REPORT ON THE GEOTECHNICAL CONDITIONS ON PORTION 128 AND A PORTION OF THE RESTANT OF THE FARM KOUSAS 459, KEIMOES

2020/J032/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 50 hectare of land on Portion 128 and a portion of the restant of the farm Kousas 459 to the west of Keimoes as a residential area. For this purpose Cedar Land Geotechnical Consult (Pty) Ltd was appointed as subconsultant to Macroplan by Ms Y Botha and Mr R van den Berg of Barzani Town Planning per letter of appointment dated 20 January 2020 to conduct a geotechnical investigation on the property.

2 SITE DESCRIPTION

2.1 Site Location

Portion 128 and a portion of the restant of the farm Kousas 459 are situated on the western boundary of the existing town of Keimoes in the Northern Cape. The eastern boundary of the property is formed by Aalwyn Street ; the southeastern boundary by the railway line ; the western boundary by vacant land ; and the northern boundary by a powerline. The size of the property is 50 hectare.

2.2 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.

2.3 Existing Facilities

2.3.1 Informal Housing

Informal housing consisting of galvanized iron structures and some masonry structures is present in the western part of the site, bordering Aalwyn Street. Water and electricity are provided to the structures, though it may not always be legal connections.

2.3.2 Vacant Land

Vacant, undeveloped land is present close to the railway line in the south and to the west of the informal settlement.

3 NATURE OF INVESTIGATION

Thirty five test pits were excavated with a Case 580T TLB. All test pits were excavated to refusal, except where collapse of sidewalls occurred. The test pits were profiled by a professionally registered geotechnical engineer.

Soil testing consisted of the following :

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

4 GEOLOGY, SOIL PROFILES AND GROUNDWATER

4.1 Stratigraphy

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 Kakamas Terrane and the site is located on Friersdale charnockite and Vaalputs granite-gneiss of the Keimoes Suite that is intrusive into the terrane. The charnockite is described as dark grey, unfoliated rock. The texture is fine to medium and uneven grained. Many of the quartz grains have an opalescent blue colour. Charnockite consists of a fine grained groundmass of quartz, feldspar, minor plagioclase and biotite, with larger biotite, hypersthene and augite grains

4.2 Soil Profile

4.2.1 Colluvium

The soil profile consists of a surface horizon of colluvium comprising of coarse sand to fine sand containing occasional gravels of banded ironstone, quartz and quartzite. The horizon extended to a maximum depth of 800mm. The colluvium is not expansive or collapsible, but compressible due to its general loose consistency.

4.2.2 Alluvium

A surface horizon of alluvium is present in the drainage gullies on site, comprising of fine sand containing gravels of quartz. Calcification may occur with depth. The horizon extended to a maximum depth of 2700mm. The alluvium is not expansive or collapsible, but highly compressible due to it's very loose to loose consistency.

4.2.3 Pebblestone Marker

Only a minor occurrence of the pebblestone marker was encountered in one test pit only. It was 100mm thick maximum, consisting predominantly of gravels of banded ironstone in a matrix of fine sand. The pebblestone marker is not expansive or collapsible and only negligibly compressible and erodible.

4.2.4 Residual Charnockite

Residual charnockite underlies the colluvium and in some instances the pedogenic deposits, occurring from depths between 200mm and 1100mm minimum, extending to 300mm to 1900mm maximum. It can be described as dirty white speckled dark grey varying to light brown gravelly sand. The presence of flakes of biotite was occasionally encountered in the charnockite soil profile. The consistency of the residual charnockite varied between loose and very dense in the test pits. The residual charnockite is not expansive or collapsible and only negligibly compressible and erodible.

4.2.5 Residual Granite-gneiss

Residual granite-gneiss underlies the colluvium, occurring from depths between 200mm and 1100mm minimum, extending to 700mm to 1600mm maximum. The residual granite-gneiss can be described as dirty white speckled dark grey varying to dark grey speckled white gravelly sand. The consistency of the residual granite-gneiss varied between dense and very dense in the test pits. The residual granite-gneiss is not expansive or collapsible and only negligibly compressible and erodible.

4.2.6 Mokalanen Formation

4.2.6(i) Hardpan Calcrete

Hardpan calcrete underlies the colluvium, occurring from depths between 100mm and 200mm minimum, extending to 300mm and 400mm maximum in isolated occurrences. The hardpan calcrete can be described as dirty white, very fine grained and very dense. It was possible to

penetrate the calcrete in the test pits as the horizon is fairly thin and it overlies residual soil material of lesser dense consistency.

