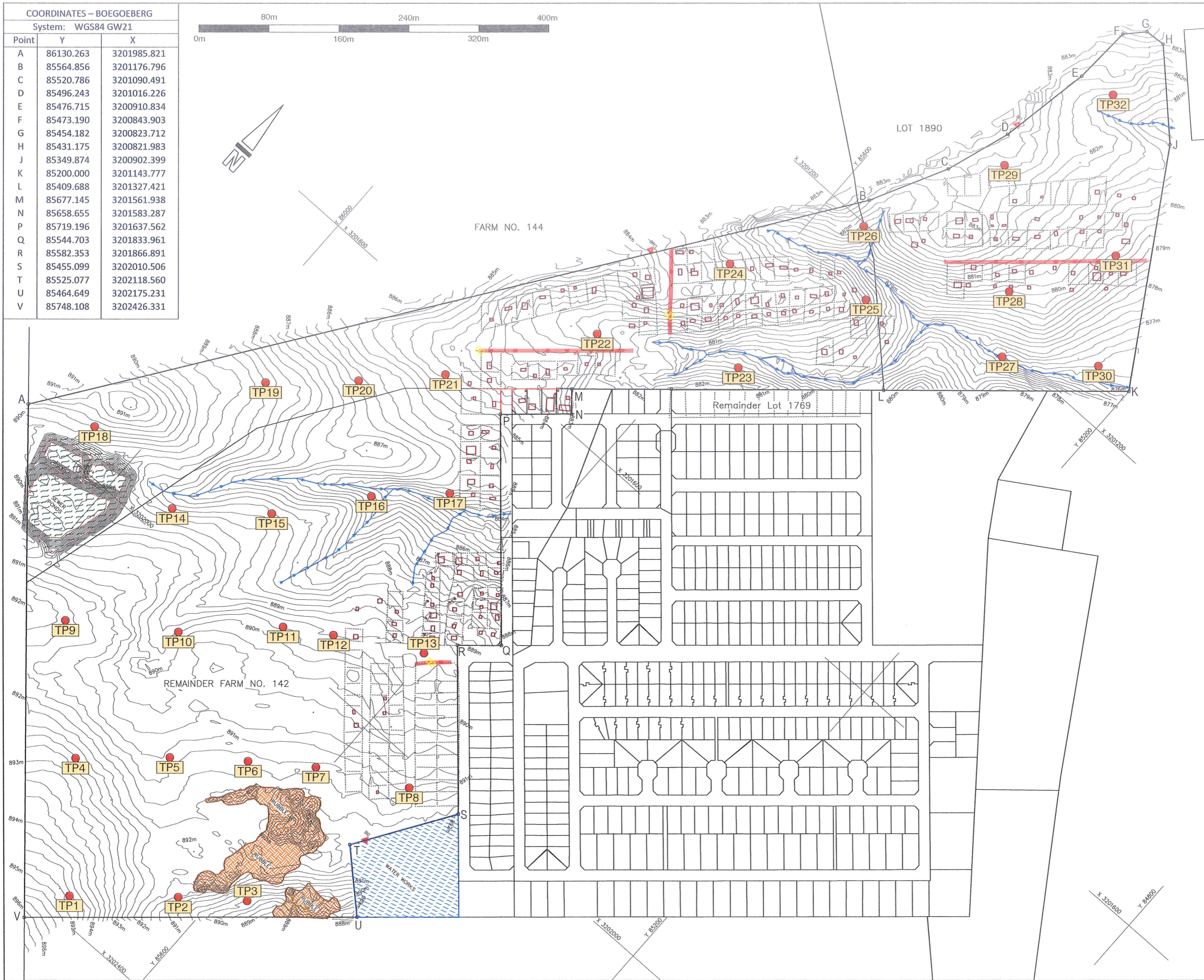


FIGURE 2 :
SITE PLAN

- LEGEND
- TEST PIT POSITION
 - RUBBLE
 - SEWER PONDS
 - WATER WORKS



Cedar Land Geotechnical Consult (Pty) Ltd
 POSBUS 607 CERES
 6885 SEL : 082 570-2767 (Frans) 082 373-2146 (Mariette)
 P O BOX 607 CERES 6885
 CELL : 082 570-2767 (Frans) 082 373-2146 (Mariette)
 EPOS/E-MAIL: cedarland.frans@breede.co.za (Frans) cedarland.mariette@breede.co.za (Mariette)

TAAK: Expansion and Formalisation of Boegoeberg Community
 LIGGING: Plot 1890, Boegoeberg Settlement and the Remainder of Farms 142 and 144
 KLIENT: IKheis Municipality

TEKENING NO: Figure 2 : Site Plan
 DRAWING NO:
 DATUM: 23 September 2020

TABLE 2 : SUMMARY OF SOIL TESTING

TEST PIT NO	SAMPLE NO (CLG)	DEPTH (mm)	SOIL ORIGIN	SOIL TYPE	GM	PI	LL	ACTIVITY	pH	CONDUCTIVITY (Sm ⁻¹)	% < 0,002mm	OMC	MDD	SOIL CLASS			
														COLTO	PRA	UNIFIED	
1	U9316	200-400	Hardpan calcrete	Sandy gravel	2,40	2	20	Low			0,9				A-1-a(0)		GM-GC
6	U9317	200-400	Hardpan calcrete	Sandy gravel	2,20	1	21	Low	7,78	0,13	0,5	9,3	2,033			G6	GC
10	U9318	100-500	Hardpan calcrete	Sandy gravel	2,10	3	22	Low			0,9						GC
13	U9315	150-500	Hardpan calcrete	Sandy gravel	2,30	4	26	Low	7,43	0,01	0,8						GM
15	U9319	0-100	Terrace gravels	Sandy gravel	2,30	6	25	Low	7,75	0,06	0,5	11,4	1841			G8	GM-GC
20	U9320	0-200	Terrace gravels	Sandy gravel	2,10	6	30	Low	7,84	0,08	1,2						GM
22	U9314	300-800	Terrace gravels	Sandy gravel	2,20	4	20	Low	7,63	0,19	2,5	4,3	2336			G6	GM-GM-GC
24	U9313	0-300	Terrace gravels	Sandy gravel	2,20	3	19	Low			0,7						GC
29	U9312	0-300	Rock fragments	Sandy gravel	2,20	4	23	Low			0,8						GC
30	U9311	0-300	Terrace gravels	Sandy gravel	2,10	2	18	Low	7,78	0,17	0,1						GC

- *Terrane* : A terrane is a term for a tectonostratigraphic unit, which is a fragment of crustal material formed on, or broken off from, one tectonic plate and accreted or "sutured" to crust lying on another plate. The crustal block or fragment preserves its own distinctive geologic history, which is different from that of the surrounding areas.

6.1 Regional Geology

The geological processes by which the area under consideration was shaped, initiated some 1000 million years ago with the formation of the supercontinent Rodinia. A mountain chain of global extent formed along the boundaries, underlain by metamorphic rocks that have since then been exposed due to erosion. Metamorphic rocks of this age formed across South Africa to the south and west of the Kaapvaal Craton, known as the Namaqua-Natal Province. The Namaqua-Natal Province can be divided into five tectonostratigraphic sub provinces and terranes, based on marked changes in the lithostratigraphy across structural discontinuities. The five domains so recognized are the Richtersveld Sub province, the Bushmanland Terrane, Kakamas Terrane, Areachap Terrane and Kaaien Terrane. The tectonic subdivision as proposed on Figure 2 (Cornell) is reproduced in this document as Figure 3.

The process of landforming can be described as compatible to the modern concept of plate tectonics. In this case the Namaqua plate became buried beneath the Kaapvaal Craton in a subduction zone. Considering the forces involved it can be regarded as a violent process, resulting in the breaking up of the landmass into the five domains as described above, associated with the intrusion of recycled rock material from the subduction zone. What is important for this report is that in the case of the Kaaien terrane, the formation of metaquartzites, deformed early Namaquan volcano-sedimentary rocks and deformed, but thermally metamorphosed bimodal volcanic rocks resulted, amongst others. These rocks are at present referred to amongst others as the Brulpan Group, on which Boegoeberg is located. There is controversy about the age of the Brulpan Group, but is estimated between 1710Ma to 1780Ma, underlying the Wilgenhoutsdrif Group.

The regional geology is indicated on Figure 4 : Regional Geology.

6.2 Site Geology

The site geology is illustrated on Figure 5. The soil and pedocretes form an ubiquitous cover over bedrock with only localized exposures in areas of thin and less dense pedocretic cover, thus hampering field investigations. The inferred material boundaries must be accepted as indicative of the actual conditions only.

Bedrock on site occurs as quartz-sericite schist and quartzite of the Groblershoop Formation, Brulpan Group. Localised outcrops of Dwyka Group tillite are present close to the site and extensive outcrops of Transvaal Supergroup sediments further to the east.

Measurements close to Boegoeberg show the strata of the Groblershoop Formation dip at 85° to the southwest in the area of investigation. The presence of a fault zone is indicated to the north of Boegoeberg, but not on in the village itself. However, such fault zone is covered by the pedocretes overlying bedrock, and extrapolating the strike of the fault zone, it may extend through the village.

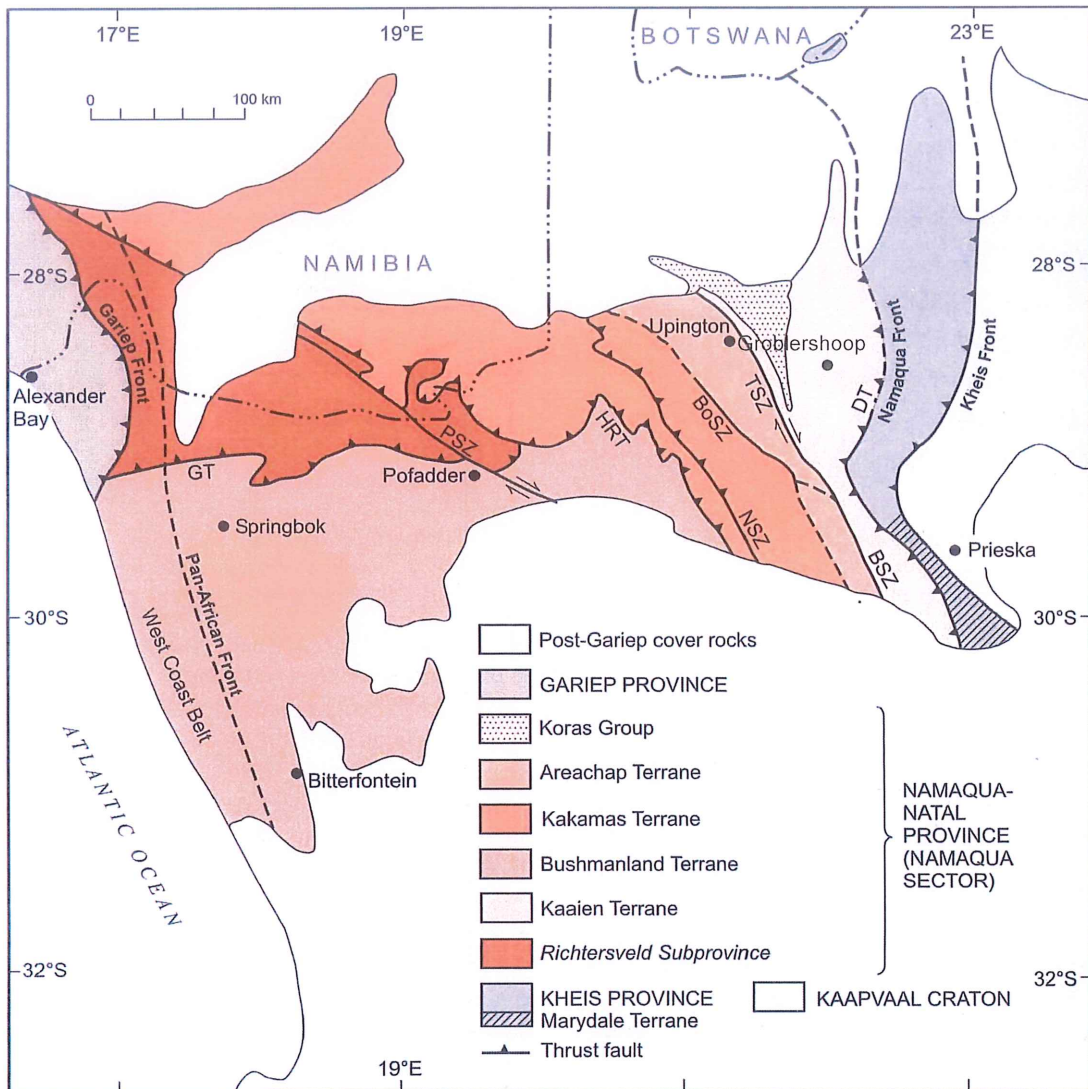
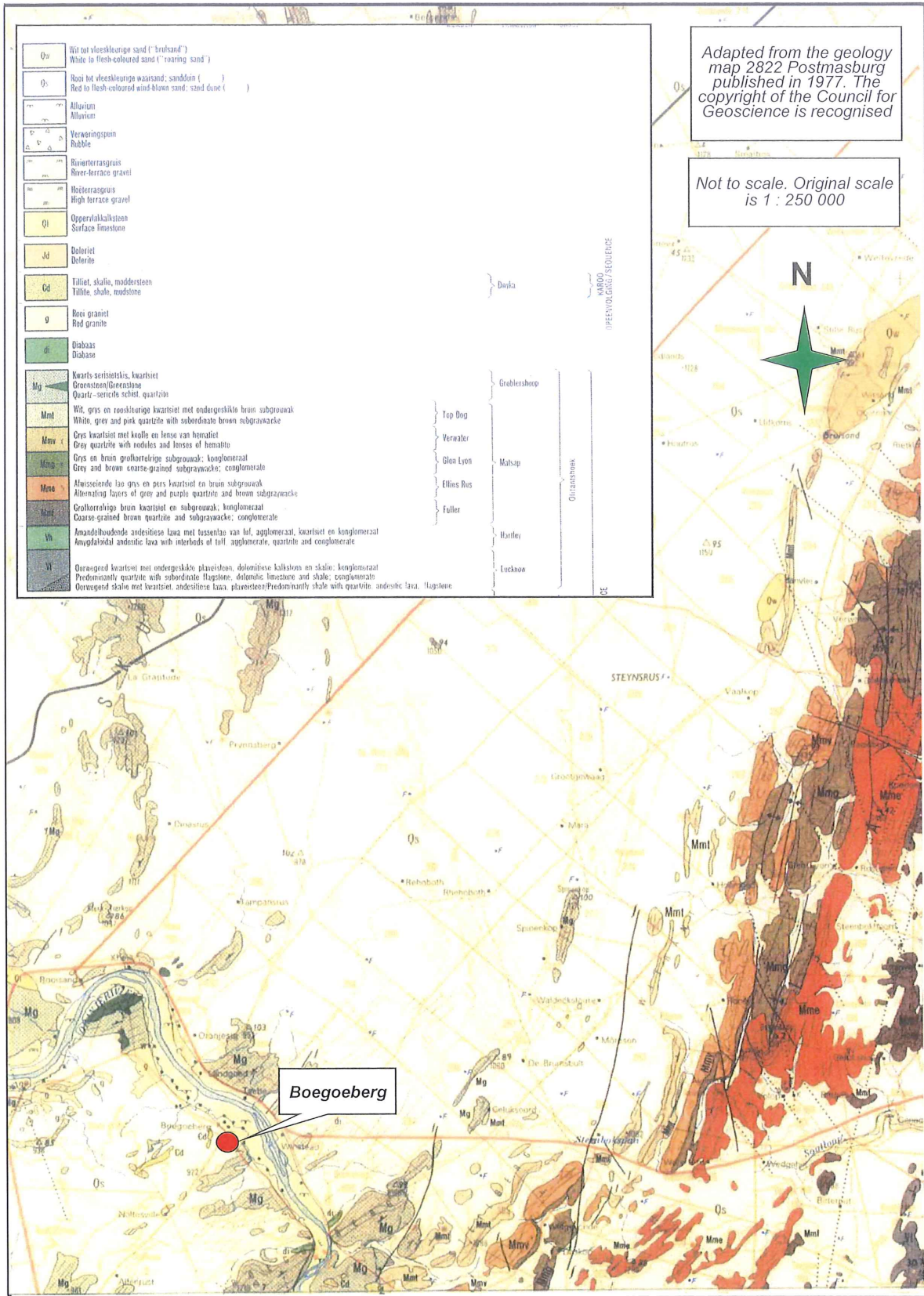


FIGURE 3 : TECTONIC SUBDIVISION OF THE NAMAQUA SECTOR

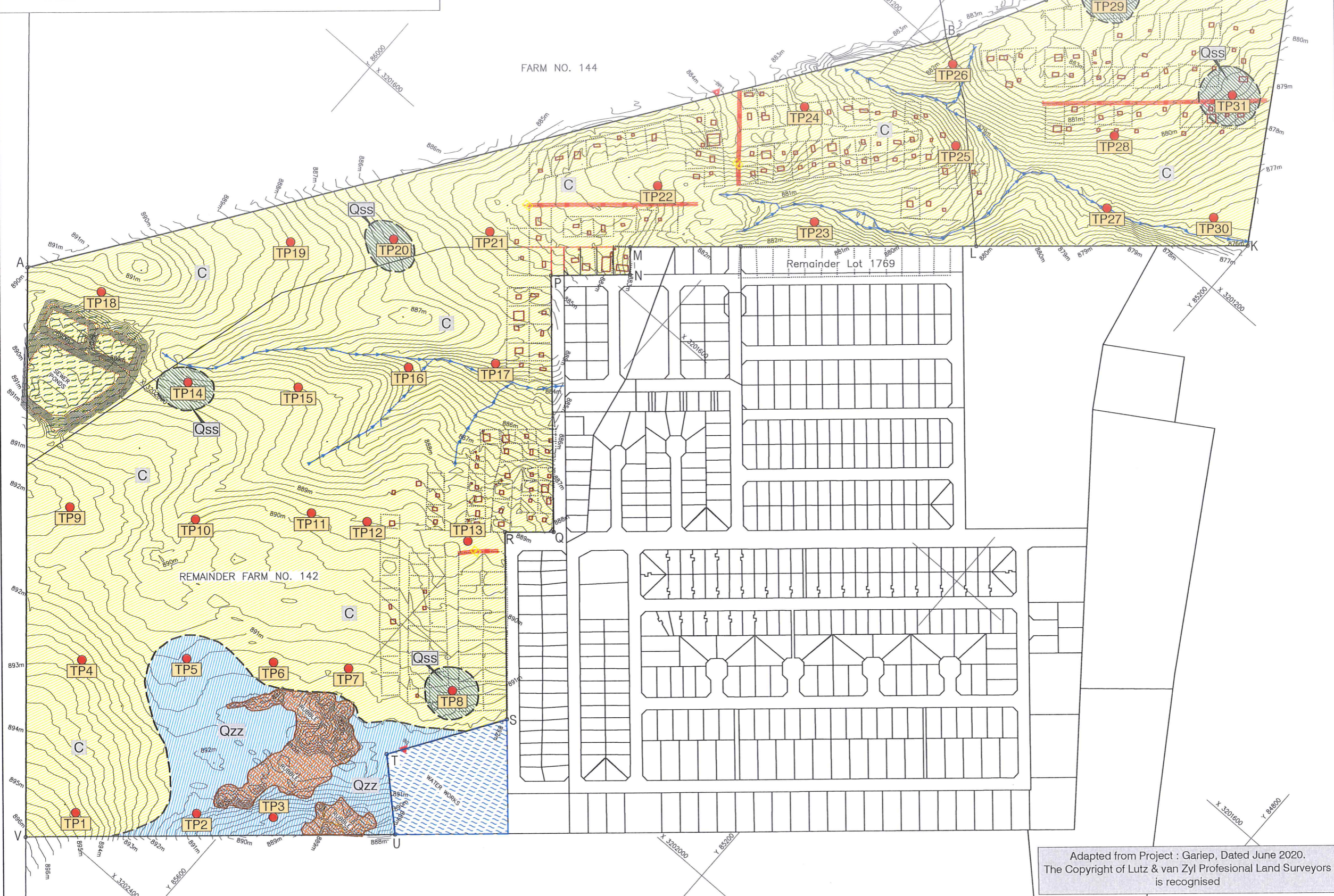
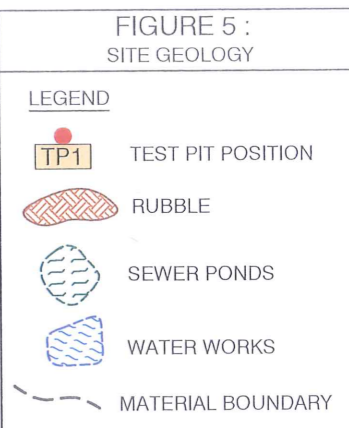
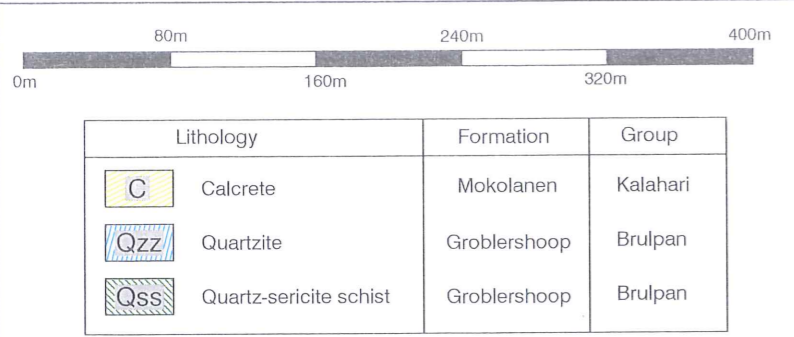
6.2.1 Quartz-sericite Schist

On site the quartz-sericite schist was exposed in TP's 8, 14, 20, 29 and 31, but elsewhere covered by a very dense horizon of hardpan calcrete. One can accept that quartz-sericite schist is the most widely distributed lithological material in the area. The quartz-sericite schist



BOEGOEBERG : REGIONAL GEOLOGY

FIGURE 4



Adapted from Project : Gariep, Dated June 2020.
The Copyright of Lutz & van Zyl Professional Land Surveyors is recognised

Cedar Land Geotechnical Consult (Pty) Ltd
 POSBUS 607 CERES 6835
 SEL : 082 570-2767 (Frans) 082 373-2146 (Mariette)
 P O BOX 607 CERES 6835
 CELL : 082 570-2767 (Frans) 082 373-2146 (Mariette)
 EPOS/E-MAIL: cedarland.frans@breede.co.za (Frans) cedarland.mariette@breede.co.za (Mariette)

TAAK: Expansion and Formalisation of Boegoeberg Community
 JOB NAME: Plot 1890, Boegoeberg Settlement and the Remainder of Farms 142 and 144
 KLIENT: !Kheis Municipality
 TEKENING NO: Figure 5 : Site Geology
 DATUM: 25 September 2020

is described as yellow-green, unweathered, hard rock, weathering to light grey-green, very closely jointed, very fine grained, very intensely laminated, slightly weathered, medium hard rock. Dark grey, needle like crystals of amphibole are present in the schist. Joints are open and filled with white, fine, calcareous sand.

6.2.2 Quartzite

A very prominent outcrop of quartzite was encountered close to the southern perimeter of the site. It was also encountered in TP's 2, 3 and 5. It is present as a band of light grey speckled black, medium jointed, fine grained, unweathered, very hard rock, striking east-west and dipping almost vertically. The discontinuities in the quartzite are closed, smooth and clean.

6.3 Soil Profile

The soil profile on site is of limited vertical extent. This condition can be attributed to several factors of which the presence of a surface horizon of calcrete is perhaps the most important. It provides a durable capping, protecting bedrock against the processes of weathering, be it due to mechanical or chemical agents. Another contributing factor is the combination of the dry climatic conditions and bedrock with a high quartz content and low basic mineral content. These rock materials are resistant against chemical decomposition in dry conditions and the high quartz content thereof ensure durability in hot and dry conditions. Surface materials that are present therefore consist of materials transported by the river and deposited in the wider surface bed thereof.