4.2.6(ii) Nodular Calcrete

Nodular calcrete was encountered in variable conditions on site : from underlying the colluvium directly as a pure pedocretes ; to a sub-horizon contained within a horizon of residual soil ; or as an extensively calcified and nodular horizon, especially in the alluvium. It was present between 100mm and 800mm minimum, extending to 300mm to 1600mm maximum. The nodular calcrete can be described as dirty white, rounded fine to medium coarse, concretions contained in a matrix of fine sand. The consistency varies from loose to very dense.

4.3 Groundwater

4.3.1 Perched Water

Perched groundwater was encountered in TP 3 at a depth of 1500mm and in TP 35 at 1400mm during the investigation. In both cases the presence of the water can be associated with the existing major drainage course through the site. Perched water was not encountered in any of the other test pits on site. It is anticipated that perched water will generally not prove problematic on the site, except in the major water course almost on a permanent basis ; and in the lesser drainage courses after events of inundation.

4.3.2 Permanent Groundwater

Groundwater is expected to occur at depths between 20 meters and 30 meters in fractures restricted to a zone directly below the water table. The presence of permanent water has no influence on the geotechnical conditions on site.

5 SITE CLASS DESIGNATION

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 15% of the proposed area for development. Slope across the land is less than 2%. Two foundation design alternatives are applicable to the zone, namely conventional strip foundations or slab-on-the-ground foundations placed directly on bedrock of granite-gneiss or charnockite.

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 2% of the proposed area for development. Slope across the land is approximately 5%. 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.

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 51% of the proposed area for development. Slope across the land is less than 2%. Two foundation design alternatives are applicable to the zone, namely conventional strip foundations or slab-on-the-ground foundations placed directly on medium dense to very dense residual soil or pedocretes.

5.4 Geotechnical Zone IV

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 17% of the proposed area for development. Slope across the land is approximately 5%. 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 placed directly on medium dense to very dense residual soil or pedocretes.

5.5 Geotechnical Zone V

The zone is classed as S1, meaning that the proposed horizon for founding is moderately compressible and rapid settlement between 10mm and 20mm is expected. The distribution thereof encompasses 5% of the proposed area for development. Slope across the land is less than 2%. Structures can be founded by reinforced strip foundations. Alternatively the loose overburden soil can be excavated and replaced with a compacted horizon supporting lightly reinforced strip foundations.

5.6 Geotechnical Zone VI

The zone is classed as S2, meaning that the proposed horizon for founding is highly compressible and rapid settlement in excess of 20mm is expected. The distribution thereof encompasses 8% of the proposed area for development. Slope across the land is less than 2%. Structures can be founded by reinforced strip foundations or concrete rafts. The foundations shall be designed by a suitably qualified and experienced professional engineer.

5.7 Geotechnical Zone VII

The zone is classed as S2, meaning that the proposed horizon for founding is highly compressible and quick settlement in excess of 20mm is expected. The distribution thereof encompasses 2% of the proposed area for development. Slope across the land is approximately 5%. The use of reinforced raft foundations will require additional works in the form of the construction of an engineered fill or cutting to establish a level platform for construction. Structures can thus be founded by reinforced strip foundations. The foundations shall be designed by a suitably qualified and experienced professional engineer.

6 CONDITIONS OF EXCAVATION

On average over the entire site bedrock was encountered at depths between 200mm minimum exceeding 3000mm maximum, averaging 950mm deep. The implication of this is that should trenches require excavated depths to 1000mm, 5% of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 37% of the excavation may be classified as hard.

6.1 Geotechnical Zones I and II

The average depth to bedrock is 300mm. Refusal of excavation occurred at an average depth of 400mm. The implication of this is that should trenches require excavated depths to 1000mm, 70% of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 80% of the excavation may be classified as hard.

6.2 Geotechnical Zones III and IV

The average depth to bedrock is 1090mm. Refusal of excavation occurred at an average depth of 1190mm. The implication of this is that should trenches require excavated depths to 1000mm, 100% of the excavation may be classified as soft, suitable for TLB excavation.

Should the required depth of excavation increase to 1500mm, 27% of the excavation may be classified as hard, requiring drilling and blasting.

6.3 Geotechnical Zone V

The average depth to bedrock is 1500mm. Refusal of excavation occurred at an average depth of 1800mm. The implication of this is that should trenches require excavated depths to 1000mm, 100% of the excavation may be classified as soft, suitable for TLB excavation. Should the required depth of excavation increase to 1500mm, 100% of the excavation may still be classified as soft, suitable for TLB excavation.