6.3.1 Terrace Gravels

Although the surface soil deposits may easily be regarded as alluvial sands transported by the Orange River, this is not the case. Moen (Reference 14.4 page 149) describes the presence of alluvium and terrace gravels associated with the Orange River as being present on the northeastern banks of the river in the area between Grootdrink and Groblershoop, To the southeast of Groblershoop, that is upstream of the river, the terrace gravels are encountered over a much wider area. This was confirmed during the investigation as the bulk of the surface soil deposits encountered consists of terrace gravels.

Terrace gravels were encountered in all test pits as a surface soil except in TP's 2, 3, 6, 8, 11, 13, 14 and 29. In TP 22 it underlies a surface horizon of alluvium. It is described as abundant clast supported, coarse, rounded gravels of banded ironstone and quartz in a matrix of light red brown, fine sand. The consistency of the terrace gravels is medium dense and the thickness of the horizon varies between 100mm and 800mm, but usually less than 400mm in the test pits. The presence of the banded ironstone clasts is regarded as the identifying factor

to classify the materials as transported gravels. These banded ironstone clasts originate from the Transvaal Supergroup along the course of the Orange River.

6.3.2 Alluvium

On site alluvium was encountered in TP 6, 8, 11, 14 and 22 as a surface horizon. The alluvial deposits proper are located closer to the course of the Orange River and are used as the soils sought after for agriculture in the area. The alluvium is described as light red to grey brown fine sand of loose consistency containing some gravels of calcrete. The thickness of the horizon varies between 100mm and 300mm in the test pits.

6.3.3 Mokalanen Formation

Calcrete of the Mokalanen Formation, Kalahari Group, is present as an ubiquitous surface duricrust on site. Again there is a difference in opinion between Moen (Reference 14.4 page 147) and Partridge^{Reference 14.5} regarding the origin of the calcrete. Moen regards the calcrete as being of Tertiary age, but some doubt whether the outcrops are of the same age and in some localities it may still be in the process of forming. Partridge describes the age of the calcrete as straddling the boundary between the Pliocene and Quaternary, making it some 2,6 to 2,8 million years old. It was deposited under arid conditions and possibly reflects a climatic interval of global aridification.

The engineering properties of calcrete may differ widely for samples taken from the same locality. It is therefore important to provide some background in this regard to aid in the understanding of these conditions.

Brink^{Reference 14.6} states that during pedocrete development, clay and silt become flocculated and cemented into larger silt to gravel-sized complexes of varying strength and porosity. These particles and aggregations may or may not break down during laboratory testing and under compaction. The mineralogy of the cementing material and of the clay fraction is different from those of normal, temperate zone soils on which current specifications for soil testing and classification is based. Calcrete can therefore be expected to exhibit differences in behaviour from those of traditional soil materials.

Whereas in traditional soil mechanics it is assumed that all the water is outside the particles, calcrete aggregates retain moisture and this affects conventional moisture content and Atterberg limit determinations. Palygorskite which is the dominant clay in calcrete has approximately the same plasticity index as some smectites, which can be regarded as highly expansive. However, the palygorskite has a non-expansive lattice and a hollow, needle-like shape instead of the usual flaky particle shape of most other clays. It has the lowest

shrinkage limit and dry density and the highest optimum moisture content and shear strength of all clays.

Be it as it may, calcrete was encountered as the dominant lithic material on site, in virtually a continuous cover over the Groblershoop Formation, with the schist and quartzite outcropping occasionally only in limited areas of localized extent. The calcrete is present as very dense hardpan calcrete and was encountered in TP's 1, 4, 6, 7, 9 to 13, 15 to 19, 21 to 28, 30 and 32. It underlies the terrace gravels and alluvium, occurring from depths between 100mm and 800mm minimum, extending to 200mm to 900mm maximum, at which stage refusal of excavation occurred. Minor outcrops of calcrete are present randomly across the site.

6.3.4 Fill

Areas of stockpiled material were encountered in the area enclosed by TP's 1 to 8, but surface rubble were distributed widely over the site. The fill consists mostly of household waste. Such waste is also present on the surface over a widespread area. The presence of these stockpiles are indicated on Figure 2 : Site Plan and illustrated on the photo sheet.

6.3.5 Residual Quartzite

Residual quartzite was encountered in TP's 2 and 3 only. It is described as light red brown fine sand with a variable content of cobbles of quartzite. The consistency of the residual quartzite is medium dense and it extended to a depth of 300mm in both test pits.

6.4 Groundwater

6.4.1 Perched Water

Perched groundwater was not encountered in any of the test pits excavated for this investigation. Considering the climate of the area and the nature of in situ materials, it is anticipated that perched water will generally not prove problematic on the site, except in the lesser drainage courses of the site after events of inundation. Even if it did occur, the grading of in-situ materials is such that dispersal will take place fairly rapidly. Furthermore, it is expected that perched water and/or surface seepage may occur shortly after precipitation events and in years of excessive rain only.

6.4.2 Permanent Groundwater

Vegter^{Reference 14.7} indicates the probability for drilling successfully for water in the area to be between 40% and 60%, and the probability that such a borehole will yield more than 2l/s is

between 10% and 20%. Groundwater is expected to occur at depths less than 15 meters in compact, argillaceous strata.

7 GEOTECHNICAL EVALUATION

The engineering properties of the in-situ materials are summarized in Table 3 : Summary of Engineering Properties. The characterizations have been derived based on the Unified materials classifications as reported by literature studies.

7.1 Engineering and Material Characteristics

7.1.1 Properties of Heave

The results of the materials testing as reported in Table 2 indicate the in-situ materials are not expansive. Any future structures will thus not be subject to heave. The content of active clay, that is the material smaller than 0,002mm in diameter, was tested as 2,5% maximum for Sample U9314, but in most cases it is less than 1%.

7.1.2 Properties of Settlement

7.1.2(i) Terrace Gravels

Terrace gravels were encountered in all test pits as a surface soil except in TP's 2, 3, 6, 8, 11, 13, 14 and 29. It is described as abundant clast supported, coarse, rounded gravels of banded ironstone and quartz in a matrix of light red brown, fine sand. The consistency of the terrace gravels is medium dense and the thickness of the horizon varies between 100mm and 800mm, but usually less than 400mm in the test pits. The properties of the terrace gravels are thus such that it does not tend to excessive settlement.

7.1.2(ii) Pedocretes

Calcrete was encountered as the dominant lithic material on site. The calcrete is present as very dense hardpan calcrete and was encountered in TP's 1, 4, 6, 7, 9 to 13, 15 to 19, 21 to 28, 30 and 32. It underlies the terrace gravels and alluvium, occurring from depths between 100mm and 800mm minimum, extending to 200mm to 900mm maximum, at which stage refusal of excavation occurred. Minor outcrops of calcrete are present randomly across the site. The material matrices are either intact or calcareous cemented. It can thus accommodate stresses imposed by conventional housing structures without undue settlement. Only limited – if any – settlement can thus be expected for structures such as single storey units of masonry construction.

TABLE 3 : SUMMARY OF ENGINEERING PROPERTIES

TEST PIT NO	SAMPLE NO	DEPTH (mm)	SOIL ORIGIN	SOIL TYPE	SOIL CLASS		COHESION ¹ (kNm ⁻²)	FRICTION ANGLE (°) ¹	COMPRESSIBILITY ²	EROSION RESISTANCE ²⁺⁵	PERMEABILITY ² k (cms ⁻¹)	SPECIFICATIONS FOR UNPAVED ROADS ³					SUITABILITY FOR ROAD CONSTRUCTION ⁴	
					PRA	UNIFIED						MAXIMUM SIZE	OVERSIZE INDEX (I ₆)	GRADING COEFFICIENT (G ₆)	SHRINKAGE PRODUCT (S _p)	CBR @ 95% MOD	PAVED	UNPAVED
1	U9316	200-400	Hardpan calcrete	Sandy gravel	A-1-a(0)	GM-GC	<5	28° to 40°	Negligible to very low	Highly variable	>3X10 ⁻⁷	37,5	4	16,2	24,0			Corrugates & ravel
6	U9317	200-400	Hardpan calcrete	Sandy gravel	A-1-b(0)	GC	<5	28° to 35°	Very low	3	>3X10 ⁻⁷	50,0	7	19,3	15,5	36	Subbase & base	Corrugates & ravel
10	U9318	100-500	Hardpan calcrete	Sandy gravel	A-1-b(0)	GC	<5	28° to 35°	Very low	3	>3X10 ⁻⁷	50,0	9	14,4	54,0			Corrugates & ravel
13	U9315	150-500	Hardpan calcrete	Sandy gravel	A-1-a(0)	GM	<5	30° to 40°	Negligible	4	>3X10 ⁻⁷	37,5	17	17,5	58,0			Corrugates & ravel
15	U9319	0-100	Terrace gravels	Sandy gravel	A-1-a(0)	GM-GC	<5	28° to 40°	Negligible to very low	Highly variable	>3X10 ⁻⁷	75,0	9	9,0	62,5	21	Selected	Corrugates & ravel
20	U9320	0-200	Terrace gravels	Sandy gravel	A-1-b(0)	GM	<5	30° to 40°	Negligible	4	>3X10 ⁻⁷	50,0	6	23,5	80,0			Corrugates & ravel
22	U9314	300-800	Terrace gravels	Sandy gravel	A-1-b(0)	GW-GM-GC	<5	28° to 40°	Negligible to very low	3 to 4	2,7X10 ⁻⁶ to 5X10 ⁻⁷	50,0	3	17,0	80,0	33	Subbase & base	Corrugates & ravel
24	U9313	0-300	Terrace gravels	Sandy gravel	A-1-a(0)	GC	<5	28° to 35°	Very low	3	>3X10 ⁻⁷	37,5	6	13,9	45,0			Corrugates & ravel
29	U9312	0-300	Rock fragments	Sandy gravel	A-1-a(0)	GC	<5	28° to 35°	Very low	3	>3X10 ⁻⁷	28,0	0	20,8	58,0			Corrugates & ravel
30	U9311	0-300	Terrace gravels	Sandy gravel	A-1-b(0)	GC	<5	28° to 35°	Very low	3	>3X10 ⁻⁷	50,0	9	14,2	54,0			Corrugates & ravel

1 Obrzud RF and Truty A : The Hardening Soil Model - A Practical Guidebook, 2018 edition, revised 21 October 2018.
 2 Brink ABA et al : Soil Survey for Engineering, published in 1982.
 3 The Structural Design, Construction and Maintenance of Unpaved Roads (Draft TRH 20), Committee of State Road Authorities 1990.
 4 Structural Design of Flexible Pavements for Interurban and Rural Roads (Draft TRH 4), Committee of State Road Authorities 1996.
 5 Erosion resistance : 1 is best 10 is poor.

7.1.2(iii) Alluvium

On site alluvium was encountered in TP 6, 8, 11, 14 and 22 as a surface horizon. The alluvium is described as light red to grey brown fine sand of loose consistency containing some gravels of calcrete. The thickness of the horizon varies between 100mm and 300mm in the test pits. Due to its consistency the alluvium can be regarded as moderately compressible. However, the vertical extent of the horizon of alluvium is limited to less than 400mm and ultimately will not influence foundation design.

7.1.2(iv) Residual Quartzite

Residual quartzite was encountered in TP's 2 and 3 only. It is described as light red brown fine sand with a variable content of cobbles of quartzite. The consistency of the residual quartzite is medium dense and it extended to a depth of 300mm in both test pits. Only limited – if any – settlement can thus be expected for structures such as single storey units of masonry construction.

7.1.3 Corrosivity

When discussing soil corrosivity, it is applicable to consider the guidelines as proposed by EvansReference^{14,8}. The corrosivity of a soil towards buried, exposed, metallic surfaces is dependent on the following properties of the soil :

- Electrical conductivity.
- Chemical properties of the soil.
- Ability of the soil to support sulphate reducing bacteria.
- Heterogeneity of the soil.

The tests carried out for the compilation of this report must be considered as indicative of the corrosivity of the soils only. The pH of a soil gives an indication of potential acid related problems. Should the soil pH be less than 6,0, corrosion may take place ; and should the pH be less than 4,50, the problem of corrosion may be serious. If the conductivity of the soil is less than $0,01\text{Sm}^{-1}$, corrosiveness is generally not a problem. However, the potential for corrosivity of the soil increases with an increase in conductivity. Should the conductivity of the soil exceed $0,05\text{Sm}^{-1}$, the soil can be regarded as very corrosive. Should exposed metal pipes pass from argillaceous soils to arenaceous soils or vice versa, electrochemical cells are set up due to the different rates of oxygen diffusion of the soils. Sulphate reducing bacteria is usually present under anaerobic conditions, that is, typically saturated or waterlogged clays.

The results of the chemical testing carried out for this report indicate the following :

- *Acidity* : The pH of the samples of material tested varied between 7,43 and 7,78. The soils are thus regarded as not corrosive due to the acidity there of.
- *Water Soluble Salts Content* : The conductivity of the samples of material tested varied from 0,01Sm⁻¹ for Sample U9315 (hardpan calcrete) to 0,19Sm⁻¹ for Sample U9314 (terrace gravels). With the exception of Sample U9315 the conductivity of all samples tested exceeded 0,05 Sm⁻¹ and can thus be regarded as corrosive due to high soluble salts contents.

Other considerations are :

- *Heterogeneity of the Soil* : Conditions of corrosive soils due to a heterogeneous soil profile do not occur on the property.
- *Water Logged Soils* : Conditions of water logged soils were not encountered on site.

7.1.4 Materials Utilisation

7.1.4(i) Backfilling of Service Trenches

The hardpan calcrete is not suitable to be used for any type of backfill due to its tendency to break into boulder and cobble sized fragments on excavation. Such fragments cannot be compacted properly on backfilling.

The terrace gravels and alluvium can be used for normal backfilling of services trenches. However, due to the coarse granular composition thereof these materials are not suitable for pipe bedding or selected backfill around pipes.

7.1.4(ii) Construction of Paved or Segmental Block Streets

Only provisional indicators for future guidance of development are provided as far as material quality for road construction is concerned, complying with the requirements applicable to the level of investigation.

The results of the compaction testing on samples of terrace gravels show it to be generally of G6 to G8 quality. The material is therefore suitable for the construction of selected layerworks for lightly trafficked access roads in townships, and with selection it may be used as material for the construction of subbase and base course material.

The results of the compaction testing on a sample of hardpan calcrete show it to be of G6 quality. The material is therefore suitable for the construction of subbase and base course layerworks for lightly trafficked access roads in townships.

7.1.4(iii) Wearing Course for Urban Gravel Roads

The properties to provide guidance for the use of soil materials for the structural design of a wearing course for urban gravel roads are contained in the various sub-columns of the column "Specifications for Unpaved Roads" in Table 3. The various parameters are colour-coded : Green = suitable ; red = unsuitable. The two sub-columns with a light yellow-brown background contain the parameters on which the physical behaviour of the wearing is course is determined.

From the table it is clear that none of the in-situ materials comply in all aspects to the requirements for a gravel wearing course. In most cases the use of these materials will result in a wearing course subject to raveling and corrugations. This can be attributed the non-cohesive character of most of the materials.

7.1.5 Other Considerations

The properties discussed in this subsection of the report were obtained from literature reported values based on studies done by the US Army Corps of Engineers as reported by Brink^{Reference 14.9} for compacted material. This approach is followed as the arenaceous character of the in-situ materials that did not allow the retrieval of undisturbed sampling. The typical soil properties associated with the Unified classifications of the materials are thus reported.

7.1.5(i) Compressibility

The compressibility of the material can be regarded as a necessary input to pavement design as well as lesser important supporting information for geotechnical classification for site class designation.

- *Terrace Gravels* : The terrace gravels can be regarded negligible to very low compressible with cohesion (c_0) of less than $5,0\text{kNm}^{-2}$ and the effective stress envelope approximately 28° to 40° .
- *Hardpan Calcrete* : The hardpan calcrete is regarded as negligible to very low compressible with cohesion (c_0) of less than $5,0\text{kNm}^{-2}$ and the effective stress envelope approximately 28° to 40° .

- *Quartz-sericite Schist Fragments* : The rock fragments can be regarded as very low compressible with cohesion (c_0) of less than $5,0\text{kNm}^{-2}$ and the effective stress envelope approximately 28° to 35° .

7.1.5(ii) Permeability

Permeability is an important parameter in the design of surface drainage and seepage drains. As such indicators in this regard are provided.

- *Terrace Gravels* : The terrace gravels can be regarded as semi-pervious to impervious. The soil permeability coefficient varies between $2,7 \times 10^{-6} \text{cms}^{-1}$ and $5,0 \times 10^{-7} \text{cms}^{-1}$.
- *Hardpan Calcrete* : The hardpan calcrete can be regarded as semi-pervious to impervious. The soil permeability coefficient exceeds $3,0 \times 10^{-7} \text{cms}^{-1}$.
- *Quartz-sericite Schist Fragments* : The rock fragments can be regarded as impervious. The soil permeability coefficient exceeds $3,0 \times 10^{-7} \text{cms}^{-1}$.

7.1.5(iii) Erosion Potential

All soil materials encountered during the investigation can be regarded as moderately to highly resistant against erosion, although vulnerable to erosion. The aspect of erosion potential is important in the area. The thin soil cover of terrace gravels and residual soils is indicative of erodible soil, which may be partially attributed to the low clay content of the soil materials. The net result of these properties is favourable founding conditions on the horizons of terrace gravels and competent hardpan calcrete.

7.2 Properties of Bedrock

The TLB used to excavate the test pits did not penetrate hardpan calcrete or bedrock of schist or quartzite to any significant extent and refusal of excavation occurred within millimeters after encountering these materials. It is not customary to penetrate bedrock in the case of a geotechnical investigation for purposes of a residential development. Refusal of excavation on hard rock is accepted as suitable. One can thus accept bedrock to be hard tending to very hard once refusal of excavation was encountered.

7.2.1 Calcrete

Voided matrices were occasionally encountered in the boulder calcrete, but not in the hardpan calcrete during the investigation. The results of the materials testing on samples of the hardpan calcrete approach that of the nodular calcrete. However, it must be borne in mind that in in-situ conditions the properties of hardpan calcrete approaches that of soft rock rather

than a gravelly sand. The grading modulus of the samples of hardpan calcrete fragments tested as 2,10 to 2,40 ; plasticity index between one and four ; and active clay content as 0,9% maximum. The activity of the hardpan calcrete is described as low. The PRA classification of the calcrete is A-1-a(0) to A-1-b(0) ; and the Unified classification is GM-GC. Based on these properties and material classification the hardpan calcrete is regarded as non-expansive and no consolidation settlement and no collapse settlement can thus be expected for structures such as single storey units of masonry construction.

The test results of the samples of hardpan calcrete reflect the properties of excavated fragments of material and not the intact mass of hardpan calcrete. It is therefore accepted that the properties of the very dense calcrete can be considered as tending towards soft rock to medium hard rock, limestone.

Brink (Reference 14.6) reports an average UCS of 32MPa for intact samples of hardpan calcrete from the Kalahari region. Using this as input to parametric calculations with Roclab software results for very dense calcrete tending to widely jointed, slightly weathered, medium hard rock, limestone result in the following properties :

- Cohesion : 1,08MPa
- Friction Angle : 24°
- Tensile Strength : 0,018MPa
- Uni-axle Compressive Strength : 550kPa
- Young's Modulus : 2340MPa

All which show a sound pedocrete, not compressible, not permeable nor subject to erosion.

7.2.2 Quartz-sericite Schist

Parametric calculations with Roclab software results for slightly weathered, very closely jointed, very intensely laminated, medium hard rock result in the following properties :

- Cohesion : 3,4MPa
- Friction Angle : 29,0°
- Tensile Strength : 0,07MPa
- Uni-axle Compressive Strength : 2,5MPa
- Young's Modulus : 8082,4MPa

The above calculations are for schists dipping at 90° with the horizontal plane. Should the angle of dip change the tensile strength, UCS and Young's modulus may change accordingly.

7.2.3 Quartzite

Parametric calculations with Roclab software results for unweathered, jointed, very hard rock result in the following properties :

- Cohesion : 11,0MPa
- Friction Angle : 36,6°
- Tensile Strength : 0,35MPa
- Uni-axle Compressive Strength : 14,1MPa
- Young's Modulus : 21435MPa

All which show a sound, very hard and durable rock.

7.3 Excavation Classification with Respect to Services

7.3.1 Hand Excavation

7.3.1(i) Terrace Gravels

The terrace gravels can be considered as suitable to be excavated by swing tools.

7.3.1(ii) Alluvium

The alluvium can be considered as suitable to be excavated by swing tools.

7.3.1(iii) Residual Quartzite

The residual quartzite can be considered as suitable to be excavated by swing tools, although the presence of cobbles of quartzite may tend to increase the level of difficulty of such exercise.

7.3.1(iv) Pedogenic Deposits

The hardpan calcrete is of very dense consistency. Such material cannot be considered as suitable to be manually excavated and may as minimum require the use of a 55kW TLB, but preferably a 30 ton excavator to remove it on an economical basis.

7.3.1(v) Bedrock

Bedrock of quartz-sericite schist and quartzite cannot be excavated manually successfully.

7.3.2 Classification of Material for Machine Excavation

In terms of Table 5 of SANS 634 : 2012 the following is applicable :

7.3.2(i) *Restricted Excavation*

- *Soft Excavation* : The terrace gravels, alluvium and residual quartzite can be regarded as soft excavation. The combined thickness of these strata varied between 100mm and 800mm in the test pits, averaging 210mm prior to encountering conditions of intermediate or hard rock excavation.
- *Intermediate Excavation* : Refusal of excavation with a TLB occurred in most cases once very dense, hardpan calcrete or slightly weathered to unweathered rock was encountered. However, some penetration into the hardpan calcrete or quartz-sericite schist was possible and can be regarded as intermediate excavation. It was possible to penetrate between 100mm and 500mm into the hardpan calcrete and quartz-sericite schist, averaging 210mm thick, prior to encountering hard rock excavation.
- *Hard Rock Excavation* : Refusal of excavation occurred on conditions of hard rock excavation in all the test pits at depths varying between 200mm and 900mm, averaging 450mm.

From the above it is clear that the transition of conditions of excavation is very rapid from soft to hard rock excavation with virtually no intermediate excavation.

7.3.2(ii) *Non-restricted Excavation*

The classification as per subparagraph 7.3.2(i) : Restricted Excavation as above is also applicable for non-restricted excavation.

7.4 Seismicity

A 10% probability of an event with magnitude less than 100cms^{-2} to take place once in 50 years is regarded as favourable ; and a natural seismic activity with magnitude exceeding 100cms^{-2} is regarded as unfavourable. Based on a report compiled by Kijko^{Reference 14.10} a 10% probability exists that an earthquake with Peak Ground Acceleration exceeding of 0,04g may take place once in 50 years in Boegoeberg.

The closest source of seismic measurements to Boegoeberg under control of the Council for Geoscience is Tontelbos at $31^{\circ} 10' 12''\text{S}$ and $20^{\circ} 30' 00''\text{E}$.

- The annual probability for an earthquake with intensity of 4,5 on the Modified Mercalli Scale to occur in the area is less than $10^{-0,7}$; and with an intensity of 8,5 to occur the probability is $10^{-3,8}$.
- The annual probability for an earthquake with an acceleration of $10^{-1,9}g$ to occur in the area is less than $10^{-0,7}$; and with an acceleration of $10^{-0,75}g$ to occur in the area is less than $10^{-3,8}$.

To put the above information into perspective, Table 4 : Earthquake and Magnitude and Intensity, is attached to this report.

7.5 Undermining

The area of investigation is not undermined.

7.6 Dolomite Stability

The area of investigation is not subject to dolomite related instabilities.

8 SITE CLASS DESIGNATIONS

Based on the above discussions the property can be divided into three zones as per the guidelines posted by SANS 10400 : Section H^{Reference 14.11} . The zonation is indicated on Figure 6 : Site Class Designation.

8.1 Geotechnical Zone I

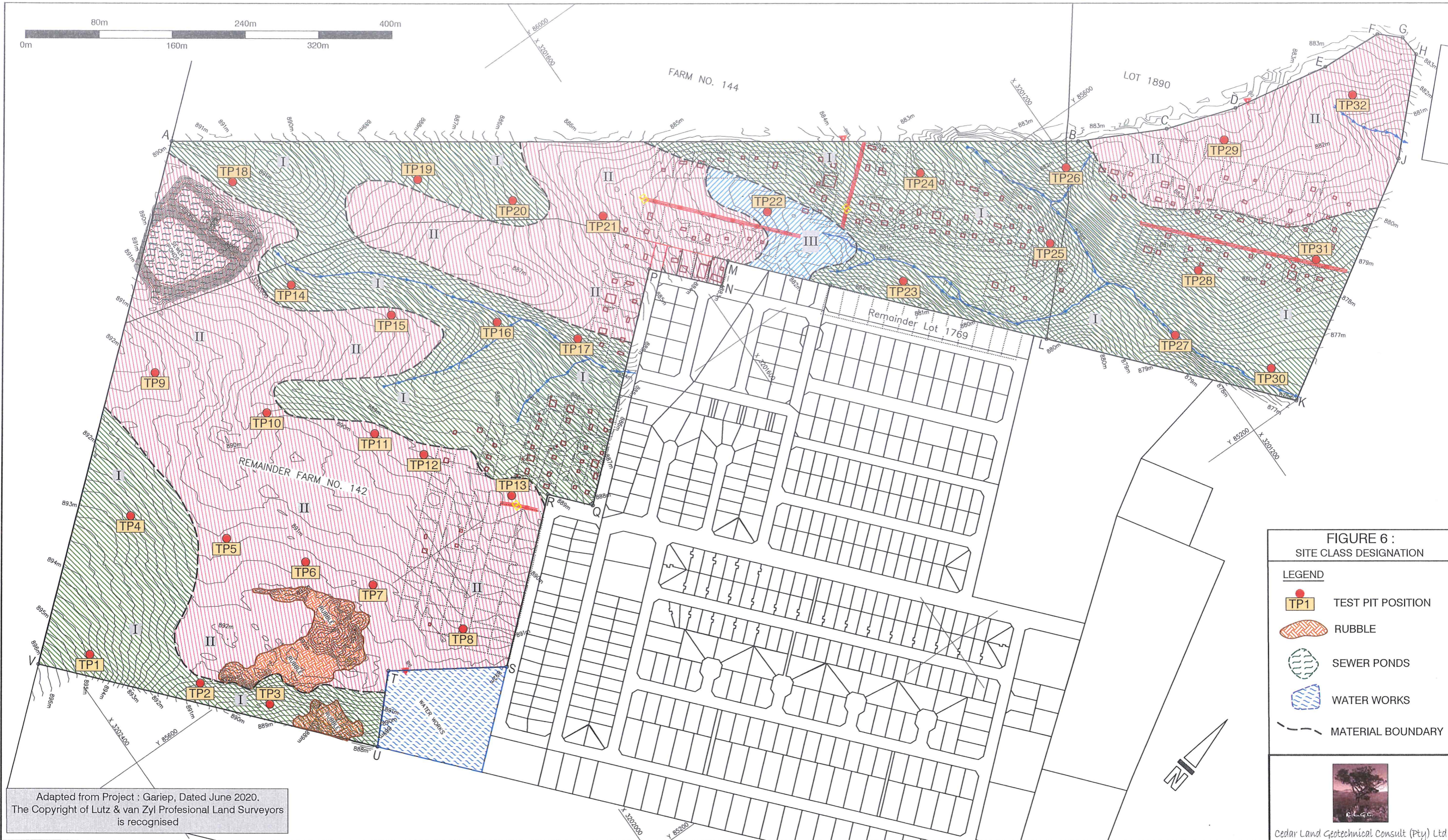
This zone comprises 48% of the area investigated. It is characterized by the materials profiles of TP's 1 to 4, 14, 16 to 20, 23 to 28 and 30 to 31. It covers the northern, central and southern parts of the site and the previously described water courses are contained within them. It consists of a superficial horizon less than 400mm thick comprising of terrace gravels and very dense calcrete less than 400mm thick overlying bedrock of quartz-sericite schist or quartzite. Several outcrops of calcrete occur in the area. Slope across the land is approximately between 2% and 6%. Foundation stresses induced by conventional strip foundations for single and double storey structures will result in almost negligible settlement if founded directly on the slightly weathered and unweathered hard rock to very hard rock, or on the very dense calcrete. The area is thus zoned as "R" and regarded as stable.

TABLE 4 : EARTHQUAKE MAGNITUDE AND INTENSITY

MODIFIED MERCALLI INTENSITY SCALE	INTENSITY	DESCRIPTION	RICHTER SCALE MAGNITUDE	RADIUS OF PERCEPTIBILITY (km)
I	Instrumental	Detected only by seismography		
II	Feeble	Noted only by sensitive people	3.5 to 4.2	3 to 24
III	Slight	Like the vibrations due to a passing lorry. Felt by people at rest, especially on upper floors		
IV	Moderate	Felt by people while walking. Rocking of loose objects, including vehicles	4.3 to 4.8	24 to 48
V	Rather strong	Felt generally ; most sleepers are awakened and bells ring		
VI	Strong	Trees sway and suspended objects swing ; damage by overturning and fling of loose objects	4.9 to 5.4	48 to 112
VII	Very strong	General public alarm ; walls crack ; plaster falls	5.5 to 6.1	110 to 200
VIII	Destructive	Car drivers seriously disturbed; masonry fissured ; buildings damaged	6.2 to 6.9	200 to 400
IX	Ruinous	Houses collapse ; pipes break		
X	Disasterous	Ground cracks badly ; buildings destroyed ; railway lines bent ; landslides on steep slopes	7.0 to 7.3	400 to 700
XI	Very disasterous	Few buildings remain standing; bridges destroyed ; all services out of action ; great landslides and floods	7.4 to 8.1	400 to 700
XII	Catastrophic	Total destruction ; objects thrown into the air; ground rises and falls in waves	>8.1	400 to 700

8.2 Geotechnical Zone II

This zone comprises 50% of the area investigated. It is characterized by the materials profiles of TP's 5 to 13, 15, 21, 29 and 32. It is present as localized flat plateaus between the sloping land of Geotechnical Zone I. It consists of a superficial horizon less than 400mm thick comprising of terrace gravels and very dense calcrete less than 400mm thick overlying



Adapted from Project : Gariep, Dated June 2020.
The Copyright of Lutz & van Zyl Professional Land Surveyors is recognised

**FIGURE 6 :
SITE CLASS DESIGNATION**

LEGEND

- TP1** TEST PIT POSITION
- RUBBLE
- SEWER PONDS
- WATER WORKS
- MATERIAL BOUNDARY

Cedar Land Geotechnical Consult (Pty) Ltd
PO BOX 607
CERES
6835
SEL : 082 570-2767 (Frans)
082 373-2146 (Mariette)
EPOS/E-MAIL: cedarland.frans@breede.co.za (Frans)
cedarland.mariette@breede.co.za (Mariette)

FOUNDATION DESIGN, BUILDING PROCEDURES AND PRECAUTIONARY MEASURES

AREA	AREA OF PROPERTY (%)	GEOTECHNICAL CLASS	ESTIMATED SOIL MOVEMENT(mm)	SOIL PROFILE	CONSTRUCTION TYPE	FOUNDATION DESIGN	ASSOCIATED PROBLEMS	DEVELOPMENT POTENTIAL
I	48,37	R	Negligible	Less than 400mm of terrace gravels overlying bedrock and pedogenic deposits	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Founding to take place on very dense pedocretes or bedrock	Conditions of hard rock excavation. Landslope between 2% and 6% favours strip footing foundations	Intermediate
II	49,80	R	Negligible	Less than 400mm of terrace gravels overlying bedrock and pedogenic deposits	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Founding to take place on very dense pedocretes or bedrock.	Conditions of hard rock excavation. Landslope less than 2% favours slab-on-the-ground foundations.	Intermediate
III	1,83	S	0mm to 10mm compression settlement	More than 400mm of terrace gravels overlying bedrock and pedogenic deposits	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Founding to take place on medium dense terrace gravels or very dense hardpan calcrete Foundation bearing pressure not to exceed 50kPa. Good site drainage.	Conditions of hard rock excavation. Landslope less than 2% favours slab-on-the-ground foundations.	Intermediate

TAASK: Expansion and Formalisation of Boegoeberg Community
JOB NAME:
LIGGING: Plot 1890, Boegoeberg Settlement and the Remainder of Farms 142 and 144
SITE:
KLIJNT: IKheis Municipality
CLIENT:
TEKENING NO: Figure 6 :
DRAWING NO: Site Class Designation
DATE: 23 September 2020

bedrock of quartz-sericite schist. Several outcrops of calcrete occur in the area. Slope across the land is less than 2%. Foundation stresses induced by conventional strip foundations for single and double storey structures will result in almost negligible settlement if founded directly on the slightly weathered and unweathered hard rock to very hard rock, or on the very dense calcrete. The area is thus zoned as "R" and regarded as stable.

8.3 Geotechnical Zone III

This zone comprises 2% of the area investigated. The zone is present as a single area in the central-northern section of the property. It is characterized by the materials profiles of TP 22. It consists of a surface horizon of medium dense alluvial sand 300mm thick in the test pit, overlying medium dense terrace gravels to a depth of 800mm and very dense hardpan calcrete at depth. Slope across the land is less than 2%. Foundation stresses induced by conventional strip foundations for single and double storey structures will result in limited compression settlement less than 10mm if founded directly on the medium dense terrace gravels. As per the materials profile encountered in the test pits the thickness of the horizon of terrace gravels and underlying calcrete soil is sufficient to dissipate the stresses induced by the foundations effectively. The area is thus zoned as "S" and the materials strata can be regarded as compressible to a maximum of 10mm.

8.4 Other Considerations

The contents of this subparagraph 8.4 largely fall outside the scope of a geotechnical investigation and refer to the widespread presence of various types of waste as described briefly in subsections 4.5 and 6.3.4 of this document. However, it is given in good faith in an effort to find a solution to the presence of waste in the area. To implement these measures will require inputs from both the local municipal authorities as well as the community of Boegoeberg.

The excavation of a large pit locally to bury and cover the waste is an exercise requiring environmental, geotechnical and groundwater inputs, amongst others. The provision of such a facility may require a considerable period of time, costs and construction to finalise.

Therefore, two options can be considered to deal with this waste :

8.4.1 Disposal at a Waste Site

The waste material can be removed and disposed at a waste site. However, this creates logistical and legal issues. Loading and transporting the waste to Groblershoop may be possible if suitable facilities are available at this location. Transporting waste to Upington will

be expensive. It is also doubtful whether the waste sites at these two locations will accept the waste and can treat such a volume in a suitable manner.

8.4.2 Recycling

The suitability of the stockpiles of waste for recycling depends on the composition of the waste. Basically three components have been identified visually, namely :

- *Household Waste* : Including putrefied food, nappies, bubble sheet pill containers, clothing etc.
- *Recyclable Waste* : Including plastic beverage bottles, glass, various metals and wood.
- *Construction Waste* : This includes blocks of concrete, bricks and stockpiles of calcrete.

To solve the issue it can be considered to involve the community by separating the waste. As the household waste represents a much smaller volume than the entire bulk of waste, this may potentially be disposed of at either Uppington or Groblershoop. The recyclable may be sold. The construction waste can be crushed and used as fill material during construction. Such material may also be used as successfully as a gravel wearing course for streets in Boegoeberg.

8.4.3 Presence of Terrace Gravels

Terrace gravels are widely distributed in the area which is earmarked for residential development as well as stockpiled east of the site. These gravels consist of fragments of quartz and banded ironstone. There exists a big demand for such gravels as ornamental features in urban areas, especially for water-wise gardens. The community can benefit from the collecting and marketing these materials through a coordinated effort.

8.4.4 Obsolete Oxidation Dam

It is not sure whether the oxidation dam present in the northwestern corner of the area of investigation had ever been in operation. However, it is clear that the infrastructure is vandalized beyond a level of operation and it cannot be reinstated without extensive rehabilitation.

9 FOUNDATION RECOMMENDATIONS AND SOLUTIONS

The foundation design alternatives and ancillary issues as discussed in subparagraphs 9.1 and 9.3 below are summarized in Table 5 : Foundation Design, Building Procedures and Precautionary Measures. In some cases more than one foundation solution is offered in the

TABLE 5 : FOUNDATION DESIGN, BUILDING PROCEDURES AND PRECAUTIONARY MEASURES

AREA	AREA OF PROPERTY (%)	GEOTECHNICAL CLASS	ESTIMATED SOIL MOVEMENT (mm)	SOIL PROFILE	CONSTRUCTION TYPE	FOUNDATION DESIGN AND BUILDING PROCEDURES	ASSOCIATED PROBLEMS	DEVELOPMENT POTENTIAL
I	48	R	Negligible	Less than 400mm of terrace gravels overlying bedrock and pedogenic deposits	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Founding to take place on very dense pedocretes or bedrock	Conditions of hard rock excavation Landslope between 2% and 6% favours strip footing foundations	Intermediate
II	50	R	Negligible	Less than 400mm of terrace gravels overlying bedrock and pedogenic deposits	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Founding to take place on very dense pedocretes or bedrock	Conditions of hard rock excavation. Landslope less than 2% favours slab-on-the-ground foundations.	Intermediate
III	2	S	0mm to 10mm compression settlement	More than 400mm of alluvium and terrace gravels overlying bedrock and pedogenic deposits	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Founding to take place on medium dense terrace gravels or very dense hardpan calcrete Foundation bearing pressure not to exceed 50kPa Good site drainage	Conditions of hard rock excavation. Landslope less than 2% favours slab-on-the-ground foundations.	Intermediate

discussion below. Whichever option is used, the design must adhere strictly on the proposals of SANS 10400H. As geotechnical conditions favour the use of both alternatives, the decision of which option to use must be based on financial and practical considerations. In all cases service trenches shall not be excavated parallel to buildings within 1500mm of the building perimeter.

9.1 Geotechnical Zone I

The zone is classed as R, meaning that the proposed horizon for founding is stable and negligible soil movement is expected. The slope across the land varies between approximately 2% and 6%. Two founding alternatives can be considered :

9.1.1 Strip Foundations

The preferable founding alternative is foundations of 400mm wide strip footings placed directly on very dense hardpan calcrete or bedrock of quartz-sericite schist. Should the areas of the proposed dwellings not exceed 200m² foundations for internal non-loadbearing walls may consist of thickened floorslabs. Should this option be adopted the floorslabs shall be reinforced steel mesh.

9.1.2 Slab-on-the-ground Foundations

Considering the slope across the land of approximately 2% to 6% the use of slab-on-the-ground foundations may require additional works in the form of the construction of an engineered fill or cutting to establish a level platform for construction, but it still remains a viable alternative. This latter option of additional earthworks may be costly and hence is regarded as less attractive than conventional strip footings.

9.2 Geotechnical Zone II

The zone is classed as R, meaning that the proposed horizon for founding is stable and negligible soil movement is expected. Considering the limited slope across the land of less than 2% only and the favourable geotechnical site classification as per Section 8 above, two foundation design alternatives are applicable to the zone.

The two options can be discussed as follows :

9.2.1 Strip Foundations

Foundations of 400mm wide placed directly on the very dense hardpan calcrete may be used.

Should the areas of the proposed dwellings not exceed 200m² foundations for internal non-loadbearing walls may consist of thickened floorslabs. Should this option be adopted the floorslabs shall be reinforced steel mesh.

9.2.2 Slab-on-the-ground Foundations

This is the preferred method of founding. The solution of slab-on-the-ground foundations may only be used for dwellings less than 200m² in area. Edge beams shall be placed directly on the very dense hardpan calcrete.

Foundations for internal non-loadbearing walls shall consist of thickened floorslabs. The foundations shall not contain any changes in surface levels with steps exceeding 400mm and do not support any chimneys or walls which support concrete roofs.

9.3 Geotechnical Zone III

The zone is classed as S, meaning that less than 10mm of compression settlement may occur. Considering the slope across the land is less than 2% and the favourable geotechnical site classification as per Section 8 above, two foundation design alternatives are applicable to the zone.

The two options can be discussed as follows :

9.3.1 Strip Foundations

Foundations of 400mm wide placed directly on the medium dense terrace gravels or very dense calcrete may be used. Should the areas of the proposed dwellings not exceed 200m² foundations for internal non-loadbearing walls may consist of thickened floorslabs. Should this option be adopted the floorslabs shall be reinforced steel mesh.

9.3.2 Slab-on-the-ground Foundations

This is the preferred method of founding. The solution of slab-on-the-ground foundations may only be used for dwellings less than 200m² in area. Edge beams shall be placed directly on the very dense hardpan calcrete.

Foundations for internal non-loadbearing walls shall consist of thickened floorslabs. The foundations shall not contain any changes in surface levels with steps exceeding 400mm and do not support any chimneys or walls which support concrete roofs.

10 DRAINAGE

The water courses on site are contained in narrow and well-defined gullies of such extent that they do not influence the various geotechnical site class designations. They are therefore not zoned separately. However, the presence of these water courses must be taken into account and infrastructure established only in a safe distance from these features.

The slope of less than 2% in certain areas of the land is regarded as marginal and may result in problems with the design of stormwater and sewerage disposal systems depending on dissipation by gravity.

11 SPECIAL PRECAUTIONARY MEASURES

Some issues need to be resolved prior to residential development may take place on the land. The Cedar Land Geotechnical Consult appointment excludes the investigation of possible soil and groundwater contamination due to the presence of the obsolete oxidation dams. However, as a matter of due diligence this issue need to be considered in a geotechnical report. If the dam has never been in use the following contents of paragraph 11 can be ignored.

Even though no in-situ testing was conducted to determine whether the dam is responsible for, or has historically been responsible for soil or water contamination, it can be stated that such conditions may have occurred. It is a source of concern that one of the gullies drains directly into the village. Due to the relative absence of groundwater of any sort close to the surface and an impermeable barrier formed by the calcrete and bedrock it is unlikely that groundwater contamination may have taken place, but contamination of surface water could have occurred. Similarly could bacterial contamination of the surface soils have taken place.

It is thus essential that the developer ensure that the areas surrounding the features concerned be investigated by a suitably qualified professional practitioner to determine the absence/presence of contamination. Should it be found that contamination exists and that the oxidation dam will be reinstated in future, the facilities shall be upgraded to comply to modern legal requirements and applicable minimum distances between the facilities and residential developments maintained as per legal requirements and complying to the proposals of the investigating professional.

12 CONCLUSIONS

The property is regarded as being of intermediate suitability for residential development.

Founding conditions can be defined as R and S. The only factors that reduce the suitability of the land for development are :

- The presence of hard rock and very dense hardpan calcrete close to the surface. The presence thereof will result in conditions of hard excavation. On the other hand it provides conditions favouring conventional methods of founding.
- The limited slope of less than 2% in Geotechnical Zones II and III will have a detrimental influence on the design of stormwater disposal systems and sewerage reticulation.
- The presence of waste material need to be addressed.
- The issue of the vandalized oxidation dam need to be clarified.

The conclusions as based on the site conditions are summarized in Table 6 : Influence of Constraints per Geotechnical Zoning. This classification is based on the proposals of the document *Geotechnical Site Investigations for Housing Developments (Generic Specification GFSH-2)*, issued by the National Department of Housing in September 2002.

12.1 Stratigraphy

The available information shows that the area of investigation is located on a subduction zone dating approximately 1000 million years old. The zone is located between the lithology of the Kaapvaal Craton and the Namaqua-Natal mobile belt. The remains of the original geology in the area are referred to as the Kaaien Terrane and the site is located on the Groblershoop Formation of the Brulpan Group.

12.1.1 Quartz-sericite Schist

The quartz-sericite schist is described as yellow-green, unweathered, hard rock, weathering to light grey-green, very closely jointed, very fine grained, very intensely laminated, slightly weathered, medium hard rock. Dark grey, needle like crystals of amphibole are present in the schist. Joints are open and filled with white, fine, calcareous sand.

12.1.2 Quartzite

A very prominent outcrop of quartzite was encountered close to the southern perimeter of the site. It was also encountered in TP's 2, 3 and 5. It is present as a band of light grey speckled black, medium jointed, fine grained, unweathered, very hard rock, striking east-west and dipping almost vertically. The discontinuities in the quartzite are closed, smooth and clean.

TABLE 6 : INFLUENCE OF CONSTRAINTS PER GEOTECHNICAL ZONING

CONSTRAINT	KEY TO CLASSIFICATION			CLASSIFICATION PER GEOTECHNICAL ZONE		
	MOST FAVOURABLE (1)	INTERMEDIATE (2)	LEAST FAVOURABLE (3)	I	II	III
Collapsible soil	Any collapsible horizon or consecutive horizons totalling a depth of less than 750mm in thickness	Any collapsible horizon or consecutive horizons with a depth of more than 750mm in thickness	A least favourable situation for this constraint does not occur			
Seepage	Permanent or perched water table more than 1,5m below ground surface	Permanent or perched water table less than 1,5m below ground surface	Swamps and marshes			
Active soil	Low soil heave potential anticipated	Moderate soil heave potential anticipated	High soil heave potential anticipated			
Highly compressible soil	Low soil compressibility anticipated	Moderate soil compressibility anticipated	High soil compressibility anticipated			
Erodibility of Soil	Low	Intermediate	High			
Difficulty of excavation to 1,5m depth	Scattered or occasional boulders less than 10% of the 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			
Undermined ground	Undermining at a depth greater than 240m below surface, except where total extraction mining has not occurred	Old undermined areas to a depth of 90m to 240m below surface where slope closure has ceased	Mining within less than 90m to 240m of surface or where total extraction mining has taken place			
Dolomite and limestone stability	Possibly stable. Areas of dolomite overlain by Karroo rocks or intruded by sills. Areas of Black Reef rocks. Anticipated Inherent Risk Class 1	Potentially characterised by instability. Anticipated Inherent Risk Classes 2 to 5	Known sinkholes and dolines. Anticipated Inherent Risk Classes 6 to 8			
Steep slopes*	Between 2° and 6° in all regions	Slopes between 6° and 18° and less than 2° (Natal and Western Cape) Slopes between 6° and 12° and less than 2° (all other regions)	More than 18° (Natal and Western Cape) More than 12° (all other regions)			
Areas of unstable natural slopes*	Low risk	Intermediate risk	High risk (Especially in areas subject to seismic activity)			
Areas subject to seismic activity	10% probability of an event less than 100cms ⁻² within 50 years	Mining induced seismic activity more than 100cms ⁻²	Natural seismic activity more than 100cms ⁻²			
Areas subject to flooding	A "most favourable" situation for this constraint does not occur	Areas adjacent to a known drainage channel or floodplain with slope less than 1%	Areas with a known drainage channel or floodplain			

12.2 Soil Profile

12.2.1 River Terrace Gravels

It is described as abundant clast supported, coarse, rounded gravels of banded ironstone and quartz in a matrix of light red brown, fine sand. The consistency of the terrace gravels is medium dense and the thickness of the horizon varies between 100mm and 800mm, but usually less than 400mm in the test pits.

12.2.2 Alluvium

The alluvium is described as light red fine sand of medium dense consistency. The horizon extended to a maximum depth of 800mm in the test pits.