6.4 Geotechnical Zones VI and VII

In two of the four test pits excavated in the S2 zones, collapse of sidewalls occurred at depths exceeding 2000mm prior to encountering refusal or bedrock. One can thus state that the average depth to bedrock exceeds 1500mm. The implication of this is that should trenches require excavated depths to 1000mm, 100% of the excavation may be classified as soft, suitable for TLB excavation. Should the required depth of excavation increase to 1500mm, 100% of the excavation may still be classified as soft, suitable for TLB excavation. However, one must also expect the presence of perched water in the proximity of the major non-perennial water course and collapse of the excavation sidewalls.

7 LAND SLOPE

The average slope across the larger part of the land is less than 2%. Only in the southern extreme of the property is the slope approximately 5%. 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.

8 AREAS SUBJECT TO FLOODING

Three areas that may possibly be subject to flooding have been identified from satellite imagery and the presence of alluvial deposits in these areas confirm the possibility that they serve to dispose of stormwater. In all cases the stormwater is of seasonal nature in an arid area, which may lessen the impact thereof on residential development. Although the gullies located in the northern and southern extremes of the site may be regarded as being of lesser importance, the gully in the central part of the site may also accommodate possible treated effluent from the waste water disposal works.

9 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 residual soils are suitable for the construction of in-situ selected layerworks. The plasticity index of the calcrete exceeds the upper limit applicable for classification its suitability as road construction material. It can therefore be considered suitable only as roadbed only.
- *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.

10 OTHER CONSIDERATIONS

- *Undermining* : The area is not subject to undermining.
- *Seismic Activity* : The Peak Ground Acceleration expected in 50 years is 0,09g. 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 or a high soluble salts content.
- *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.

11 SPECIAL PRECAUTIONARY MEASURES

No extraordinary features requiring special precautionary measures to decrease the impact thereof are present on site.

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Cedar Land
Geotechnical
Consult (Pty) Ltd

PO Box 607
Ceres
6835

Reg no 2015/423890/07
VAT no 4810272098
Tel : 082702767 or 0823732146
E-mail : cedarland.frans@breede.co.za
or cedarland.mariette@ breede.co.za

REPORT ON THE GEOTECHNICAL CONDITIONS ON PORTION 128 AND A PORTION OF THE RESTANT OF THE FARM KOUSAS 459, KEIMOES

1 INTRODUCTION

It is envisaged to develop some 50 hectare of land on Portion 128 and a portion of the restant of the farm Kousas 459 to the west of Keimoes as a residential area. For this purpose Cedar Land Geotechnical Consult (Pty) Ltd was appointed as subconsultant to Macroplan by Ms Y Botha and Mr R van den Berg of Barzani Town Planning per letter of appointment dated 20 January 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 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 AVAILABLE INFORMATION

The following sources of available information recording available data obtained in the larger Keimoes area have been consulted for background information :

- *Breytenbach FJ* : Geotechnical Conditions in a Part of Keimoes Extension 7 : A Report for

the Establishment of 121 Housing Units, issued by Soilkraft cc on behalf of Roadlab/Prehab JV on 12 April 2009.

- *Breytenbach FJ* : Geotechnical Report for the Town of Keimoes : Rezoning and Subdivision of Erf 666, Keimoes, issued by Soilkraft cc on behalf of the Kai !Garib Municipality on 31 July 2012.
- *Breytenbach FJ* : Geotechnical Conditions on the Remainder of Erf 2867 Keimoes : A Phase 3 Report for the Proposed Construction of a New Magistrate's Office, issued by Soilkraft cc on behalf of WorleyParsons (Pty) Ltd on 14 May 2013.