12.2.3 Mokalanen Formation

Calcrete of the Mokalanen Formation, Kalahari Group, is present as an ubiquitous surface duricrust on site, in virtually a continuous cover over the Groblershoop Formation, with the schist and quartzite outcropping occasionally only in limited areas of localized extent. The calcrete is present as very dense hardpan calcrete and was encountered in TP's 1, 4 to 7, 9 to 13, 15 to 19, 21 to 28, 30 and 32. It underlies the terrace gravels and alluvium, occurring from depths between 100mm and 800mm minimum, extending to 200mm to 900mm maximum, at which stage refusal of excavation occurred. Minor outcrops of calcrete are present randomly across the site.

12.2.4 Fill

Areas of stockpiled material were encountered in the area enclosed by TP's 1 to 8, but surface rubble were distributed widely over the site. The fill consists mostly of household waste. Such waste is also present on the surface over a widespread area.

12.2.5 Residual Quartzite

Residual quartzite was encountered in TP's 2 and 3 only. It is described as light red brown fine sand with a variable content of cobbles of quartzite. The consistency of the residual quartzite is medium dense and it extended to a depth of 300mm in both test pits.

12.3 Groundwater

12.3.1 Perched Water

Perched groundwater was not encountered in any of the test pits excavated for this investigation. It is anticipated that perched water will generally not prove problematic on the site.

12.3.2 Permanent Groundwater

The probability for drilling successfully for water in the area is between 40% and 60%, and the probability that such a borehole will yield more than 2l/s is between 10% and 20%. Groundwater is expected to occur at depths less than 15 meters in compact, argillaceous strata.

12.4 Conditions of Excavation

On average over the entire site bedrock or refusal of excavation on very dense hardpan calcrete or bedrock of quartzite and quartz-sericite schist was encountered at depths between 200mm minimum and 900mm maximum, averaging 450mm deep. The implication of this is that should trenches require excavated depths to 1000mm, 55% of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 70% of the excavation may be classified as hard.

12.5 Site Class Designation

It is concluded that the entire area is regarded as suitable for residential development as follows :

12.5.1 Geotechnical Zone I

The zone is classed as R, meaning that the proposed horizon for founding is stable and negligible soil movement is expected. The distribution thereof encompasses 48% of the proposed area for development. Slope across the land is approximately between 2% and 6%. The use of slab-on-the-ground foundations will require additional works in the form of the construction of an engineered fill or cutting to establish a level platform for construction. The more viable foundation alternative therefore remains founding by conventional strip foundations.

Geotechnical conditions related to foundation design can be regarded as favourable, but the conditions of hard rock excavation close to the surface detracts from the suitability of establishing services and overall the development potential is regarded as intermediate only.

12.5.2 Geotechnical Zone II

The zone is classed as R, meaning that the proposed horizon for founding is stable and negligible soil movement is expected. The distribution thereof encompasses 50% of the proposed area for development. Slope across the land is less than 2%. Considering the limited slope and the favourable geotechnical site classification, two foundation design alternatives are applicable to the zone, namely conventional strip foundations or slab-on-the-ground foundations placed directly on bedrock or very dense pedocrete.

Geotechnical conditions related to foundation design can be regarded as favourable, but the conditions of hard rock excavation close to the surface and slope less than 2% detract from the suitability of establishing services and overall the development potential is regarded as intermediate only.

12.5.3 Geotechnical Zone III

The zone is classed as S, meaning that the proposed horizon for founding is slightly compressible and rapid settlement less than 10mm is expected. The distribution thereof encompasses 2% of the proposed area for development. Slope across the land is less than 2%. Considering the limited slope and the favourable geotechnical site classification, two foundation design alternatives are applicable to the zone, namely conventional strip foundations or slab-on-the-ground foundations placed directly on medium dense terrace gravels.

Geotechnical conditions related to foundation design can be regarded as favourable, but the conditions of slope less than 2% detract from the suitability of establishing services and overall the development potential is regarded as intermediate only.

12.6 Land Slope

The average slope across 48% of the land is between 2% and 6%. In Geotechnical Zones II and III is the slope less than 2%, that is over 52% of the site. This slope of less than 2% has a detrimental influence on especially the design of a stormwater disposal system depending on gravity to dissipate of the surface water due to downpours. The land slope also affects the design of the sewerage disposal but to a lesser extent as the gradient of the pipes can be adjusted according to design requirements.

No steep slopes are present on the property.

12.7 Areas Subject to Flooding

The non-perennial water courses on site are contained in well-defined, narrow gullies and may be regarded as being of lesser importance, requiring no additional precautionary measures to ensure the safety of the population against flooding. The effects of the gully draining from the old oxidation dam into the village need to be addressed should the oxidation dam be commissioned again.

12.8 Materials Utilization

- *Trench Backfilling* : None of the materials are suitable for selected fill or pipe bedding. With exception of the hardpan calcrete all materials can be used for normal backfill.
- *Layerworks for Paved or Segmental Block Paving* : The in-situ materials are suitable for the construction of selected layerworks for lightly trafficked access roads in townships, and with selection it may be used as material for the construction of subbase and base course material.
- *Wearing Course for Gravel Roads in Urban Areas* : None of the soil materials are 100% suitable for this purpose. The use of these materials will generally result in a road surface subject to raveling and corrugations.

12.9 Other Considerations

- *Undermining* : The area is not subject to undermining.
- *Seismic Activity* : The Peak Ground Acceleration expected in 50 years is 0,10g. A low risk for the development of earth tremors therefore exist.
- *Soil Corrosivity* : The in-situ soils and pedocretes are not corrosive due to acidic properties. All soil materials can be regarded as corrosive due to high soluble salt contents.
- *Dolomite* : The area of investigation is not subject to any restrictions due to the presence of dolomite. Bedrock of dolomite does not occur in the area of investigation.

13 RECOMMENDATIONS

13.1 Foundation and Structural Design

Section 9 of this document provides guidelines for foundation and structural design. These guidelines are based strictly on the contents of SANS 10400H and the NHBRC Home Owners Manual published in 2015. It is recommended that development take place strictly according to these guidelines. More than one founding solution is applicable on the site, and the

property developer can base his choice on financial constraints.

13.2 Materials Utilization

- *Trench Backfill* : With exception of the hardpan calcrete, the in-situ materials may be used for normal backfill of trenches. The hardpan calcrete shall be spoilt or stockpiled for gravel wearing course construction and not used at all for this purpose. Material for pipe bedding and selected backfill shall be obtained from commercial sources.
- *Layerworks for Paved or Segmental Block Paving* : Material for subbase and base course construction may with selection be obtained from the in-situ material or otherwise from commercial sources. Depending on the pavement design, G6 or G8 material may have to be imported for the construction of selected layerworks. It is recommended that a centerline investigation consisting of test pitting and soil sampling be conducted to allow the consulting engineer to produce suitable pavement designs for the project.
- *Wearing Course for Gravel Roads in Urban Areas* : Material for the construction of a gravel wearing course shall be obtained from stockpiled or calcrete from a licensed borrow pit.

13.4 Conditions of Excavation

Although manual excavation is possible through the colluvium, residual soil and to some extent through the calcrete, it is considered as not an economic proposition, mostly due to the consistency and composition of the soil. Excavation through these soils shall require the use of a TLB rated at 55kW minimum, or preferably a 30 ton excavator of the very dense pedocretes need to be removed. It is recommended that adequate provision be made for hard rock excavation.

13.5 Land Slope

Slope across the 52% of the land is less than 2%. This is regarded as being of intermediate suitability for urban development only. This has an influence on especially the stormwater disposal system but to a lesser extent on the waste water design. In theory the slope of 2% to 6% on 48% of the land can be regarded as favourable for urban development, but the combination of the slope and presence of rock outcrops result in conditions less desirable for development.

13.6 Presence of the Oxidation Pond

It is recommended that the possible effects of the unused, obsolete oxidation pond on the proposed development be investigated. The future development must comply to legal

requirements to mitigate any negative effects that these facilities may have on the development of the site.

14 SOURCES OF REFERENCE

14.1 Mucina L et al : *The Vegetation of South Africa, Lesotho and Swaziland*, pages 335 and 336, published in 2006 by SANBI.

14.2 McCarthy T and Rubidge B : *The Story of Earth and Life*, pages 156 to 161, funded by Exxaro and published in 2006 by Struik Nature.

14.3 Cornell DH et al : *Section 16 The Namaqua-Natal Province, pages 325 to 380, as contained in the Geology of South Africa*, under editorship of MR Johnson, published by the Council for Geoscience in 2006.

14.4 Moen HFG : *The Geology of the Upington Area*, pages 72 to 87, published by the Council for Geoscience in 2007.

14.5 Partridge TC et al : *Section 29 Cenozoic Deposits of the Interior, pages 585 to 593, as contained in the Geology of South Africa*, under editorship of MR Johnson, published by the Council for Geoscience in 2006.

14.6 Brink ABA : *Engineering Geology of Southern Africa, Volume 4*, pages 294 to 295, published in 1985 by Building Publications, Pretoria.

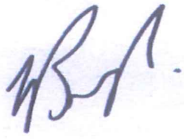
14.7 Vegter JR : *An Explanation of a Set of National Ground Water Maps*, published by the Water Research Commission, in August 1995.

14.8 Evans UR : *The Corrosion and Oxidation of Metals*, published by Edward Arnold in 1971.

14.9 Brink ABA et al : *Soil Survey for Engineering*, pages 38 to 39, published by Clarendon Press in 1982.

14.10 Kijko A et al : *Probabilistic Peak Ground Acceleration and Spectral Seismic Hazard Maps for South Africa*, Report 2003-0053 by the Council for Geoscience.

14.11 SANS 10400 : Section H Edition 3 pages 14 to 28.

A handwritten signature in blue ink, appearing to read 'FJ Breytenbach'.

FJ Breytenbach, Pr Eng

25 September 2020

For Cedar Land Geotechnical Consult (Pty) Ltd

**GEOTECHNICAL CONDITIONS ON PLOT 1890
BOEGOEBERG SETTLEMENT AND THE REMAINDERS
OF FARMS 142 AND 144: A REPORT FOR THE
EXPANSION AND FORMALISATION OF
BOEGOEBERG COMMUNITY**

2020/J09/MCP_01

ADDENDUM A: TEST PIT PROFILES

TRIAL HOLE: 1

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 11/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°56'05,7" S 22°07'14,8" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 400 mm on very dense hardpan calcrete.
0.20		Abundant, clast supported, medium coarse, rounded and subrounded GRAVELS of quartz and banded ironstone in a matrix of dry, light red brown, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.40		Dirty white, very fine grained, very dense, hardpan CALCRETE with minor voids filled with light red brown, fine sand. Pedogenic deposits.	U9316	0,2-0,4		
0.60						▽ Water encountered ▼ Water level ~ Bottom of hole --- Approximate material change • Disturbed sample ■ Undisturbed sample
0.80						
1.00						

Contractor: ALS Plant Hire

Date Drilled: 11/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 1

FIGURE: A1

TRIAL HOLE: 2

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 11/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°56'03,1" S 22°07'18,3" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 400 mm on very hard rock, quartzite.
0.20		Abundant, clast supported, angular <i>COBBLES</i> of dirty white quartzite in a matrix of dry, light red brown, fine sand. Overall consistency is medium dense. Residual quartzite.				
0.40		Light grey speckled black, medium jointed, fine grained, unweathered, very hard rock, <i>QUARTZITE</i> . Discontinuities are closed, smooth and clean.				
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 11/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 2

FIGURE: A2

TRIAL HOLE: 3

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 11/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°56'01,5" S 22°07'20,6" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

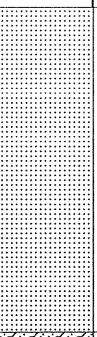
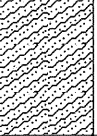
Ceres







6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 500 mm on very hard rock, quartzite.
0.20		Dry, light brown, loose, intact, fine SAND and matrix supported, angular, cobbles of grey quartzite. Overall consistency is medium dense. Residual quartzite.				
0.40		Light grey speckled black, medium jointed, fine grained, unweathered, very hard rock, QUARTZITE. Discontinuities are closed, smooth and clean.				
0.60						
0.80						
1.00						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 11/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 3

FIGURE: A3

TRIAL HOLE: 4	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i>
PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY	P O Box 607
LOGGED BY: FJB	Ceres
SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144	6835
	Cell: 082 570 2767
DATE LOGGED: 11/7/2020	Email:
CLIENT: !KHEIS MUNICIPALITY	cedarland.frans@breede.co.za
LOCATION: 28°56'01,7" S 22°07'11,2" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 400 mm on very dense hardpan calcrete.
0.20		Abundant, clast supported, medium coarse, rounded and subrounded GRAVELS of quartz and banded ironstone in a matrix of dry, light red brown, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.40		Dirty white, very fine grained, very dense, hardpan CALCRETE with minor voids filled with light red brown, fine sand. Pedogenic deposits.				
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 11/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1
SOIL PROFILE: TEST PIT 4	FIGURE: A4

TRIAL HOLE: 5

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 11/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'59,4" S 22°07'14,2" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

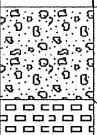

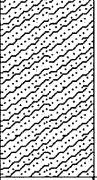
Ceres







6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 400 mm on very hard rock, quartzite.
		Abundant, clast supported, medium coarse, rounded and subrounded GRAVELS of quartz and banded ironstone in a matrix of dry, light red brown, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.20		Dirty white, very fine grained, very dense, hardpan CALCRETE with minor voids filled with light red brown, fine sand. Pedogenic deposits.				
		Dark grey, medium jointed, fine grained, unweathered, very hard rock, QUARTZITE. Discontinuities are open, smooth and filled with white, calcareous silt.				
0.40						
0.60						
0.80						
1.00						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 11/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 5

FIGURE: A5

TRIAL HOLE: 6

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 11/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'57,6" S 22°07'16,8" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607




Ceres







6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 400 mm on very dense hardpan calcrete.
0.20		Dry, light red, loose, intact, fine SAND and matrix supported, medium coarse, angular gravels of calcrete. Alluvium.				
0.40		Dirty white, very fine grained, very dense, hardpan CALCRETE with minor voids filled with light red brown, fine sand. Pedogenic deposits.	U9317	0-0,4		
0.60						
0.80						
1.00						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 11/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 6

FIGURE: A6

TRIAL HOLE: 7

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'56,1" S 22°07'19,1" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 400 mm on very dense boulder calcrete.
		Abundant, clast supported, coarse, rounded GRAVELS of banded ironstone and quartz in a matrix of dry, pale light grey, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.20						
		Dirty white, very fine grained, very dense, voided, boulder CALCRETE. Voids are filled with pale light grey brown sand. Pedogenic deposits.				
0.40						
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 7

FIGURE: A7

TRIAL HOLE: 8

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'54,4" S 22°07'22,6" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

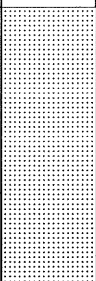
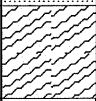
Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 400 mm on hard rock, quartz-sericite schist.
0.20		Dry, light grey brown, loose, intact, fine SAND and matrix supported, medium coarse, subrounded gravels of quartz and coarse, angular gravels of calcrete. Alluvium.				
0.40		Yellow green, closely jointed, very intensely laminated, very fine grained, unweathered, hard rock, quartz-sericite SCHIST. Discontinuities are open, smooth and filled with calcareous sand.				
0.60						
0.80						
1.00						

- ∇ Water encountered
- ↓ Water level
- ┌ Bottom of hole
- - - Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 8

FIGURE: A8

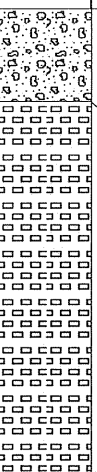
TRIAL HOLE: 9	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i>
PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY	P O Box 607
LOGGED BY: FJB	Ceres
SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144	6835
DATE LOGGED: 11/7/2020	Cell: 082 570 2767
CLIENT: !KHEIS MUNICIPALITY	Email:
LOCATION: 28°55'58,1" S 22°07'07,1" E	cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 400 mm on very dense hardpan calcrete.
0.20		Abundant, clast supported, medium coarse, rounded and subrounded GRAVELS of quartz and banded ironstone in a matrix of dry, light red brown, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.40		Dirty white, very fine grained, very dense, hardpan CALCRETE with minor voids filled with light red brown, fine sand. Pedogenic deposits.				
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 11/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1
SOIL PROFILE: TEST PIT 9	FIGURE: A9

<p>TRIAL HOLE: 10</p> <p>PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY</p> <p>LOGGED BY: FJB</p> <p>SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144</p> <p>DATE LOGGED: 11/7/2020</p> <p>CLIENT: !KHEIS MUNICIPALITY</p> <p>LOCATION: 28°55'55,7" S 22°07'11,0" E</p>	<p><i>Cedar Land Geotechnical Consult (Pty) Ltd</i></p> <p>P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za</p>
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p><u>NOTES:</u></p> <p>1 Refusal of excavation at 500 mm on very dense hardpan calcrete.</p>
0.20		Abundant, clast supported, medium coarse, rounded and subrounded GRAVELS of quartz and banded ironstone in a matrix of dry, light red brown, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.40		Dirty white, very fine grained, very dense, hardpan CALCRETE with minor voids filled with light red brown, fine sand. Pedogenic deposits.	U9318	0,1-0,5	●	
0.60						
0.80						
1.00						

<p>Contractor: ALS Plant Hire</p> <p>Date Drilled: 11/7/2020</p> <p>Machine: Bell 315SK</p>	<p>Hole Diameter: 600 mm</p> <p>Water Depth:</p> <p>Sheet: 1 of 1</p>
SOIL PROFILE: TEST PIT 10	FIGURE: A10

<p>TRIAL HOLE: 11</p> <p>PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY</p> <p>LOGGED BY: FJB</p> <p>SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144</p> <p>DATE LOGGED: 11/7/2020</p> <p>CLIENT: !KHEIS MUNICIPALITY</p> <p>LOCATION: 28°55'53,0" S 22°07'14,2" E</p>	<p><i>Cedar Land Geotechnical Consult (Pty) Ltd</i></p> <p>P O Box 607 Ceres 6835</p> <p>Cell: 082 570 2767</p> <p>Email: cedarland.frans@breede.co.za</p>
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p><u>NOTES:</u></p> <p>1 Refusal of excavation at 300 mm on very dense hardpan calcrete.</p>
		Dry, light red, loose, intact, fine SAND and matrix supported, medium coarse, angular gravels of calcrete. Alluvium.				
0.20		Dirty white, very fine grained, very dense, hardpan CALCRETE with minor voids filled with light red brown, fine sand. Pedogenic deposits.				<div style="border: 1px solid black; padding: 5px; margin-top: 20px;"> <ul style="list-style-type: none"> Water encountered Water level Bottom of hole Approximate material change Disturbed sample Undisturbed sample </div>
0.40						
0.60						
0.80						
1.00						

<p>Contractor: ALS Plant Hire</p> <p>Date Drilled: 11/7/2020</p> <p>Machine: Bell 315SK</p>	<p>Hole Diameter: 600 mm</p> <p>Water Depth:</p> <p>Sheet: 1 of 1</p>
SOIL PROFILE: TEST PIT 11	FIGURE: A11

TRIAL HOLE: 12

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'52,0" S 22°07'16,0" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 400 mm on very dense hardpan calcrete.
0.20		Abundant, clast supported, medium coarse, subrounded and subangular, GRAVELS of quartz in a matrix of dry, light yellow brown, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.40		Dirty white stained light yellow, very fine grained, very dense, hardpan CALCRETE. Pedogenic deposits.				
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 12

FIGURE: A12

TRIAL HOLE: 13

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'50,3" S 22°07'19,4" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

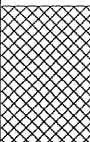



Ceres







6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface <i>FILL</i> : consisting of pieces of plastic, ½ bricks, wire and glass in a matrix of dry, light grey brown, fine sand. Overall consistency is loose. Made ground.				NOTES: 1 Refusal of excavation at 500 mm on very dense hardpan calcrete.
0.20		Dirty white stained light yellow, very fine grained, very dense, hardpan <i>CALCRETE</i> . Pedogenic deposits.				
0.40			U9315	0.15-0.5		
0.60						
0.80						
1.00						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 13

FIGURE: A13

TRIAL HOLE: 14

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 11/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'52,4" S 22°07'07,4" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607









Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 700 mm on hard rock, quartz-sericite schist.
0.20		Dry, light red, loose, intact, fine SAND and matrix supported, medium coarse, angular gravels of calcrete. Alluvium.				
0.40		Light grey green, very closely jointed, very intensely laminated, very fine grained, slightly weathered, medium hard rock, quartz-sericite SCHIST. Discontinuities are open, smooth and filled with white, calcareous silt. Discontinuities are vertically orientated.				
0.60						
0.80						 Water encountered  Water level  Bottom of hole  Approximate material change  Disturbed sample  Undisturbed sample
1.00						

Contractor: ALS Plant Hire

Date Drilled: 11/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 14

FIGURE: A14

TRIAL HOLE: 15

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 11/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'50,1" S 22°07'10,7" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 600 mm on very dense hardpan calcrete.
		Abundant, clast supported, medium coarse, rounded and subrounded GRAVELS of quartz and banded ironstone in a matrix of dry, light red brown, fine sand. Overall consistency is medium dense. Terrace gravels.	U9319	0-0,6		
0.20		Dirty white, very fine grained, very dense, hardpan CALCRETE with minor voids filled with light red brown, fine sand. Pedogenic deposits.				
0.40						
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 11/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 15

FIGURE: A15

TRIAL HOLE: 16

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 11/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'47,2" S 22°07'13,4" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607




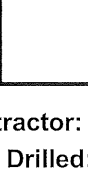
Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 900 mm on very dense hardpan calcrete.
0.20		Abundant, clast supported, medium coarse, rounded and subrounded GRAVELS of quartz and banded ironstone in a matrix of dry, light red brown, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.40						
0.60						
0.80		Dirty white, very fine grained, very dense, hardpan CALCRETE with minor voids filled with light red brown, fine sand. Pedogenic deposits.				▽ Water encountered ↓ Water level ⊥ Bottom of hole ~ Approximate material change • Disturbed sample ■ Undisturbed sample
1.00						

Contractor: ALS Plant Hire

Date Drilled: 11/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 16

FIGURE: A16

TRIAL HOLE: 17

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'45,2" S 22°07'15,8" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

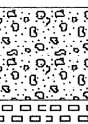

Ceres







6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 200 mm on very dense hardpan calcrete.
		Abundant, clast supported, medium coarse, rounded and subrounded GRAVELS of quartz and banded ironstone in a matrix of dry, light grey, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.20		Dirty white stained light yellow, very fine grained, very dense, hardpan CALCRETE. Pedogenic deposits.				
0.40						
0.60						
0.80						
1.00						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 17

FIGURE: A17

<p>TRIAL HOLE: 18</p> <p>PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY</p> <p>LOGGED BY: FJB</p> <p>SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144</p> <p>DATE LOGGED: 11/7/2020</p> <p>CLIENT: !KHEIS MUNICIPALITY</p> <p>LOCATION: 28°55'52,0" S 22°07'02,7" E</p>	<p><i>Cedar Land Geotechnical Consult (Pty) Ltd</i></p> <p>P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za</p>
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p><u>NOTES:</u></p> <p>1 Refusal of excavation at 400 mm on very dense hardpan calccrete.</p>
0.20		Abundant, clast supported, medium coarse, rounded and subrounded GRAVELS of quartz and banded ironstone in a matrix of dry, light red brown, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.40		Dirty white, very fine grained, very dense, hardpan CALCRETE with minor voids filled with light red brown, fine sand. Pedogenic deposits.				
0.60						
0.80						
1.00						

<p>Contractor: ALS Plant Hire</p> <p>Date Drilled: 11/7/2020</p> <p>Machine: Bell 315SK</p>	<p>Hole Diameter: 600 mm</p> <p>Water Depth:</p> <p>Sheet: 1 of 1</p>
<p>SOIL PROFILE: TEST PIT 18</p>	<p>FIGURE: A18</p>