4 SITE DESCRIPTION

4.1 Site Location

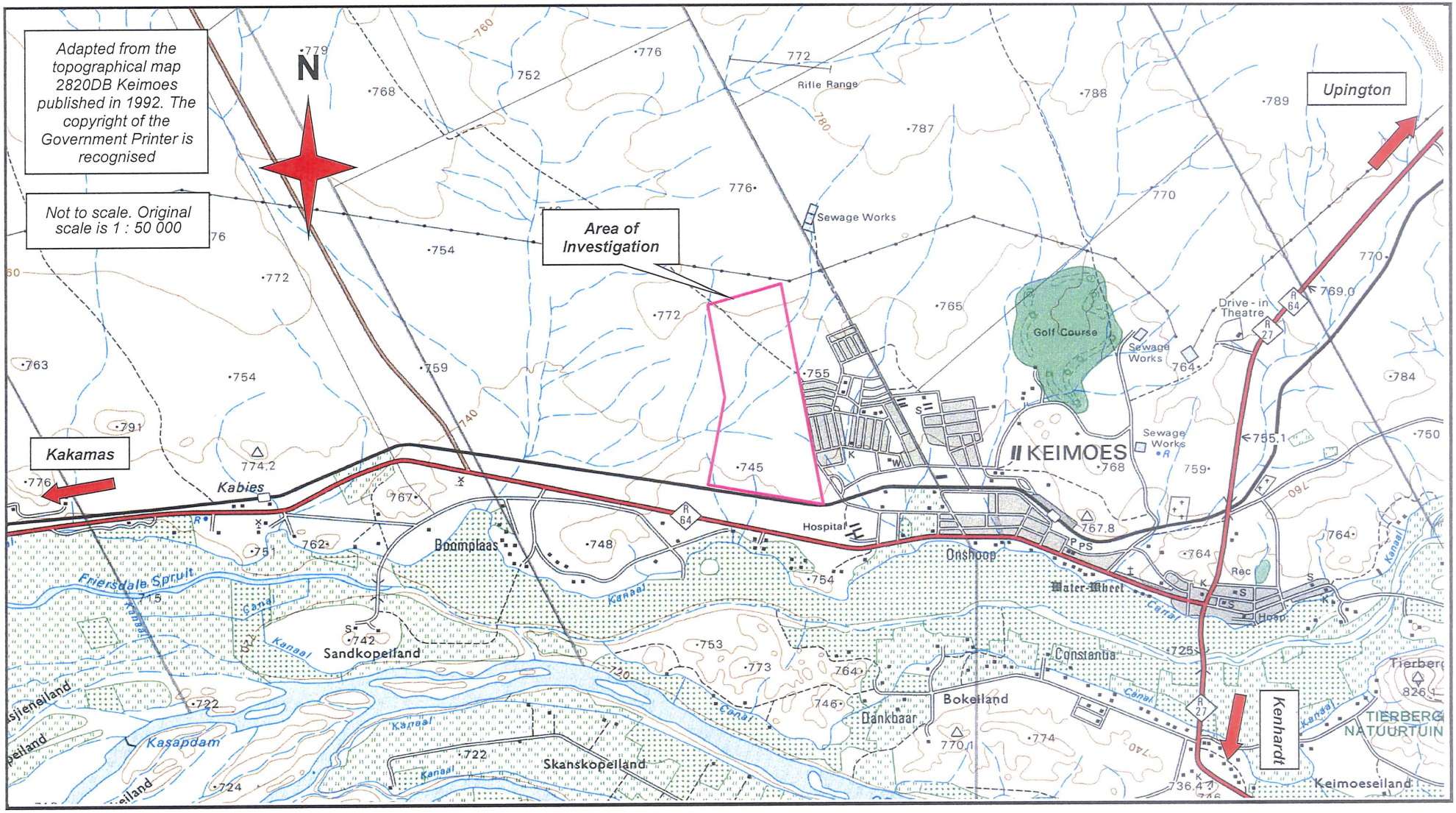
Portion 128 and a portion of the restant of the farm Kousas 459 are situated on the western boundary of the existing town of Keimoes in the Northern Cape. The eastern boundary of the property is formed by Aalwyn Street ; the southeastern boundary by the railway line ; the western boundary by vacant land ; and the northern boundary by a powerline. The size of the property is 50 hectare.

Refer to the attached Figure 1 : Locality Plan.

4.2 Topography and Drainage

The land investigated is located between 760,5mamsl and 737,0mamsl, sloping from northeast to southwest at less than 1%. However, the slope is not even and fairly level land and a rocky outcrop are present in the central part of the land at an approximate level of 754mamsl. A series of low hills formed by rocky outcrops and sloping topography are present along the southern boundary.