TRIAL HOLE: 19

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 11/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'46,6" S 22°07'06,9" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 300 mm on very dense hardpan calcrete.
		Abundant, clast supported, medium coarse, rounded and subrounded GRAVELS of quartz and banded ironstone in a matrix of dry, light red brown, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.20		Dirty white, very fine grained, very dense, hardpan CALCRETE with minor voids filled with light red brown, fine sand. Pedogenic deposits.				
0.40						
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 11/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 19

FIGURE: A19

TRIAL HOLE: 20

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 11/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'44,3" S 22°07'09,8" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 600 mm on hard rock, quartz-sericite schist.
0.20		Abundant, clast supported, medium coarse, rounded and subrounded GRAVELS of quartz and banded ironstone in a matrix of dry, light red brown, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.40		Light grey green, very closely jointed, very intensely laminated, very fine grained, slightly weathered, medium hard rock, quartz-sericite SCHIST. Discontinuities are open, smooth and filled with white, calcareous silt. Discontinuities are vertically orientated.	U9320	0,2-0,6		
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 11/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 20

FIGURE: A20

TRIAL HOLE: 21	<i>Cedar Land Geotechnical Consult (Pty) Ltd</i> P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za
PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY	
LOGGED BY: FJB	
SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144	
DATE LOGGED: 10/7/2020	
CLIENT: !KHEIS MUNICIPALITY	
LOCATION: 28°55'42,0" S 22°07'12,4" E	

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 700 mm on very dense boulder calcrete.
0.20		Abundant, clast supported, coarse, rounded GRAVELS of quartz and banded ironstone in a matrix of dry, pale light grey, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.40		Dirty white, very fine grained, very dense, voided boulder CALCRETE. Voids are filled with pale light grey brown sand. Pedogenic deposits.				
0.60						
0.80						Water encountered Water level Bottom of hole Approximate material change Disturbed sample Undisturbed sample
1.00						

Contractor: ALS Plant Hire	Hole Diameter: 600 mm
Date Drilled: 10/7/2020	Water Depth:
Machine: Bell 315SK	Sheet: 1 of 1
SOIL PROFILE: TEST PIT 21	FIGURE: A21

<p>TRIAL HOLE: 22</p> <p>PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY</p> <p>LOGGED BY: FJB</p> <p>SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144</p> <p>DATE LOGGED: 10/7/2020</p> <p>CLIENT: !KHEIS MUNICIPALITY</p> <p>LOCATION: 28°55'37,2" S 22°07'16,1" E</p>	<p><i>Cedar Land Geotechnical Consult (Pty) Ltd</i></p> <p>P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za</p>
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------

Depth (m)	Legend	PROFILE	SAMPLE			Remarks	
			Number	Type	Symbol		
0.00		Ground Surface Dry, light red, medium dense, fine SAND. Alluvium.				<p><u>NOTES:</u></p> <p>1 Refusal of excavation at 900 mm on very dense calcrete.</p>	
0.20			Abundant, clast supported, coarse, rounded GRAVELS of quartz and banded ironstone in a matrix of dry, pale light grey, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.40				U9314	0,3-0,8		
0.60		Dirty white, very fine grained, very dense, voided boulder CALCRETE. Voids are filled with pale light grey brown sand. Pedogenic deposits.				<p> Water encountered Water level Bottom of hole Approximate material change Disturbed sample Undisturbed sample </p>	
0.80							
1.00							

<p>Contractor: ALS Plant Hire</p> <p>Date Drilled: 10/7/2020</p> <p>Machine: Bell 315SK</p>	<p>Hole Diameter: 600 mm</p> <p>Water Depth:</p> <p>Sheet: 1 of 1</p>
SOIL PROFILE: TEST PIT 22	FIGURE: A22

TRIAL HOLE: 23

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'34,7" S 22°07'21,5" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 300 mm on very dense boulder calcrete.
0.20		Abundant, clast supported, coarse, rounded GRAVELS of quartz and banded ironstone in a matrix of dry, pale light grey, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.40		Dirty white, very fine grained, very dense, voided boulder CALCRETE. Voids are filled with pale light grey brown sand. Pedogenic deposits.				
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 23

FIGURE: A23

TRIAL HOLE: 24

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'32,0" S 22°07'18,4" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607




Ceres







6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 400 mm on very dense hardpan calcrete.
0.20		Abundant, clast supported, coarse, rounded GRAVELS of quartz and banded ironstone in a matrix of dry, pale light grey, fine sand. Overall consistency is medium dense. Terrace gravels.	U9313	0-0,3		
0.40		Dirty white stained light yellow, very fine grained, very dense, hardpan CALCRETE. Pedogenic deposits.				
0.60						
0.80						
1.00						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 24

FIGURE: A24

<p>TRIAL HOLE: 25</p> <p>PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY</p> <p>LOGGED BY: FJB</p> <p>SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144</p> <p>DATE LOGGED: 10/7/2020</p> <p>CLIENT: !KHEIS MUNICIPALITY</p> <p>LOCATION: 28°55'29,7" S 22°07'23,7" E</p>	<p><i>Cedar Land Geotechnical Consult (Pty) Ltd</i></p> <p>P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za</p>
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p><u>NOTES:</u></p> <p>1 Refusal of excavation at 200 mm on very dense hardpan calccrete.</p>
0.20		<p>Abundant, clast supported, coarse, angular GRAVELS of quartz and medium coarse, subrounded GRAVELS of banded ironstone in a matrix of dry, light grey brown, fine sand. Overall consistency is medium dense.</p> <p>Terrace gravels.</p> <p>Dirty white stained light yellow, very fine grained, very dense, hardpan CALCRETE.</p> <p>Pedogenic deposits.</p>				
0.40						
0.60						
0.80						
1.00						

<p>Contractor: ALS Plant Hire</p> <p>Date Drilled: 10/7/2020</p> <p>Machine: Bell 315SK</p>	<p>Hole Diameter: 600 mm</p> <p>Water Depth:</p> <p>Sheet: 1 of 1</p>
SOIL PROFILE: TEST PIT 25	FIGURE: A25

TRIAL HOLE: 26

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

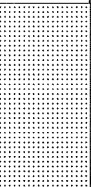

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144







DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'27,7" S 22°07'21,6" E

*Cedar Land Geotechnical
Consult (Pty) Ltd*
P O Box 607
Ceres
6835
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 500 mm on hard rock, quartz-sericite schist.
		Dry, light grey brown, loose, fine SAND and matrix supported, medium coarse, subrounded gravels of quartz and subrounded, coarse gravels of banded ironstone. Overall consistency is loose. Terrace gravels.				
0.20						
		Light grey green, very closely jointed, very intensely laminated, very fine grained, unweathered, hard rock, quartz-sericite SCHIST. Discontinuities are open, smooth and filled with white, calcareous sand. Discontinuities dip 75° with the horizontal.				
0.40						
0.60						
0.80						
1.00						

-  Water encountered
-  Water level
-  Bottom of hole
-  Approximate material change
-  Disturbed sample
-  Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 26

FIGURE: A26

TRIAL HOLE: 27

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'28,0" S 22°07'29,6" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 500 mm on very dense boulder calcrete.
0.20		Abundant, clast supported, coarse, rounded GRAVELS of quartz and banded ironstone in a matrix of dry, pale light grey, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.40		Dirty white, very fine grained, very dense, voided boulder CALCRETE. Voids are filled with pale light grey brown sand. Pedogenic deposits.				
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 27

FIGURE: A27

TRIAL HOLE: 28

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

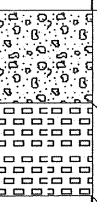
SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'26,0" S 22°07'28,0" E

*Cedar Land Geotechnical
Consult (Pty) Ltd*
P O Box 607
Ceres
6835
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 200 mm on very dense boulder calccrete.
0.20		Abundant, clast supported, coarse, angular GRAVELS of quartz and medium coarse, subrounded GRAVELS of banded ironstone in a matrix of dry, pale light grey brown, fine sand. Overall consistency is medium dense. Terrace gravels. Dirty white, very fine grained, very dense, voided boulder CALCRETE. Voids are filled with pale light grey brown sand. Pedogenic deposits.				
0.40						
0.60						
0.80						
1.00						

- ∇ Water encountered
- ↓ Water level
- ⊥ Bottom of hole
- - - Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 28

FIGURE: A28

TRIAL HOLE: 29

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 11/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'22,6" S 22°07'24,4" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607



Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 300 mm on hard rock, quartz-sericite schist.
0.20		Light grey green, very closely jointed, very intensely laminated, very fine grained, unweathered, hard rock, <i>quartz-sericite SCHIST</i> . Discontinuities are open, smooth and filled with white, calcareous sand. Discontinuities are orientated horizontally.	U9312	0,3		
0.40						▽ Water encountered ↓ Water level ~ Bottom of hole --- Approximate material change • Disturbed sample ■ Undisturbed sample
0.60						
0.80						
1.00						

Contractor: ALS Plant Hire

Date Drilled: 11/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

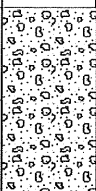


Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 29

FIGURE: A29

<p>TRIAL HOLE: 30</p> <p>PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY</p> <p>LOGGED BY: FJB</p> <p>SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144</p> <p>DATE LOGGED: 10/7/2020</p> <p>CLIENT: !KHEIS MUNICIPALITY</p> <p>LOCATION: 28°55'25,9" S 22°07'32,9" E</p>	<p><i>Cedar Land Geotechnical Consult (Pty) Ltd</i></p> <p>P O Box 607 Ceres 6835 Cell: 082 570 2767 Email: cedarland.frans@breede.co.za</p>
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				<p><u>NOTES:</u></p> <p>1 Refusal of excavation at 300 mm on very dense boulder calcrete.</p>
0.20		Abundant, clast supported, coarse, rounded GRAVELS of banded ironstone and quartz in a matrix of dry, pale light grey, fine sand. Overall consistency is medium dense. Terrace gravels.	U9311	0-0,3		
0.40		Dirty white, very fine grained, very dense, voided boulder CALCRETE. Voids are filled with pale light grey brown sand. Pedogenic deposits.				<p>▽ Water encountered ↓ Water level └ Bottom of hole --- Approximate material change • Disturbed sample ■ Undisturbed sample</p>
0.60						
0.80						
1.00						

<p>Contractor: ALS Plant Hire</p> <p>Date Drilled: 10/7/2020</p> <p>Machine: Bell 315SK</p>	<p>Hole Diameter: 600 mm</p> <p>Water Depth:</p> <p>Sheet: 1 of 1</p>
SOIL PROFILE: TEST PIT 30	FIGURE: A30

TRIAL HOLE: 31

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'22,4" S 22°07'30,4" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

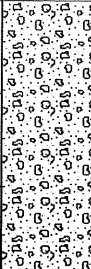
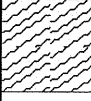






Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 400 mm on hard rock, quartz-sericite schist.
		Abundant, clast supported, coarse, rounded GRAVELS of banded ironstone and quartz in a matrix of dry, pale light grey, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.20						
		Light grey green, very closely jointed, very intensely laminated, very fine grained, unweathered, hard rock, quartz-sericite SCHIST. Discontinuities are open, smooth and filled with white, calcareous sand. Discontinuities are orientated horizontally.				
0.40						
0.60						
0.80						 Water encountered  Water level  Bottom of hole  Approximate material change  Disturbed sample  Undisturbed sample
1.00						

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 31

FIGURE: A31

TRIAL HOLE: 32

PROJECT: EXPANSION AND FORMALISATION OF THE BOEGOEBERG COMMUNITY

LOGGED BY: FJB

SITE: PLOT 1890, BOEGOEBERG SETTLEMENT AND REMAINDERS OF FARMS 142 AND 144

DATE LOGGED: 10/7/2020

CLIENT: !KHEIS MUNICIPALITY

LOCATION: 28°55'18,0" S 22°07'25,9" E

Cedar Land Geotechnical

Consult (Pty) Ltd

P O Box 607

Ceres

6835

Cell: 082 570 2767

Email:

cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE			Remarks
			Number	Type	Symbol	
0.00		Ground Surface				NOTES: 1 Refusal of excavation at 400 mm on very dense boulder calcrete.
0.20		Abundant, clast supported, coarse, angular GRAVELS of quartz and medium coarse, subrounded GRAVELS of banded ironstone in a matrix of dry, pale light grey brown, fine sand. Overall consistency is medium dense. Terrace gravels.				
0.40		Dirty white, very fine grained, very dense, voided boulder CALCRETE. Voids are filled with pale light grey brown sand. Pedogenic deposits.				
0.60						
0.80						
1.00						

- Water encountered
- Water level
- Bottom of hole
- Approximate material change
- Disturbed sample
- Undisturbed sample

Contractor: ALS Plant Hire

Date Drilled: 10/7/2020

Machine: Bell 315SK

Hole Diameter: 600 mm

Water Depth:

Sheet: 1 of 1

SOIL PROFILE: TEST PIT 32

FIGURE: A32

**GEOTECHNICAL CONDITIONS ON PLOT 1890
BOEGOEBERG SETTLEMENT AND THE REMAINDERS
OF FARMS 142 AND 144: A REPORT FOR THE
EXPANSION AND FORMALISATION OF
BOEGOEBERG COMMUNITY**

2020/J09/MCP_01

ADDENDUM B: RESULTS OF MATERIALS TESTING

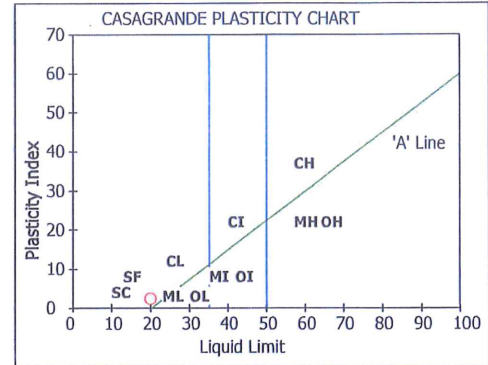
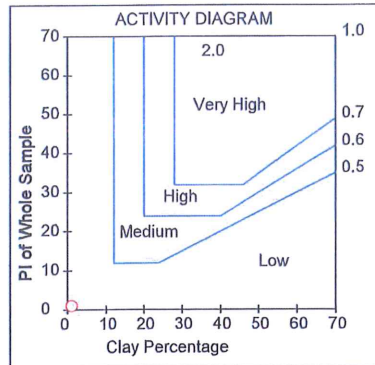
Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

Date Reported : 2020-08-24

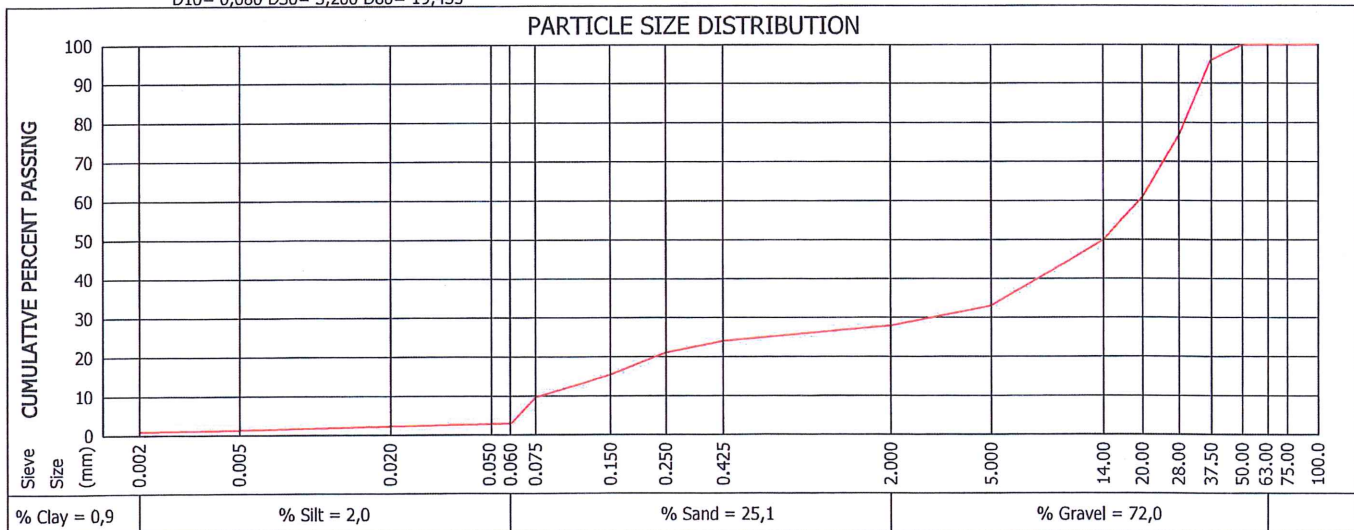
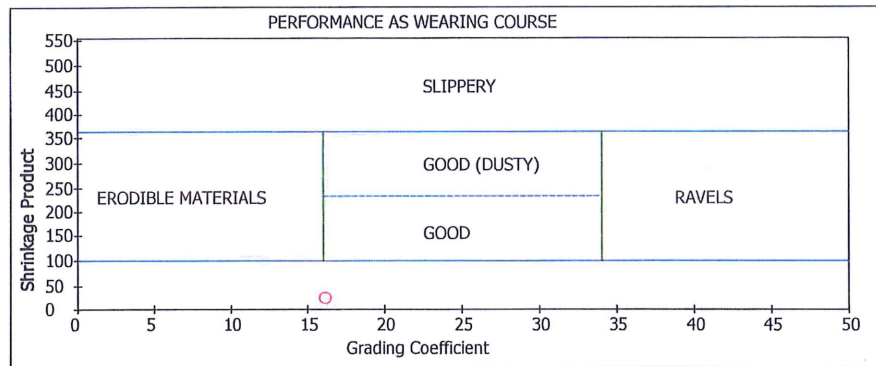
Project : Boegoeberg Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No.	: U9316
Position	: TP 1
Layer Type	: 200-400mm
Sample Colour	: Brown Gravel
Sample Type	: Mix Cal+Quartz+OCC I



Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	15	
75.00	100	0.425 - 0.250	11	
63.00	100	0.250 - 0.150	20	
50.00	100	0.150 - 0.075	19	
37.50	96	< 0.075	36	
28.00	77	Effective Size	0,080	
20.00	61	Uniformity Coefficient	243,2	
14.00	50	Curvature Coefficient	6,6	
5.000	33	Oversize Index	4,0	
2.000	28	Shrinkage Product	24,0	
0.425	24	Grading Coefficient	16,2	
0.250	21	Grading Modulus	2,40	
0.150	15	Atterberg Limits	Liquid Limit	20
0.075	9,6		Plasticity Index	2,0
0.060	2,9		Linear Shrinkage	1,0
0.050	2,8		PI < 0.075	
0.020	2,2	Unified Soil Classification	GW-GC	
0.005	1,3	US Highway Classification	A-1-a(0)	
0.002	0,9			D10= 0,080 D30= 3,200 D60= 19,455




Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
 Further use of the above information is not the responsibility or liability of Roadlab.
 Documents may only be reproduced or published in their full context.
 Report compiled by : Juraine Okkies



Accreditation No. T0296
 Prog.ver 10.7 (2019/11/07)


 D Juckers
 Technical Signatory

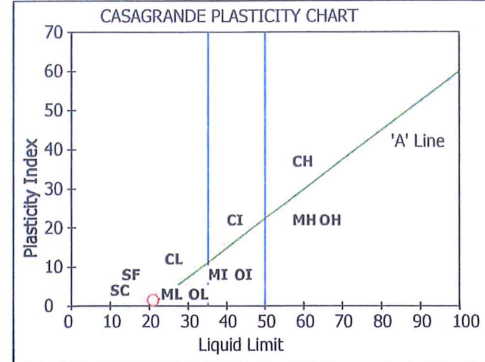
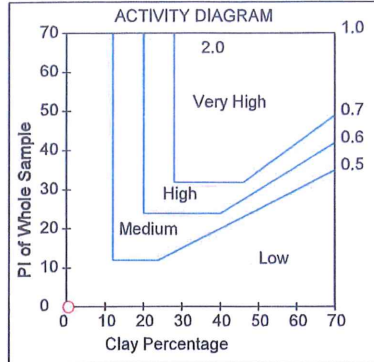
Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

Date Reported : 2020-08-06

Project : Boegoeberg Infrastructure Upgrade

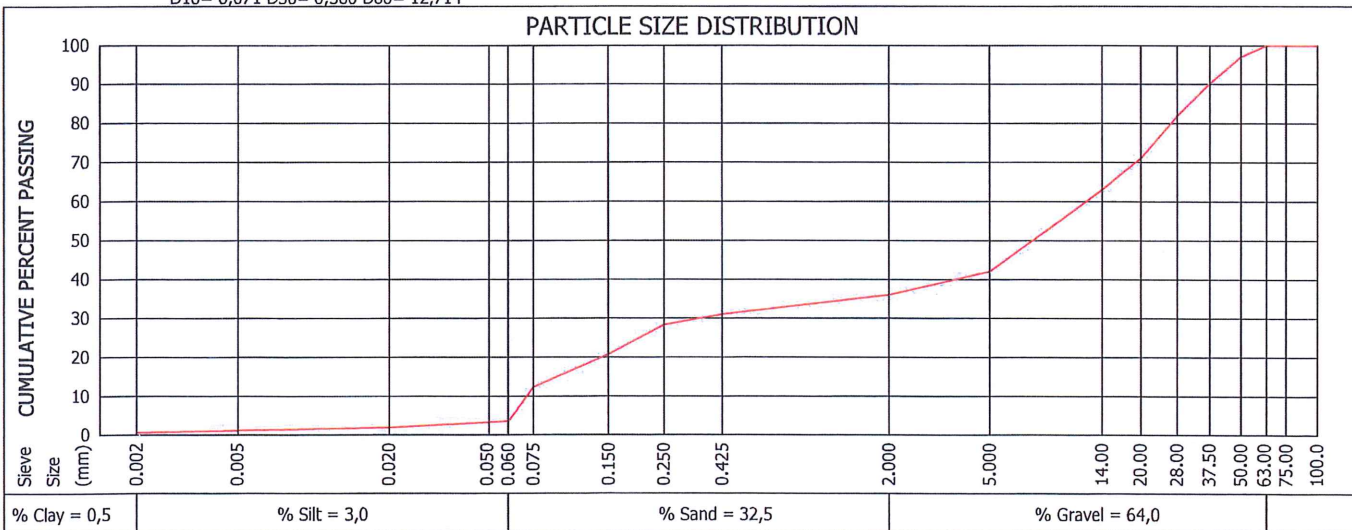
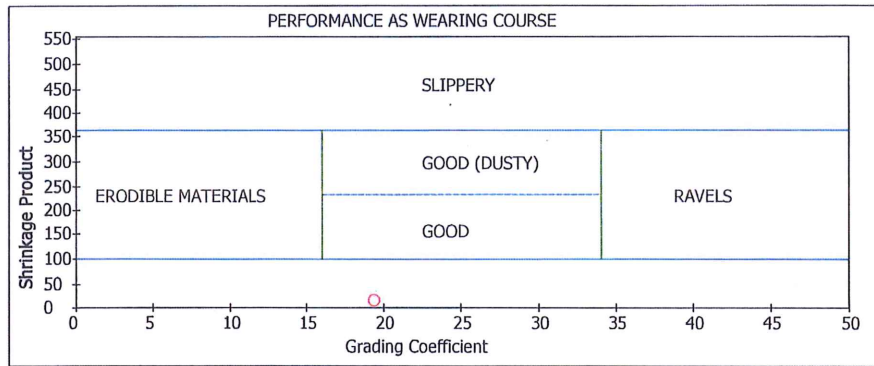
Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No.	: U9317
Position	: TP 6
Layer Type	: 0-400mm
Sample Colour	: Light Brown Gravel
Sample Type	: Mix Calcrete+Quartz



Sieve Size (mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	13	
75.00	100	0.425 - 0.250	8	
63.00	100	0.250 - 0.150	21	
50.00	97	0.150 - 0.075	24	
37.50	90	< 0.075	33	
28.00	82	Effective Size	0,071	
20.00	71	Uniformity Coefficient	179,1	
14.00	63	Curvature Coefficient	0,1	
5.000	42	Oversize Index	7,0	
2.000	36	Shrinkage Product	15,5	
0.425	31	Grading Coefficient	19,3	
0.250	28	Grading Modulus	2,20	
0.150	21	Atterberg Limits	Liquid Limit	21
0.075	12		Plasticity Index	1.0
0.060	3,5		Linear Shrinkage	0.5
0.050	3,2		PI < 0.075	
0.020	1,9	Unified Soil Classification	GC	
0.005	1,1	US Highway Classification	A-1-b(0)	
0.002	0,5			

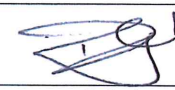
D10= 0,071 D30= 0,360 D60= 12,714



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.78 [SANS 5854] & Conductivity = 0.13 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
 Further use of the above information is not the responsibility or liability of Roadlab.
 Documents may only be reproduced or published in their full context.
 Report compiled by : Juraine Okkies




 D Juckers
 Technical Signatory
 4 of 16
 ... of ...



Roadlab Germiston
 207 Rietfontein Road Germiston
 1401
 Tel: 011 828 0279 Fax: 011 828 0279
 Email: info@roadlab.co.za
 Web: www.roadlab.co.za

Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 120
 Clanwilliam
 8135

Date Reported : 2020-08-06

Project : Boegoeberg Infrastructure Upgrade

Attention : Frans Breytenbach

Determination of the California Bearing Ratio Test Report SANS 3001 - GR1 / GR2 / GR10 / GR20 / GR30 / GR40 / PR5

SAMPLE INFORMATION AND PROPERTIES

SAMPLE NO.	U9317		
HOLE NO./ Km / CHAINAGE	TP6		
ROAD NO./ NAME Line 1 ROAD NO./ NAME Line 2	S28° 55' 57,6" E22° 07' 16,8"		
LAYER TESTED/SAMPLED	0-400mm		
SAMPLE DEPTH	0-400mm		
DATE SAMPLED	2020-07-13		
COLOUR OF SAMPLE	Light Brown		
TYPE OF SAMPLE	Mix Calcrete+Quartz		

SIEVE ANALYSIS - % PASSING SIEVES *(SANS 3001-GR1:2010, SANS 3001-GR2:2010)

SIEVE ANALYSIS (GR 1) % PASSING	100.0 mm		
	75.0 mm		
	63.0 mm	100	
	50.0 mm	97	
	37.5 mm	90	
	28.0 mm	82	
	20.0 mm	71	
	14.0 mm	63	
	5.0 mm	42	
	2.0 mm	36	
	0.425 mm	31	
0.075 mm	12		
GM %		2,2	

SOIL MORTAR ANALYSIS (SANS 3001-PR5:2011)

COARSE SAND	2.000 - 0.425	13	
COARSE FINE SAND	0.425 - 0.250	8	
MEDIUM FINE SAND	0.250 - 0.150	21	
FINE FINE SAND	0.150 - 0.075	24	
SILT CLAY	0.075	33	

ATTERBERG LIMITS ANALYSIS - *(SANS 3001-GR10:2010)

ATTERBERG LIMITS (%) SANS GR10,GR11	LIQUID LIMIT	21	
	PLASTICITY INDEX	1.4	
	LINEAR SHRINKAGE	0.5	
CLASSIFICATION	H.R.B.	A-1-b(0)	
	COLTO	G6	
	TRH 14	G6	

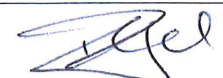
CALIFORNIA BEARING RATIO - *(SANS 3001-GR30:2010, SANS 3001-GR40:2010)

SANS GR30 MAX. DRY DENSITY	OMC %	9,3	
	MDD (kg/m³)	2033	
	COMP MC %	9,1	
SWELL % @	MOD NRB PRO	0,00 0,01 0,02	
	100 %	78	
C.B.R. SANS GR40	98 %	57	
	97 %	49	
	95 %	36	
	93 %	27	
	90 %	17	

STABILISER IN LAB	Not Applicable		
TEST TYPE	CBR		
SAMPLING METHOD	TMH 5		
WEATHER WHEN SAMPLED	Cold		

Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works.
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
 Further use of the above information is not the responsibility or liability of Roadlab.
 Documents may only be reproduced or published in their full context.
 Report compiled by : Juraine Okkies


 D Juckers
 Technical Signatory 2 ... of ... 16

Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

Date Reported : 2020-07-29

Project : Boegoeberg Infrastructure Upgrade

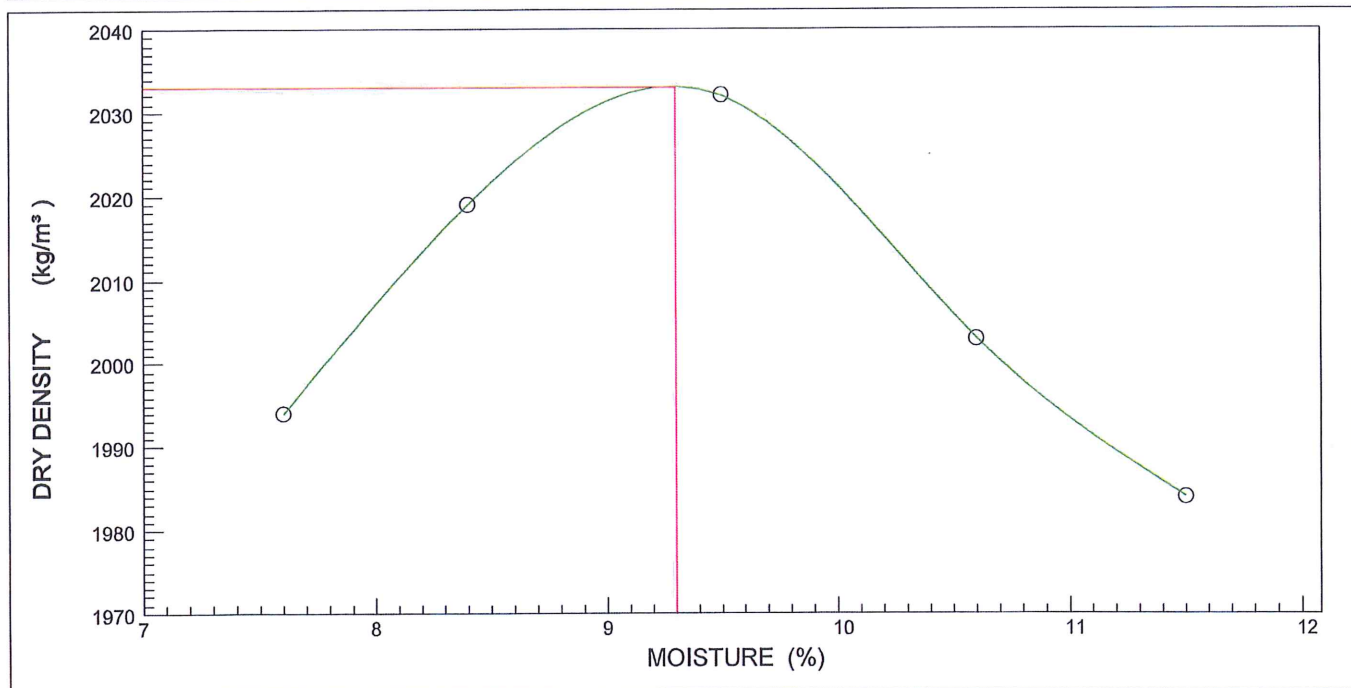
Determination Maximum Dry Density & Optimum Moisture Content Test Report

SANS 3001 - GR20/GR30

SAMPLE NO.	U9317
CONTAINER FOR SAMPLING	Black Bags
SIZE / APPROX. MASS OF SAMPLE	95kg
MOISTURE CONDITION OF SAMPLE	Moist
LAYER TESTED / SAMPLED FROM	0-400mm
MATERIAL DESCRIPTION	Mix Calcrete+Quartz
HOLE NO./ km / CHAINAGE	TP6
ROAD NO.	Not Specified
DATE RECEIVED	2020-07-14
DATE SAMPLED	2020-07-13
CLIENT MARKING	S28° 55' 57,6"; E22° 07' 16,8"
COLOUR AND TYPE	Light Brown Gravel


POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m ³)	1994	2019	2032	2003	1984			
MOISTURE (%)	7,6	8,4	9,5	10,6	11,5			

MAXIMUM DRY DENSITY (kg/m ³) : 2033	OPTIMUM MOISTURE CONTENT (%) : 9,3
-------------------------------------------------	------------------------------------




Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
 Further use of the above information is not the responsibility or liability of Roadlab.
 Documents may only be reproduced or published in their full context.
 Report compiled by : Juraine Okkies



Accreditation No. T0296
 Prog.ver 10.7 (2019/11/07)


 D Juckers
 Technical Signatory

3 of 16

Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

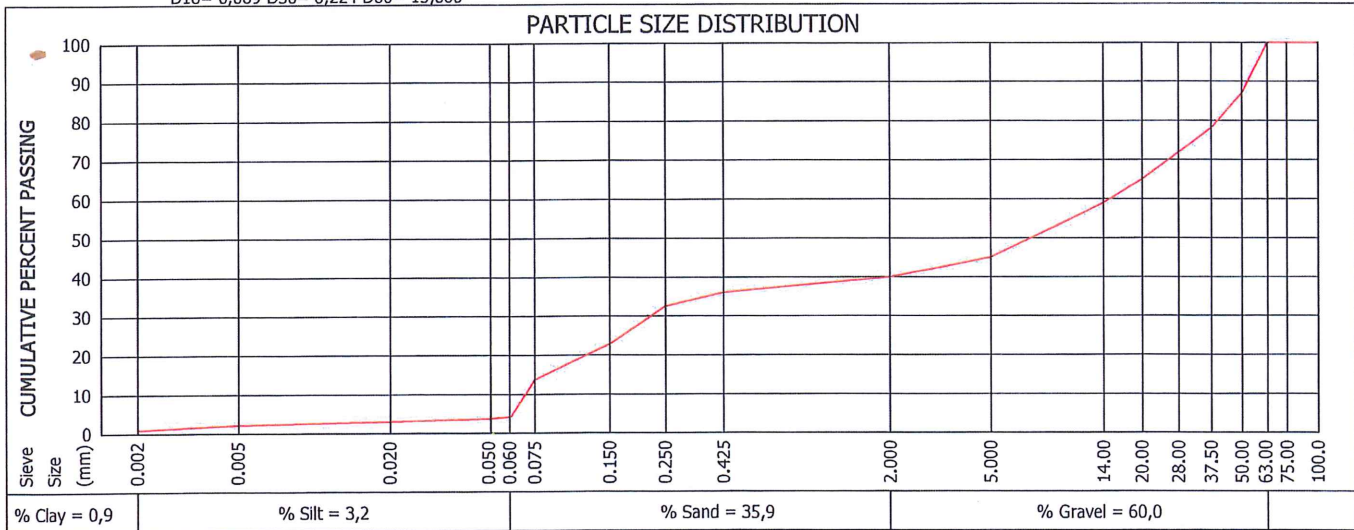
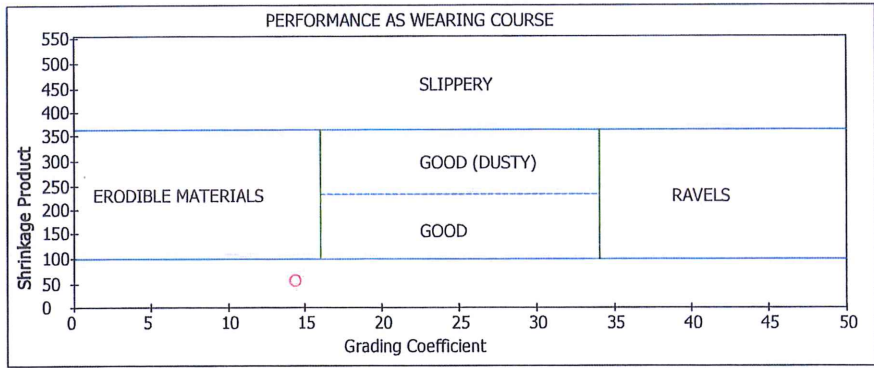
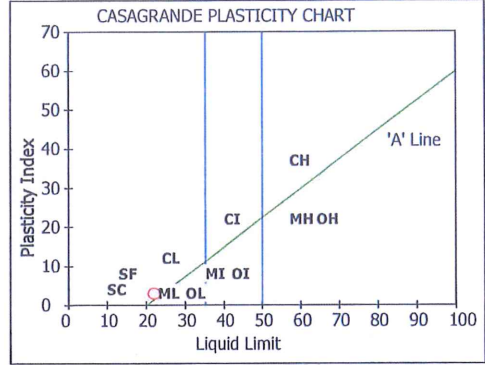
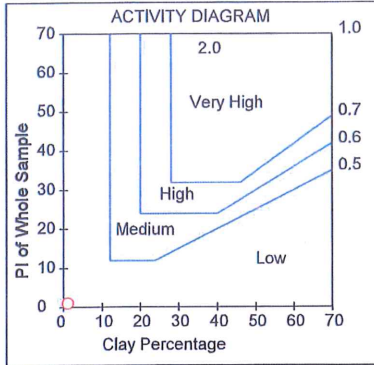
Date Reported : 2020-08-24

Project : Boegoeberg Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

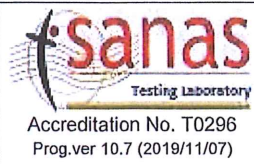
Sample No.	: U9318
Position	: TP 10
Layer Type	: 100-500mm
Sample Colour	: Brown Gravel
Sample Type	: Mix Calcrete + Quart


Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	10	
75.00	100	0.425 - 0.250	10	
63.00	100	0.250 - 0.150	24	
50.00	87	0.150 - 0.075	22	
37.50	78	< 0.075	35	
28.00	72	Effective Size	0,069	
20.00	65	Uniformity Coefficient	217,4	
14.00	59	Curvature Coefficient	0,0	
5.000	45	Oversize Index	9,0	
2.000	40	Shrinkage Product	54,0	
0.425	36	Grading Coefficient	14,4	
0.250	33	Grading Modulus	2,10	
0.150	23	Atterberg Limits	Liquid Limit	22
0.075	14		Plasticity Index	3.0
0.060	4,1		Linear Shrinkage	1.5
0.050	3,7		PI < 0.075	
0.020	3,0	Unified Soil Classification	GC	
0.005	2,1	US Highway Classification	A-1-b(0)	
0.002	0,9	D10= 0,069 D30= 0,224 D60= 15,000		



Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
 Further use of the above information is not the responsibility or liability of Roadlab.
 Documents may only be reproduced or published in their full context.
 Report compiled by : Juraine Okkies




 D Juckers
 Technical Signatory 5 of 16
 ... of ...

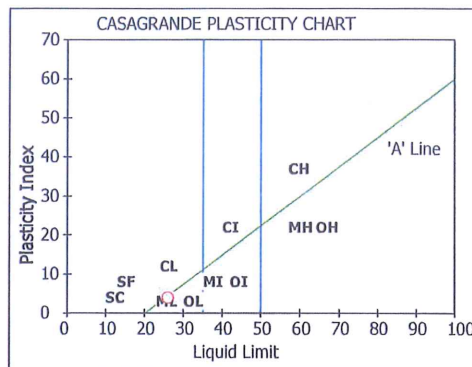
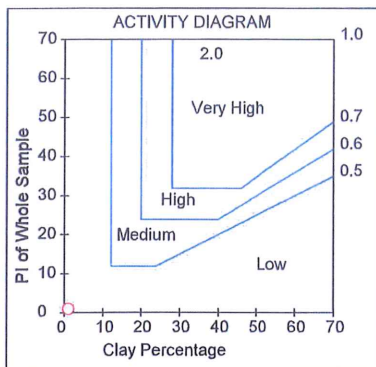
Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

Date Reported : 2020-08-24

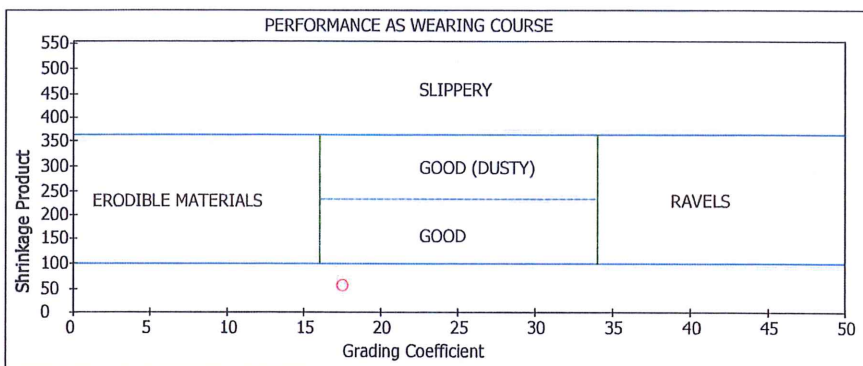
Project : Boegoeberg Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

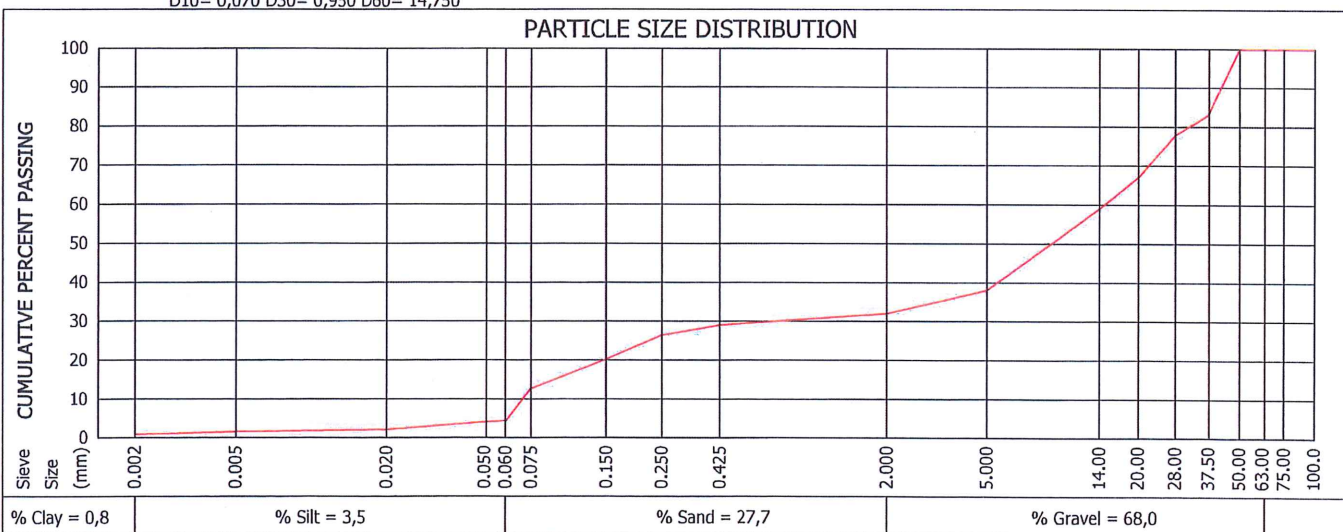
Sample No.	: U9315
Position	: TP 13
Layer Type	: 150-500mm
Sample Colour	: Brown Gravel
Sample Type	: Mix Calcrete + Quart



Sieve Size(mm)	% Passing	Soil Mortar	2.000 - 0.425	12
100.0	100		0.425 - 0.250	7
75.00	100		0.250 - 0.150	19
63.00	100		0.150 - 0.075	22
50.00	100		< 0.075	40
37.50	83	Effective Size		0,070
28.00	78	Uniformity Coefficient		210,7
20.00	67	Curvature Coefficient		0,9
14.00	59	Oversize Index		17,0
5.000	38	Shrinkage Product		58,0
2.000	32	Grading Coefficient		17,5
0.425	29	Grading Modulus		2,30
0.250	26	Atterberg Limits	Liquid Limit	26
0.150	20		Plasticity Index	4
0.075	13		Linear Shrinkage	2.0
0.060	4,3		PI < 0.075	
0.050	4,0	Unified Soil Classification		GM
0.020	2,0	US Highway Classification		A-1-a(0)
0.005	1,5			
0.002	0,8			



D10= 0,070 D30= 0,950 D60= 14,750



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.43 [SANS 5854] & Conductivity = 0.01 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
 Further use of the above information is not the responsibility or liability of Roadlab.
 Documents may only be reproduced or published in their full context.
 Report compiled by : Juraine Okkies



[Signature]
 D Juckers
 Technical Signatory
 6... of 6

Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

Date Reported : 2020-08-06

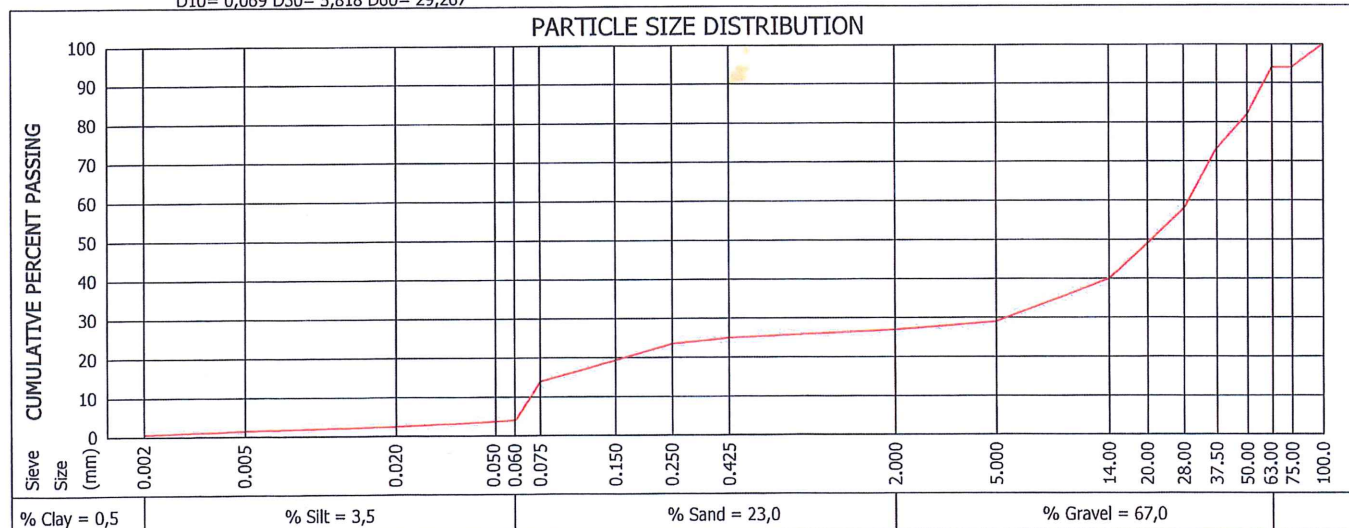
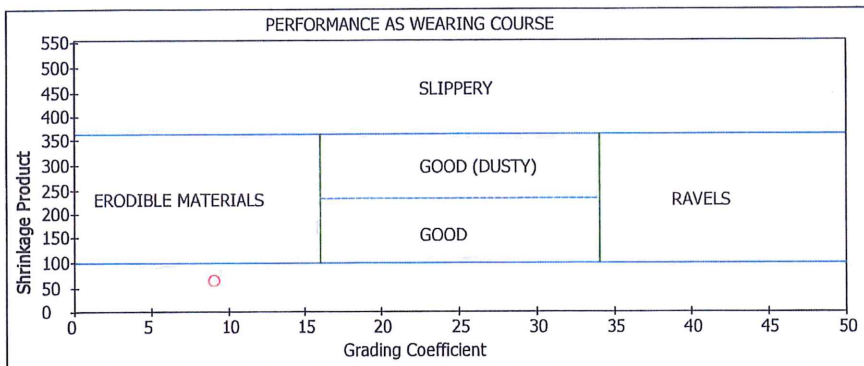
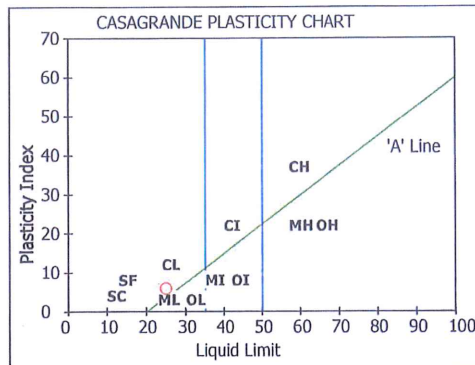
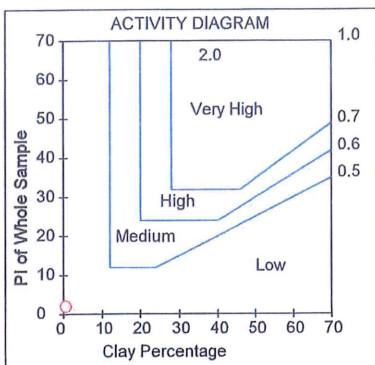
Project : Boegoeberg Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10