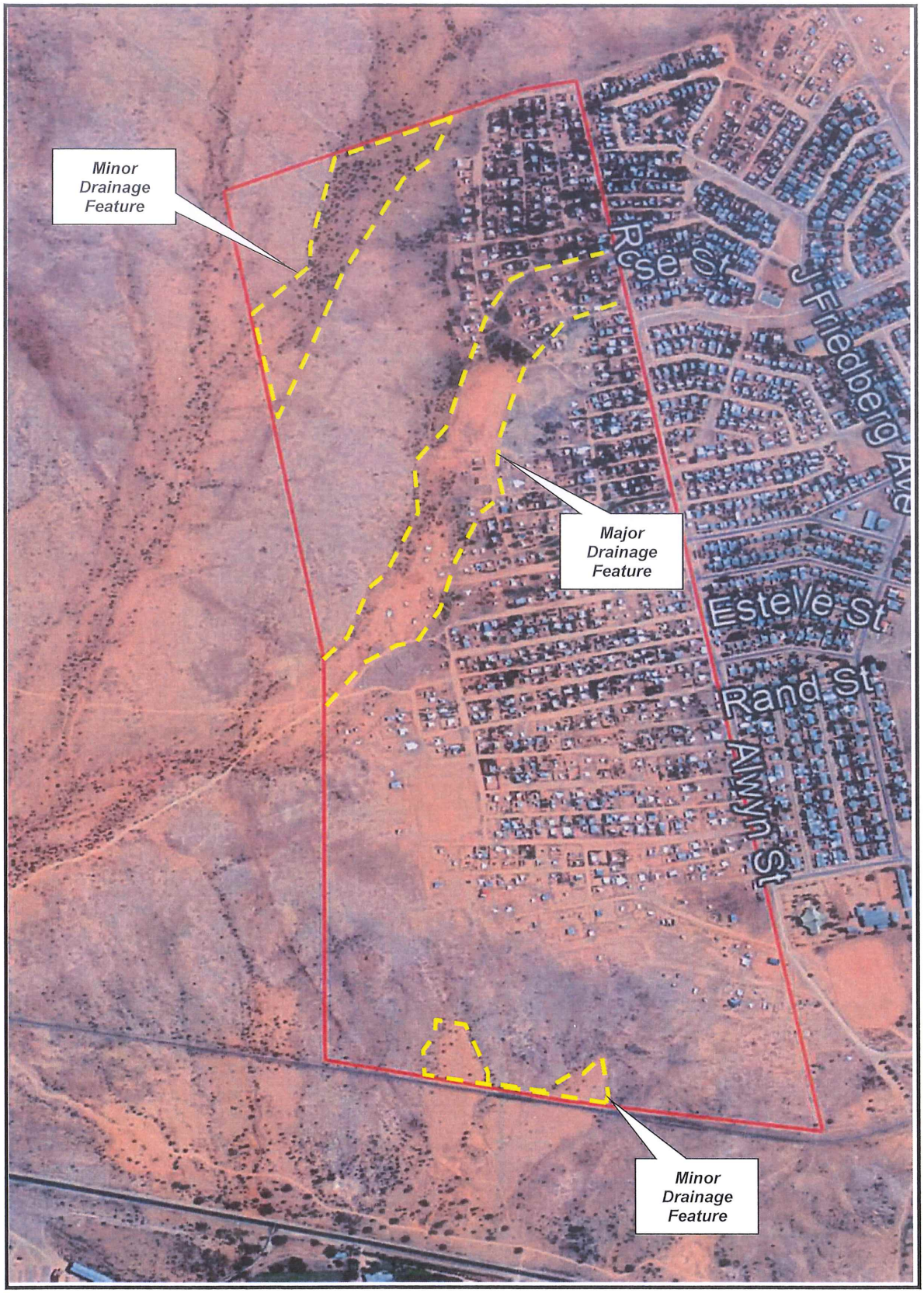
Drainage takes place by means of sheetwash. The sheetwash is disposed of towards the southwest according to the slope of the land. However, a major non-perennial water course bisects the land from northeast to southwest. Two small non-perennial water courses are also present in the southern and northern extremes of the property. These drainage features are filled with thick deposits of loose and very loose sand. These features are clearly visible on satellite imagery and reproduced as Figure 2 : Drainage Features.



C.L.G.C.

LOCALITY PLAN

FIGURE 1



C.L.G.C.

DRAINAGE FEATURES

FIGURE 2

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, prisopis and Boscia albitrunca. Stands of aloe claviflora are present, although these plants are removed for herbal medication and extension of urbanization.

Vegetation in the area is illustrated on Photo 1 : Landscape and Vegetation.

4.4 Existing Facilities

Site conditions are illustrated on Photo 2 : Site Conditions. The area can be divided into two zones as follows :

4.4.1 Informal Housing

Informal housing consisting of galvanized iron structures and some masonry structures is present in the western part of the site, bordering Aalwyn Street. Water and electricity are provided to the structures, though it may not always be legal connections. The presence of high mast street lighting is indicative of the presence of an electricity network in some parts of the area. Sewerage disposal is by means of pit latrines. Some residents have created small vegetable and flower gardens on the stands.