Sample No.	: U9319
Position	: TP 15
Layer Type	: 0-600mm
Sample Colour	: Light Brown Gravel
Sample Type	: Mix Calcrete+Quartz

Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	7	
75.00	94	0.425 - 0.250	6	
63.00	94	0.250 - 0.150	16	
50.00	82	0.150 - 0.075	20	
37.50	73	< 0.075	52	
28.00	58	Effective Size	0,069	
20.00	49	Uniformity Coefficient	424,2	
14.00	40	Curvature Coefficient	16,8	
5.000	29	Oversize Index	9,0	
2.000	27	Shrinkage Product	62,5	
0.425	25	Grading Coefficient	9,0	
0.250	24	Grading Modulus	2,30	
0.150	19	Atterberg Limits	Liquid Limit	25
0.075	14		Plasticity Index	6
0.060	4,0		Linear Shrinkage	2.5
0.050	3,6		PI < 0.075	
0.020	2,4	Unified Soil Classification	GM-GC	
0.005	1,4	US Highway Classification	A-1-a(0)	
0.002	0,5			

D10 = 0,069 D30 = 5,818 D60 = 29,267



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.75 [SANS 5854] & Conductivity = 0.06 S/m [SANS 6240]

<p>Opinions and interpretations are not included in our scope of works. (T0296) The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM). The test results reported relate to the samples tested. Further use of the above information is not the responsibility or liability of Roadlab. Documents may only be reproduced or published in their full context. Report compiled by : Juraine Okkies</p>	 <p>Accreditation No. T0296 Prog.ver 10.7 (2019/11/07)</p>  <p>D Juckers Technical Signatory</p> <p style="text-align: right;">9 of 16 ... of ...</p>
--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------



Roadlab Germiston
 207 Rietfontein Road Germiston
 1401
 Tel: 011 828 0279 Fax: 011 828 0279
 Email: info@roadlab.co.za
 Web: www.roadlab.co.za

Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835

Date Reported : 2020-08-06

Project : Boegoeberg Infrastructure Upgrade

Attention : Frans Breytenbach

Determination of the California Bearing Ratio Test Report SANS 3001 - GR1 / GR2 / GR10 / GR20 / GR30 / GR40 / PR5

SAMPLE INFORMATION AND PROPERTIES

SAMPLE NO.	U9319		
HOLE NO./ Km / CHAINAGE	TP15		
ROAD NO./ NAME Line 1	S28° 55' 50,1"		
ROAD NO./ NAME Line 2	E22° 07' 10,7"		
LAYER TESTED/SAMPLED	0-600mm		
SAMPLE DEPTH	0-600mm		
DATE SAMPLED	2020-07-13		
COLOUR OF SAMPLE	Light Brown		
TYPE OF SAMPLE	Mix Calcrete+Quartz		

SIEVE ANALYSIS - % PASSING SIEVES *(SANS 3001-GR1:2010, SANS 3001-GR2:2010)

SIEVE ANALYSIS (GR 1) % PASSING	100.0 mm	100		
	75.0 mm	94		
	63.0 mm	94		
	50.0 mm	82		
	37.5 mm	73		
	28.0 mm	58		
	20.0 mm	49		
	14.0 mm	40		
	5.0 mm	29		
	2.0 mm	27		
GM %	0.425 mm	25		
	0.075 mm	14		
		2,3		

SOIL MORTAR ANALYSIS (SANS 3001-PR5:2011)

COARSE SAND	2.000 - 0.425	7		
COARSE FINE SAND	0.425 - 0.250	6		
MEDIUM FINE SAND	0.250 - 0.150	16		
FINE FINE SAND	0.150 - 0.075	20		
SILT CLAY	0.075	52		

ATTERBERG LIMITS ANALYSIS - *(SANS 3001-GR10:2010)

ATTERBERG LIMITS (%) SANS GR10,GR11	LIQUID LIMIT	25		
	PLASTICITY INDEX	6		
	LINEAR SHRINKAGE	2.5		
CLASSIFICATION	H.R.B.	A-1-a(0)		
	COLTO	G8		
	TRH 14	G9		

CALIFORNIA BEARING RATIO - *(SANS 3001-GR30:2010, SANS 3001-GR40:2010)

SANS GR30 MAX. DRY DENSITY	OMC %	11,4		
	MDD (kg/m³)	1841		
	COMP MC %	11,5		
SWELL % @	MOD NRB PRO	0,00 0,01 0,02		
	100 %	64		
C.B.R. SANS GR40	98 %	41		
	97 %	32		
	95 %	21		
	93 %	13		
	90 %	7		

STABILISER IN LAB	Not Applicable		
TEST TYPE	CBR		
SAMPLING METHOD	TMH 5		
WEATHER WHEN SAMPLED	Cold		

Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
 Further use of the above information is not the responsibility or liability of Roadlab.
 Documents may only be reproduced or published in their full context.
 Report compiled by : Juraine Okkies



Accreditation No. T0296
 Prog.ver 10.7 (2019/11/07)



D Juckers
 Technical Signatory 7

... of ... 16

Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

Date Reported : 2020-07-29

Project : Boegoeberg Infrastructure Upgrade

Determination Maximum Dry Density & Optimum Moisture Content Test Report

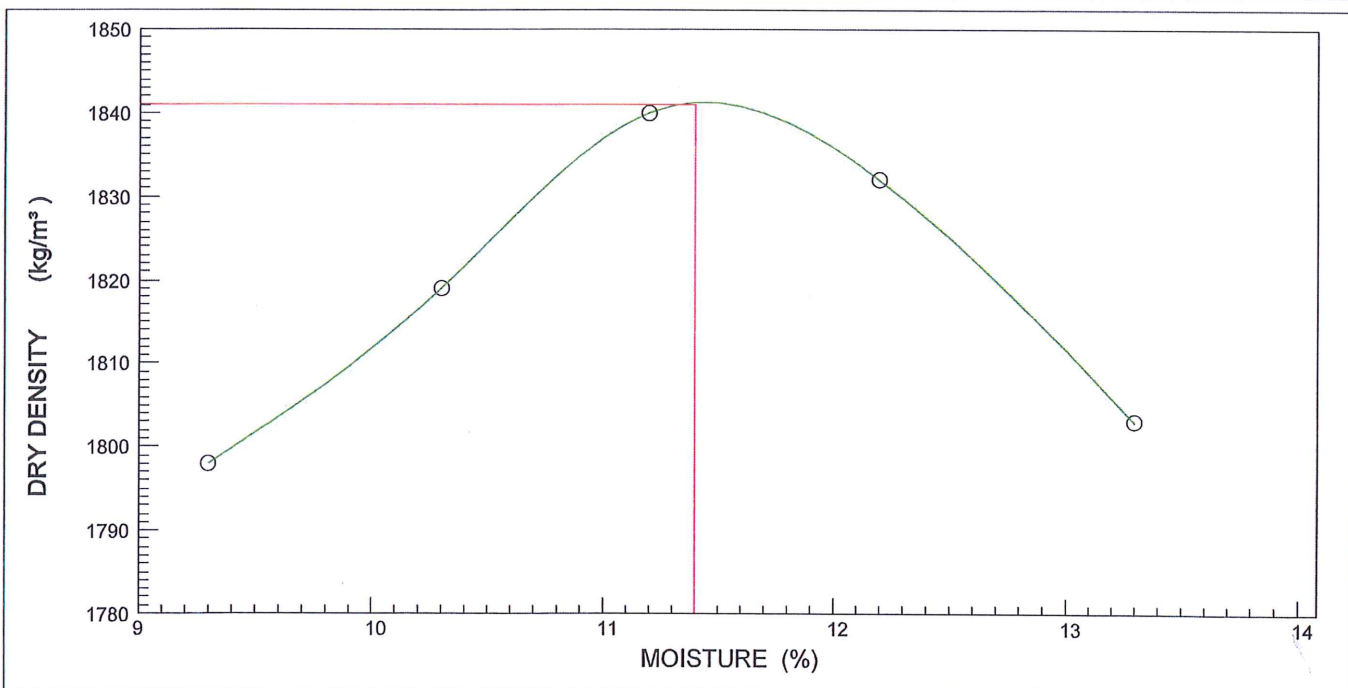
SANS 3001 - GR20/GR30

SAMPLE NO.	U9319
CONTAINER FOR SAMPLING	Black Bags
SIZE / APPROX. MASS OF SAMPLE	120kg
MOISTURE CONDITION OF SAMPLE	Moist
LAYER TESTED / SAMPLED FROM	0-600mm
MATERIAL DESCRIPTION	Mix Calcrete+Quartz
HOLE NO./ km / CHAINAGE	TP15
ROAD NO.	Not Specified
DATE RECEIVED	2020-07-14
DATE SAMPLED	2020-07-13
CLIENT MARKING	S28° 55' 50,1"; E22° 07' 10,7"
COLOUR AND TYPE	Light Brown Gravel

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m ³)	1798	1819	1840	1832	1803			
MOISTURE (%)	9,3	10,3	11,2	12,2	13,3			

MAXIMUM DRY DENSITY (kg/m³) : 1841

OPTIMUM MOISTURE CONTENT (%) : 11,4



Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
 Further use of the above information is not the responsibility or liability of Roadlab.
 Documents may only be reproduced or published in their full context.
 Report compiled by : Juraine Okkies

Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breylenbach

Date Reported : 2020-08-24

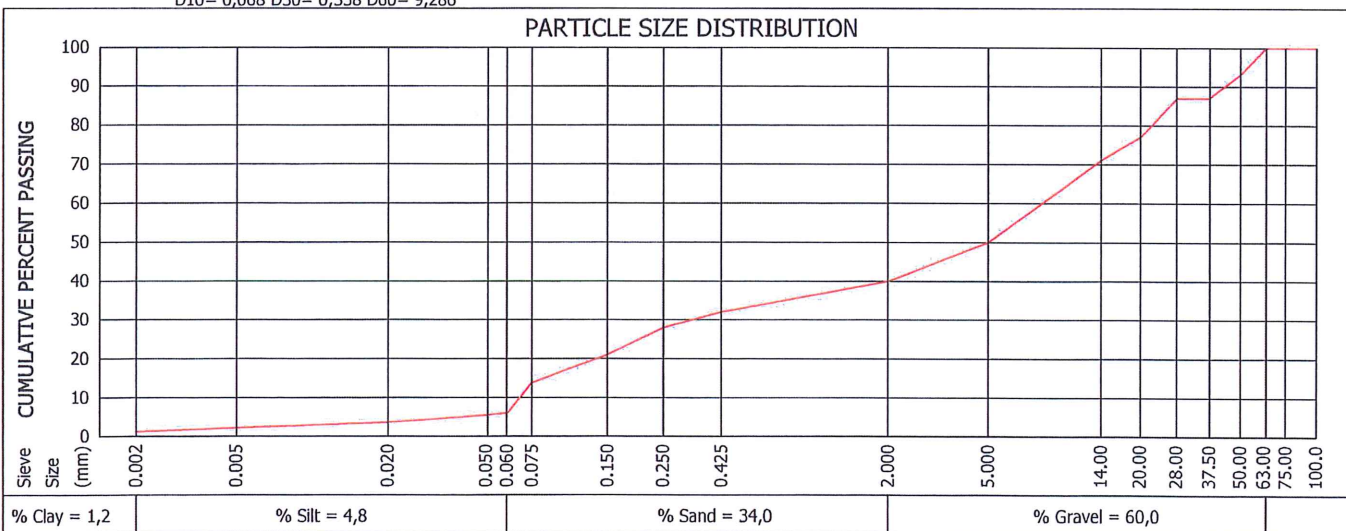
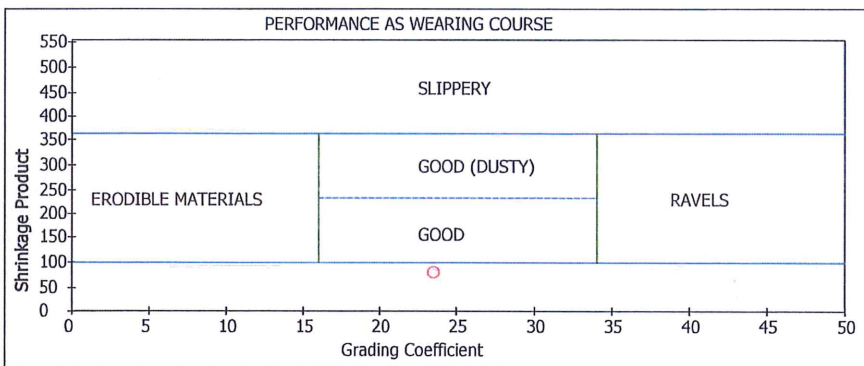
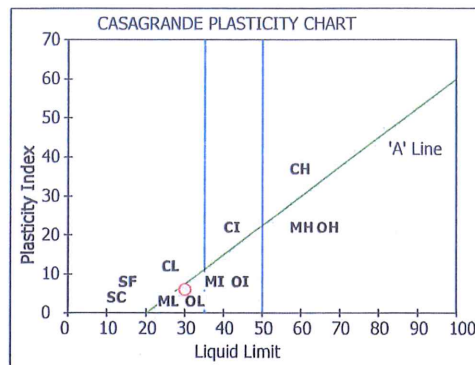
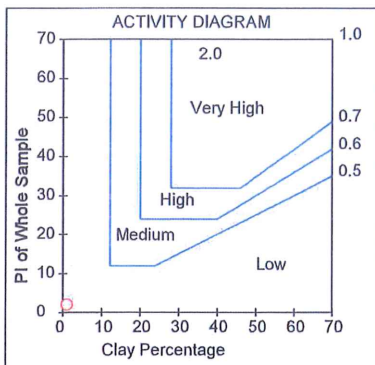
Project : Boegoeberg Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No.	: U9320
Position	: TP 20
Layer Type	: 200-600mm
Sample Colour	: Light Brown Gravel
Sample Type	: Mix Weathered Calcre

Sieve Size(mm)	% Passing	Soil Mortar	2.000 - 0.425	20
100.0	100		0.425 - 0.250	10
75.00	100		0.250 - 0.150	18
63.00	100		0.150 - 0.075	18
50.00	93		< 0.075	35
37.50	87	Effective Size		0,068
28.00	87	Uniformity Coefficient		136,6
20.00	77	Curvature Coefficient		0,2
14.00	71	Oversize Index		6,0
5.000	50	Shrinkage Product		80,0
2.000	40	Grading Coefficient		23,5
0.425	32	Grading Modulus		2,10
0.250	28	Atterberg Limits	Liquid Limit	30
0.150	21		Plasticity Index	6
0.075	14		Linear Shrinkage	2,5
0.060	6,0		PI < 0.075	
0.050	5,5	Unified Soil Classification		GM
0.020	3,6	US Highway Classification		A-1-b(0)
0.005	2,2			
0.002	1,2			


D10= 0,068 D30= 0,338 D60= 9,286



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.84 [SANS 5854] & Conductivity = 0.08 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
 Further use of the above information is not the responsibility or liability of Roadlab.
 Documents may only be reproduced or published in their full context.
 Report compiled by : Juraine Okkies

sanas
 Testing Laboratory
 Accreditation No. T0296
 Prog.ver 10.7 (2019/11/07)


 D Juckers
 Technical Signatory
 10 of 10

Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

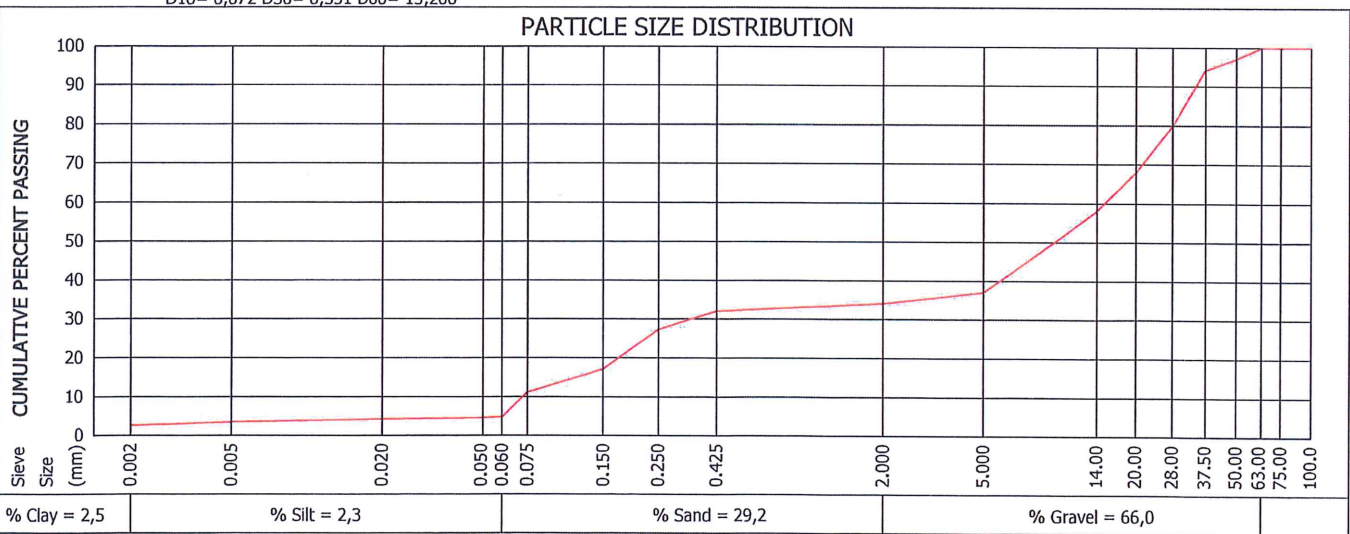
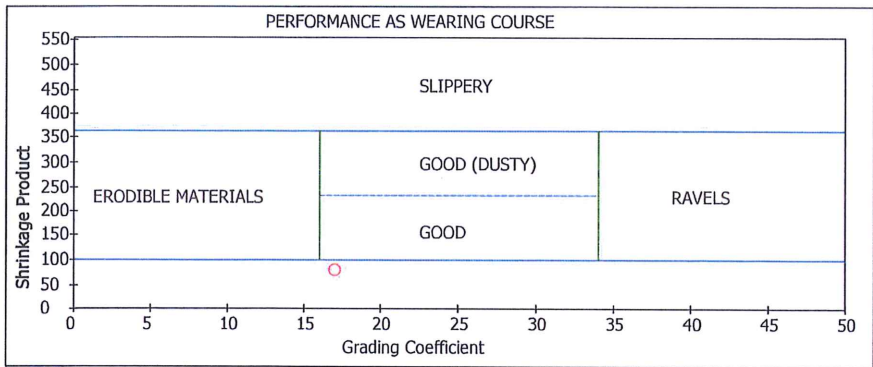
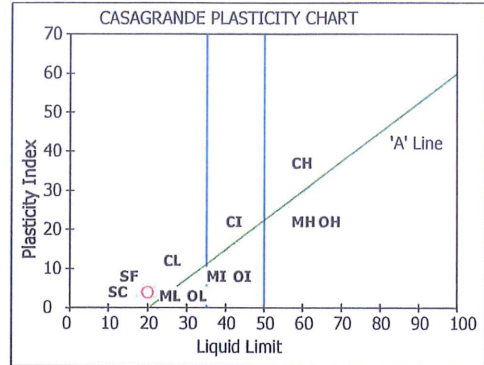
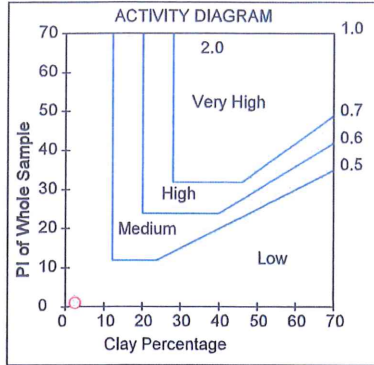
Date Reported : 2020-08-05

Project : Boegoeborg Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No.	: U9314
Position	: TP 22
Layer Type	: 300-800mm
Sample Colour	: Reddish Brown Gravel
Sample Type	: Mix Ironstone

Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	6	
75.00	100	0.425 - 0.250	15	
63.00	100	0.250 - 0.150	30	
50.00	97	0.150 - 0.075	18	
37.50	94	< 0.075	32	
28.00	80	Effective Size	0,072	
20.00	68	Uniformity Coefficient	211,1	
14.00	58	Curvature Coefficient	0,1	
5.000	37	Oversize Index	3,0	
2.000	34	Shrinkage Product	80,0	
0.425	32	Grading Coefficient	17,0	
0.250	27	Grading Modulus	2,20	
0.150	17	Atterberg Limits	Liquid Limit	20
0.075	11		Plasticity Index	4.0
0.060	4,8		Linear Shrinkage	2.5
0.050	4,6		PI < 0.075	
0.020	4,1	Unified Soil Classification	GW-GM-GC	
0.005	3,4	US Highway Classification	A-1-b(0)	
0.002	2,5	D10= 0,072 D30= 0,351 D60= 15,200		



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.63 [SANS 5854] & Conductivity = 0.19 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
 Further use of the above information is not the responsibility or liability of Roadlab.
 Documents may only be reproduced or published in their full context.
 Report compiled by : Juraine Okkies



Accreditation No. T0296
 Prog.ver 10.7 (2019/11/07)



D. Juckers
 Technical Signatory
 13 of 16

Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835

Date Reported : 2020-08-05

Project : Boegoeberg Infrastructure Upgrade

Attention : Frans Breytenbach

Determination of the California Bearing Ratio Test Report SANS 3001 - GR1 / GR2 / GR10 / GR20 / GR30 / GR40 / PR5

SAMPLE INFORMATION AND PROPERTIES

SAMPLE NO.	U9314		
HOLE NO./ Km / CHAINAGE	TP22		
ROAD NO./ NAME Line 1 ROAD NO./ NAME Line 2	S28° 55' 37,2" E22° 07' 16,1"		
LAYER TESTED/SAMPLED	300-800mm		
SAMPLE DEPTH	300-800mm		
DATE SAMPLED	2020-07-13		
COLOUR OF SAMPLE	Reddish Brown		
TYPE OF SAMPLE	Mix Ironstone		

SIEVE ANALYSIS - % PASSING SIEVES *(SANS 3001-GR1:2010, SANS 3001-GR2:2010)

SIEVE ANALYSIS (GR 1) % PASSING	100.0 mm		
	75.0 mm		
	63.0 mm	100	
	50.0 mm	97	
	37.5 mm	94	
	28.0 mm	80	
	20.0 mm	68	
	14.0 mm	58	
	5.0 mm	37	
	2.0 mm	34	
GM %	0.425 mm	32	
	0.075 mm	11	
		2,2	

SOIL MORTAR ANALYSIS (SANS 3001-PR5:2011)