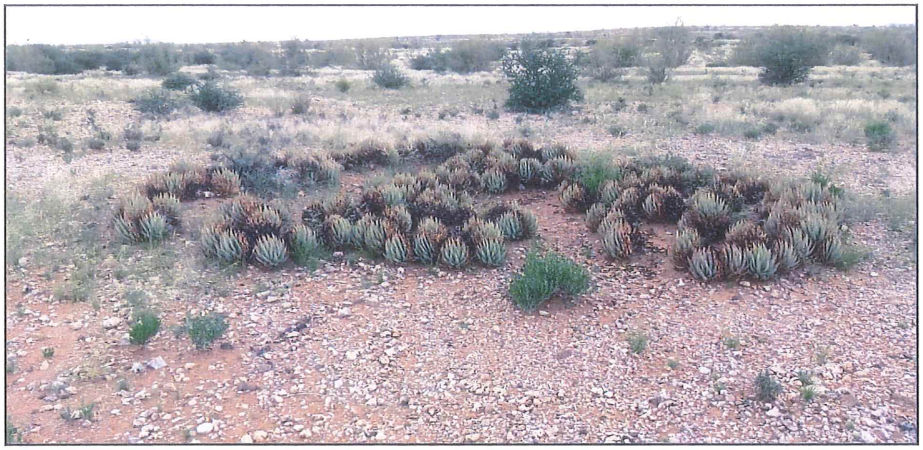
4.4.2 Vacant Land

Vacant, undeveloped land is present close to the railway line in the south and to the west of the informal settlement.

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 11 March 2020 35 test pits were excavated with a Case 580T TLB on hire from ALS Plant Rentals. The TLB was equipped with a



WELL DEVELOPED STAND OF ALOE CLAVIFLORA

INNOVATIVE GARDENING

C.L.G.C.

LANDSCAPE AND VEGETATION

PHOTO 1

CONDITIONS OF INFORMAL HOUSING

UNDEVELOPED LAND

C.L.G.C.

SITE CONDITIONS

PHOTO 2

700mm wide bucket. All test pits were excavated to refusal, except where collapse of sidewalls occurred.

The test pits were profiled by a professionally registered geotechnical engineer. For the benefit of the non-geotechnical reader of this document, these guidelines 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 3 : Site Plan. Provisional co-ordinates for property beacons A to H are indicated on this figure.

5.2 Materials Testing

Soil testing was undertaken by Specialised Testing Laboratory in Koedoespoort, Pretoria.

Soil testing consisted of the following :

- Conductivity and pH determinations on samples of the in-situ materials to determine the corrosivity thereof.
- Foundation indicator testing on samples of the in-situ materials to determine possible conditions of heave or settlement.
- CBR and road indicator testing 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.

Due to general limited vertical extent of the soil profile and coarse nature thereof, it was not feasible to retrieved undisturbed samples to determine properties of settlement or collapse fairly accurately. In the few cases where it was possible to excavate to an appreciable depth undisturbed sampling failed due to the loose consistency and arenaceous nature of the soil.

6 SITE GEOLOGY AND GEOHYDROLOGY

Although the geology of the larger area around Keimoes appears to consist ubiquitously of granitoid rock, 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 Visser[Reference 14.2], McCarthy[Reference 14.3], Cornell[Reference 14.4] and Moen[Reference 14.5] were consulted. Of these four references, the latter two can be regarded as site specific.

TABLE 1 : SOIL PROFILING PARAMETERS

CONSISTENCY : GRANULAR SOILS

SPT N	GRAVELS & SANDS Generally free draining soils		DRY DENSITY (kg/m^3)
<4	Very loose	Crumbles very easily when scraped with geological pick. Requires power tools for	<1450
4-10	Loose	Small resistance to penetration by sharp pick point. requires many blows by pick point	1450-1600
10-30	Medium dense	Considerable resistance to penetration by sharp pick point.	1600-1750
30-50	Dense	Very high resistance to penetration by sharp pick point. Requires many blows by pick point for excavation.	1750-1925
>50	Very dense	High resistance to repeated blows of geological pick. Requires power tools for excavation.	>1925

CONSISTENCY : COHESIVE SOILS

SPT N	SILTS & CLAYS and combinations with SANDS. Generally slow draining soils		UCS (kPa)
<2	Very soft	Pick point easlily pushed in 100mm. Easily moulded by fingers.	<50
2-4	Soft	Pick point easlily pushed in 30mm to 40mm. Moulded by fingers with some pressure.	50-125
4-8	Firm	Pick point penetrates to 10mm. Very difficult to mould with fingers.	125-250
8-15	Stiff	Slight indentation by pick point. Cannot be moulded by fingers. Penetrated by thumb nail.	250-500
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

COLOUR

Speckled	Very small patches of colour <2mm
Mottled	Irregular patches of colour 2-6mm
Blotched	Large irregular patches 6-20mm
Banded	Approximately parallel bands of varying colours
Streaked	Randomly orientated streaks of colour
Stained	Local colour variations : Associated with discontinuity surfaces

SOIL STRUCTURE

Intact	No structure present.
Fissured	Presence of discontinuities, possibly cemented.
Slickensided	Very smooth, glossy, often striated discontinuity planes.
Shattered	Presence of open fissures. Soil break into gravel size blocks.
Micro shattered	Small scale shattering, very closely spaced open fissures. Soil breaks into sand size crumbs.
Residual structures	Residual bedding, laminations, foliations etc.

ORIGIN

Transported	Alluvium, hillwash, talus etc.
Residual	Weathered from parent rock, eg residual granite
Pedocretes	Ferricrete, silcrete, calcrete 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

Two concepts must be identified :

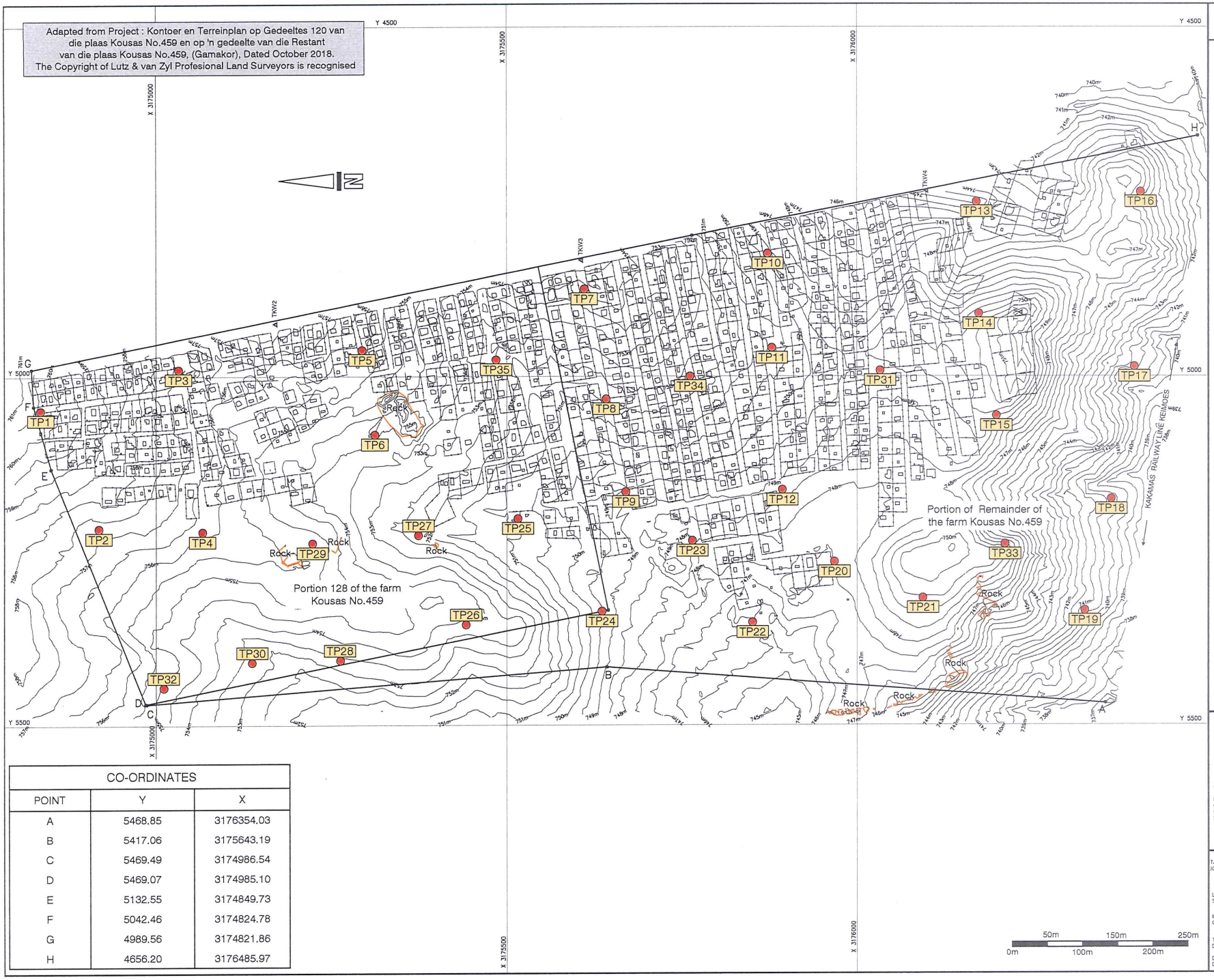
- *Craton* : A craton is a block of ancient crust, formed 3000 million years ago and its rocks have essentially remained unchanged. Cratons form the larger parts of the land-building mass.
- *Terrane* : A terrane is a term for a tectonostratigraphic unit, which is a fragment of crustal material formed 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.