COARSE SAND	2.000 - 0.425	6	
COARSE FINE SAND	0.425 - 0.250	15	
MEDIUM FINE SAND	0.250 - 0.150	30	
FINE FINE SAND	0.150 - 0.075	18	
SILT CLAY	0.075	32	

ATTERBERG LIMITS ANALYSIS - *(SANS 3001-GR10:2010)

ATTERBERG LIMITS (%) SANS GR10,GR11	LIQUID LIMIT	20	
	PLASTICITY INDEX	4.0	
	LINEAR SHRINKAGE	2.5	
CLASSIFICATION	H.R.B.	A-1-b(0)	
	COLTO	G6	
	TRH 14	G7	

CALIFORNIA BEARING RATIO - *(SANS 3001-GR30:2010, SANS 3001-GR40:2010)

SANS GR30 MAX. DRY DENSITY	OMC %	4,3	
	MDD (kg/m ³)	2336	
	COMP MC %	4,2	
SWELL % @	MOD NRB PRO	0,00 0,02 0,04	
	100 %	128	
	98 %	74	
C.B.R. SANS GR40	97 %	57	
	95 %	33	
	93 %	19	
	90 %	8	

STABILISER IN LAB	Not Applicable		
TEST TYPE	CBR		
SAMPLING METHOD	TMH 5		
WEATHER WHEN SAMPLED	Cold		

Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
 Further use of the above information is not the responsibility or liability of Roadlab.
 Documents may only be reproduced or published in their full context.
 Report compiled by : Juraine Okkies

Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

Date Reported : 2020-07-29

Project : Boegoeberg Infrastructure Upgrade

Determination Maximum Dry Density & Optimum Moisture Content Test Report

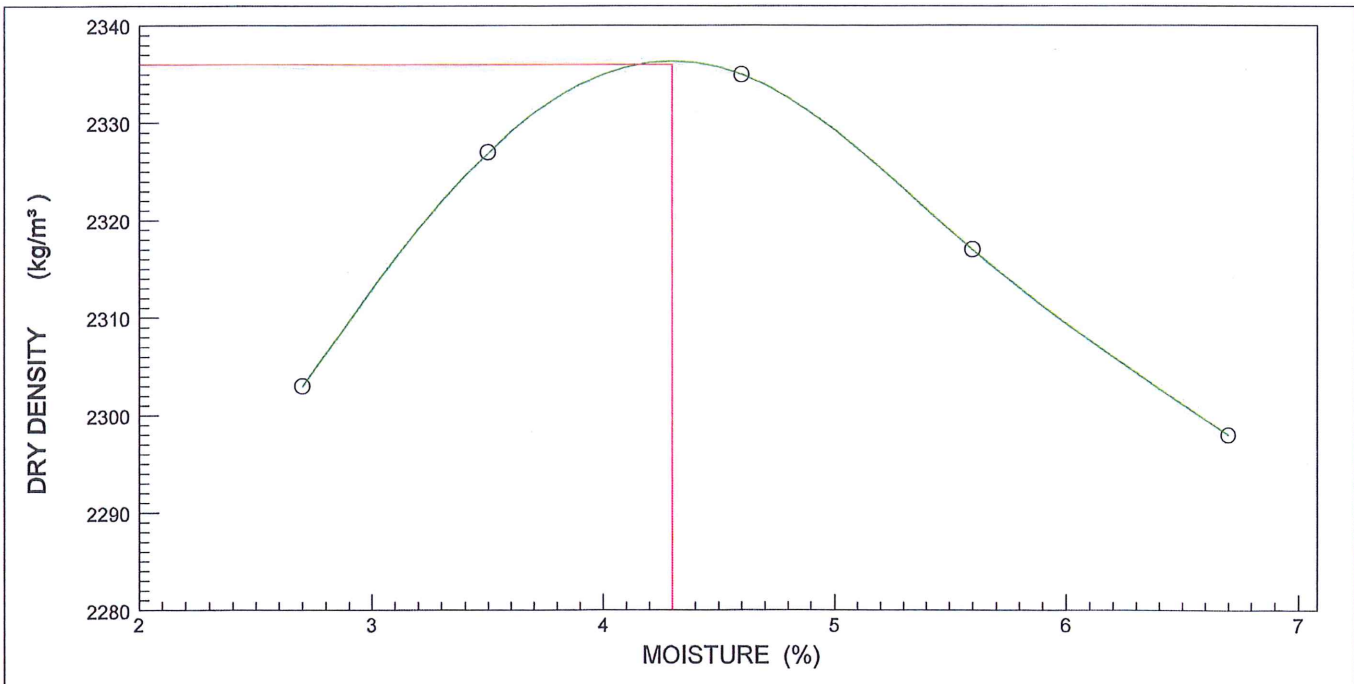
SANS 3001 - GR20/GR30

SAMPLE NO.	U9314
CONTAINER FOR SAMPLING	Black Bags
SIZE / APPROX. MASS OF SAMPLE	101kg
MOISTURE CONDITION OF SAMPLE	Moist
LAYER TESTED / SAMPLED FROM	300-800mm
MATERIAL DESCRIPTION	Mix Ironstone
HOLE NO./ km / CHAINAGE	TP22
ROAD NO.	Not Specified
DATE RECEIVED	2020-07-14
DATE SAMPLED	2020-07-13
CLIENT MARKING	S28° 55' 37,2"; E22° 07' 16,1"
COLOUR AND TYPE	Reddish Brown Gravel

POINT NO.	1	2	3	4	5			
DRY DENSITY (kg/m ³)	2303	2327	2335	2317	2298			
MOISTURE (%)	2,7	3,5	4,6	5,6	6,7			


MAXIMUM DRY DENSITY (kg/m³) : 2336

OPTIMUM MOISTURE CONTENT (%) : 4,3



Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
 Further use of the above information is not the responsibility or liability of Roadlab.
 Documents may only be reproduced or published in their full context.
 Report compiled by : Juraine Okkies



Accreditation No. T0296
 Prog.ver 10.7 (2019/11/07)


 D Juckers
 Technical Signatory
 (2 of ...)

Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

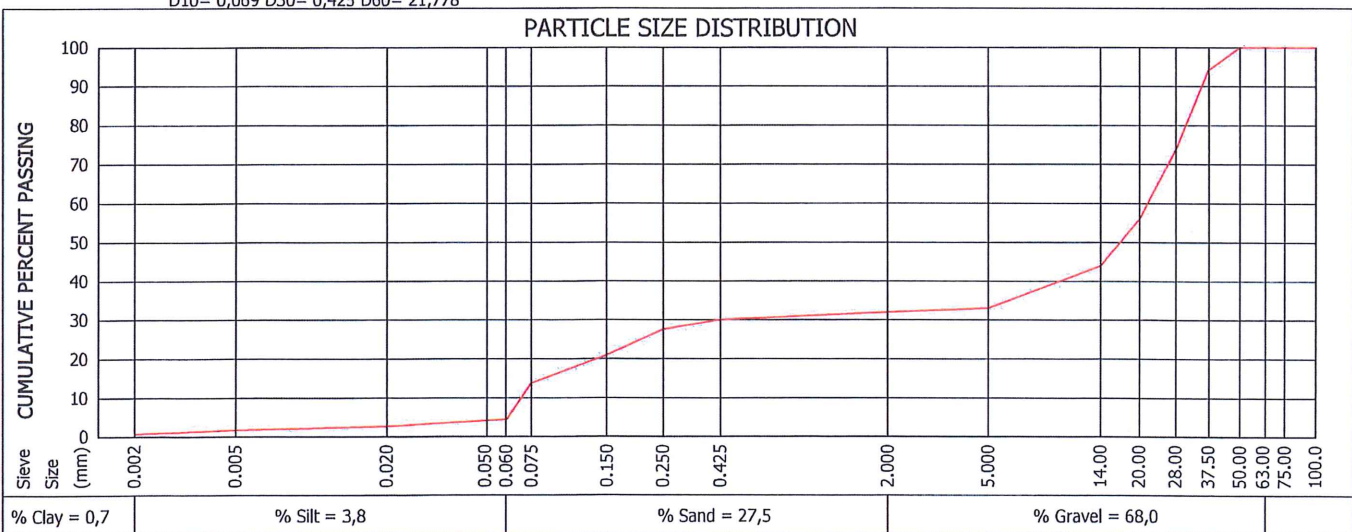
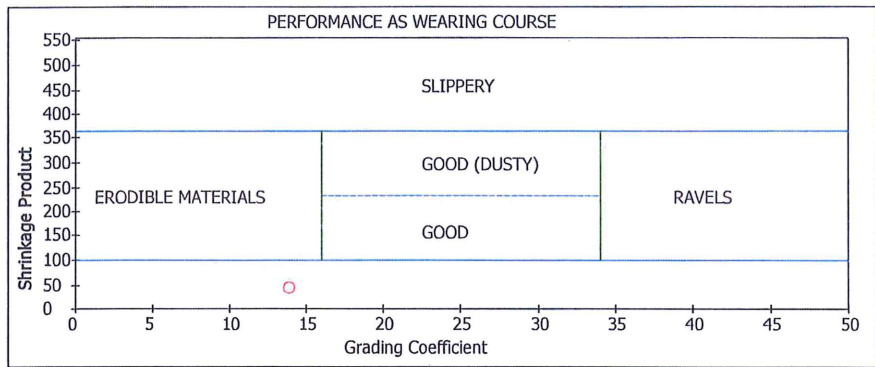
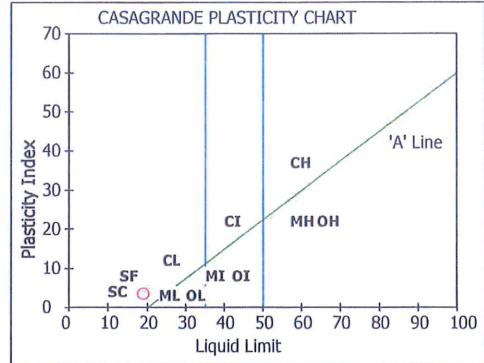
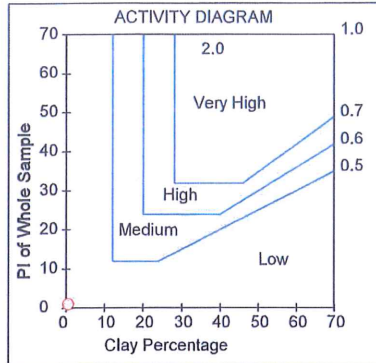
Date Reported : 2020-08-24

Project : Boegoeberg Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No.	: U9313
Position	: TP 24
Layer Type	: 0-300mm
Sample Colour	: Reddish Brown Gravel
Sample Type	: Mix Ironstone

Sieve Size(mm)	% Passing	Soil Mortar		
100.0	100	2.000 - 0.425	4	
75.00	100	0.425 - 0.250	9	
63.00	100	0.250 - 0.150	21	
50.00	100	0.150 - 0.075	22	
37.50	94	< 0.075	44	
28.00	74	Effective Size	0,069	
20.00	56	Uniformity Coefficient	315,6	
14.00	44	Curvature Coefficient	0,1	
5.000	33	Oversize Index	6,0	
2.000	32	Shrinkage Product	45,0	
0.425	30	Grading Coefficient	13,9	
0.250	28	Grading Modulus	2,20	
0.150	21	Atterberg Limits	Liquid Limit	19
0.075	14		Plasticity Index	3.0
0.060	4,5		Linear Shrinkage	1.5
0.050	4,1		PI < 0.075	
0.020	2,7	Unified Soil Classification	GC	
0.005	1,7	US Highway Classification	A-1-a(0)	
0.002	0,7	D10= 0,069 D30= 0,425 D60= 21,778		



Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
 Further use of the above information is not the responsibility or liability of Roadlab.
 Documents may only be reproduced or published in their full context.
 Report compiled by : Juraine Okkies



(Signature)
 D. Juekers
 Technical Signatory

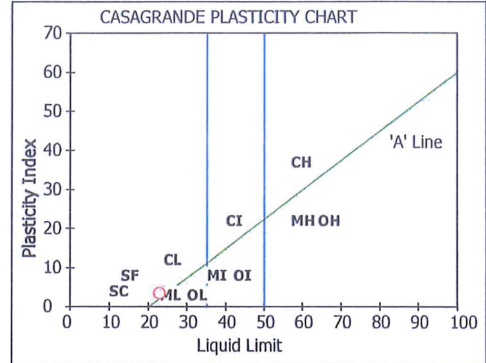
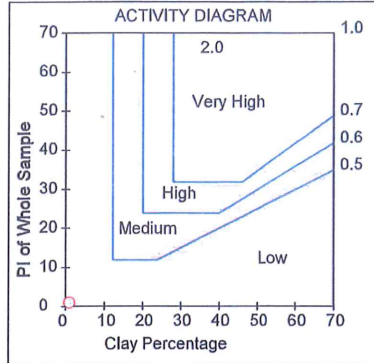
Job Request No.: RU3525
 Ceder Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

Date Reported : 2020-08-24

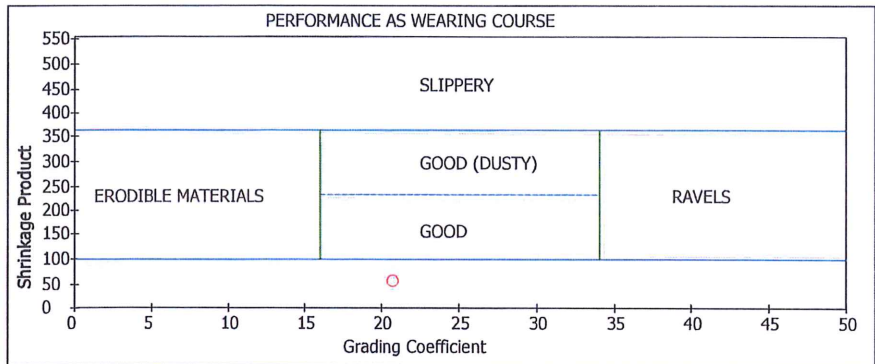
Project : Boegoeberg Infrastructure Upgrade

Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

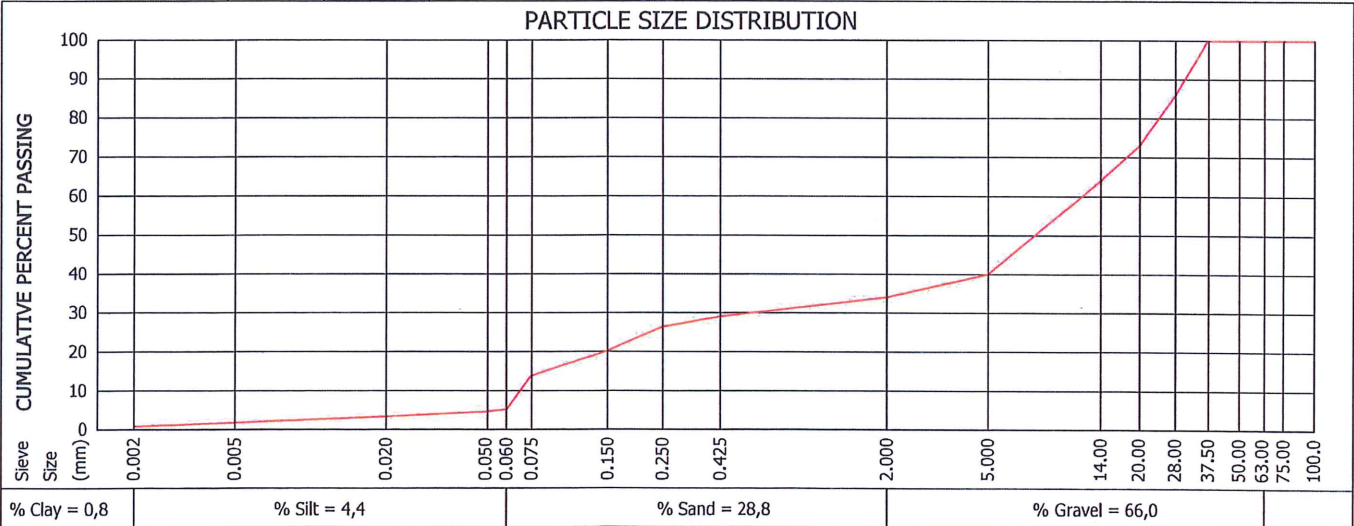
Sample No.	: U9312
Position	: TP 29
Layer Type	: 0-300mm
Sample Colour	: Brown Gravel
Sample Type	: Mix W.Cal + Quartz



Sieve Size (mm)	% Passing	Soil Mortar	2.000 - 0.425	13
100.0	100		0.425 - 0.250	8
75.00	100		0.250 - 0.150	18
63.00	100		0.150 - 0.075	19
50.00	100		< 0.075	42
37.50	100	Effective Size		0,068
28.00	86	Uniformity Coefficient		183,8
20.00	73	Curvature Coefficient		0,6
14.00	64	Oversize Index		0,0
5.000	40	Shrinkage Product		58,0
2.000	34	Grading Coefficient		20,8
0.425	29	Grading Modulus		2,20
0.250	26	Atterberg Limits	Liquid Limit	23
0.150	20		Plasticity Index	4,0
0.075	14		Linear Shrinkage	2,0
0.060	5,2		PI < 0.075	
0.060	5,2	Unified Soil Classification		GC
0.050	4,7	US Highway Classification		A-1-a(0)
0.020	3,3			
0.005	1,7			
0.002	0,8			




D10= 0,068 D30= 0,740 D60= 12,500



Deviation from Test Method :
 Remarks and Notes :

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
 Further use of the above information is not the responsibility or liability of Roadlab.
 Documents may only be reproduced or published in their full context.
 Report compiled by : Juraine Okkies




 D Juckers
 Technical Signatory 15 16
 ... of ...

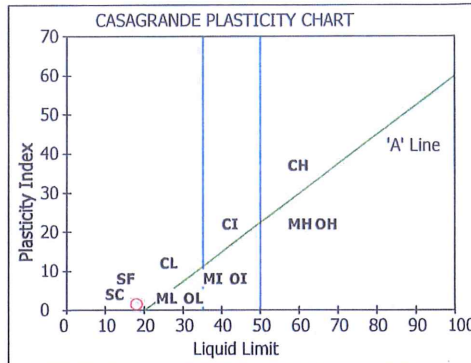
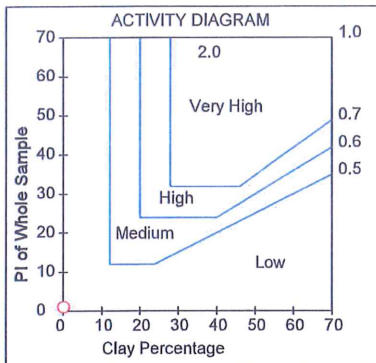
Job Request No.: RU3525
 Cedar Land Geotechnical Consult (Pty) Ltd
 PO Box 607
 Ceres
 6835
 Attention : Frans Breytenbach

Date Reported : 2020-08-24

Project : Boegoeberg Infrastructure Upgrade

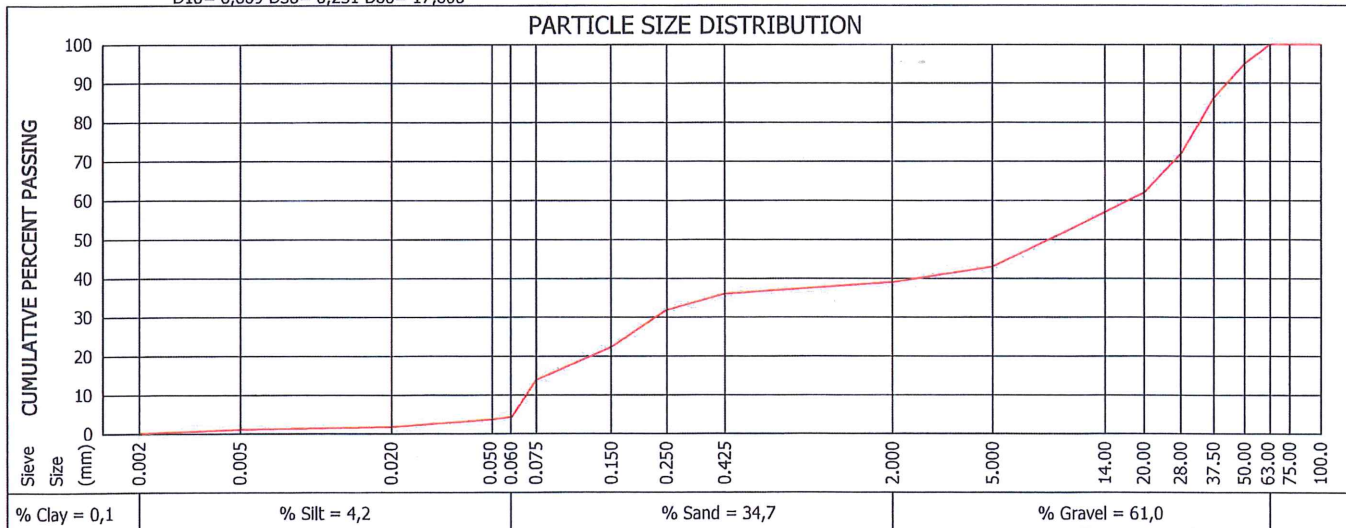
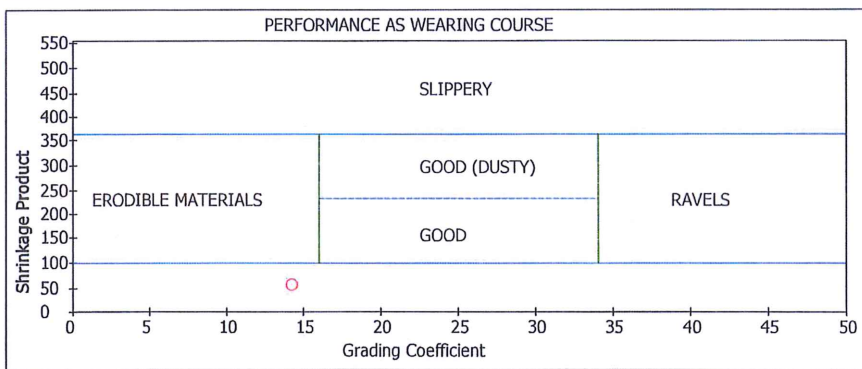
Foundation Indicator Test Report SANS 3001 - GR1 / GR3 / GR10

Sample No.	: U9311
Position	: TP 30
Layer Type	: 0-300mm
Sample Colour	: Brown Gravel
Sample Type	: Mix Calcrete + Quart



Sieve Size(mm)	% Passing	Soil Mortar	2.000 - 0.425	8
100.0	100		0.425 - 0.250	11
75.00	100		0.250 - 0.150	24
63.00	100		0.150 - 0.075	22
50.00	95		< 0.075	36
37.50	86	Effective Size		0,069
28.00	72	Uniformity Coefficient		255,1
20.00	62	Curvature Coefficient		0,0
14.00	57	Oversize Index		9,0
5.000	43	Shrinkage Product		54,0
2.000	39	Grading Coefficient		14,2
0.425	36	Grading Modulus		2,10
0.250	32	Atterberg Limits	Liquid Limit	18
0.150	22		Plasticity Index	2,0
0.075	14		Linear Shrinkage	1,5
0.060	4,3		PI < 0.075	
0.050	3,7	Unified Soil Classification		GC
0.020	1,8	US Highway Classification		A-1-b(0)
0.005	1,1			
0.002	0,1			

D10= 0,069 D30= 0,231 D60= 17,600



Deviation from Test Method :
 Remarks and Notes : Chemistry: pH = 7.78 [SANS 5854] & Conductivity = 0.17 S/m [SANS 6240]

Opinions and interpretations are not included in our scope of works. (T0296)
 The samples were subjected to analysis according to (SANS)(TMH5)(DOT)(ASTM).
 The test results reported relate to the samples tested.
 Further use of the above information is not the responsibility or liability of Roadlab.
 Documents may only be reproduced or published in their full context.
 Report compiled by : Juraine Okkies