Adapted from Project : Kontoer en Terreinplan op Gedeeltes 120 van die plaas Kousas No.459 en op 'n gedeelte van die Restant van die plaas Kousas No.459, (Gamakor), Dated October 2018.

FIGURE 3 :
SITE PLAN

LEGEND

TP1 TEST PIT POSITION



CO-ORDINATES		
POINT	Y	X
A	5468.85	3176354.03
B	5417.06	3175643.19
C	5469.49	3174986.54
D	5469.07	3174985.10
E	5132.55	3174849.73
F	5042.46	3174824.78
G	4989.56	3174821.86
H	4656.20	3176485.97

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: JOB NAME:	Gamakor
LIGGING: SITE:	Portion 128 and a Portion of the Remainder of the Farm Kousas 459
KLIENT: CLIENT:	Mun Kai !Garib!
TEKENING NO: DRAWING NO:	Figure 3 : Site Plan
DATUM: DATE:	08 April 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})	% SOIL MORTAR	OMC	MOD	SOIL CLASS		
														COLTO	PRA	UNIFIED
3	04-13	500-1500	Residual charnokite	Gravelly sand	1,79	NP	NP	Low	7,8	0,012	79				A-1-b(0)	SW-SM
13	04-15	0-800	Colluvium	Sand	1,27	NP	NP	Low			97				A-2-4(0)	SM
17	04-16	0-1100	Alluvium	Gravelly sand	1,55	NP	NP	Low			83	6,6	2084	G8	A-2-4(0)	SP-SM
23	04-17	300-1600	Nodular calcrete	Sandy gravel	2,04	28	49	Low			49	10,2	1997	No Class	A-2-7(0)	SC
26	04-18	200-1000	Nodular calcrete	Sandy gravel	2,21	NP	NP	Low			44				A-1-a(0)	SP-SM
27	04-19	300-600	Residual charnokite	Weathered rock as sandy gravel	2,61	7	26	Low			23	6,8	2146	G7	A-2-4(0)	SW
29	04-20	0-300	Colluvium	Gravels in sand	1,88	6	21	Low	7,6	0,047	52				A-1-b(0)	SC-SM
31	04-21	700-1400	Residual charnokite	Weathered rock as gravelly sand	1,80	NP	NP	Low	8,3	0,031	76				A-1-b(0)	SW-SM
33	04-22	300-700	Residual gneiss	Gravelly sand	1,96	NP	NP	Low	8,2	0,009	63				A-1-b(0)	SW-SM
34	04-23	300-1500	Residual gneiss	Fine sand & gravel	2,34	NP	NP	Low			43				A-1-a(0)	SW-SM
35	04-24	400-1500	Residual charnokite	Fine sand & gravel	2,12	7	26	Low	8,9	0,02	45				A-2-4(0)	SP-SC

6.1 Regional Geology

The regional geology of the area is indicated in Figure 4 : 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 subprovinces and terranes, based on marked changes in the lithostratigraphy across structural discontinuities. The five domains so recognized are the Richtersveld Subprovince, 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 5.

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. In the case of the Kakamas terrane, numerous intrusions occurred during the process of subduction, of which the Keimoes Suite is one. A schematic plate tectonic model showing the process as proposed on Figure 2.40 (Moen) is reproduced in this document as Figure 6. It is on the intrusive rock material of the Keimoes Suite that the proposed Gamakor development is located.

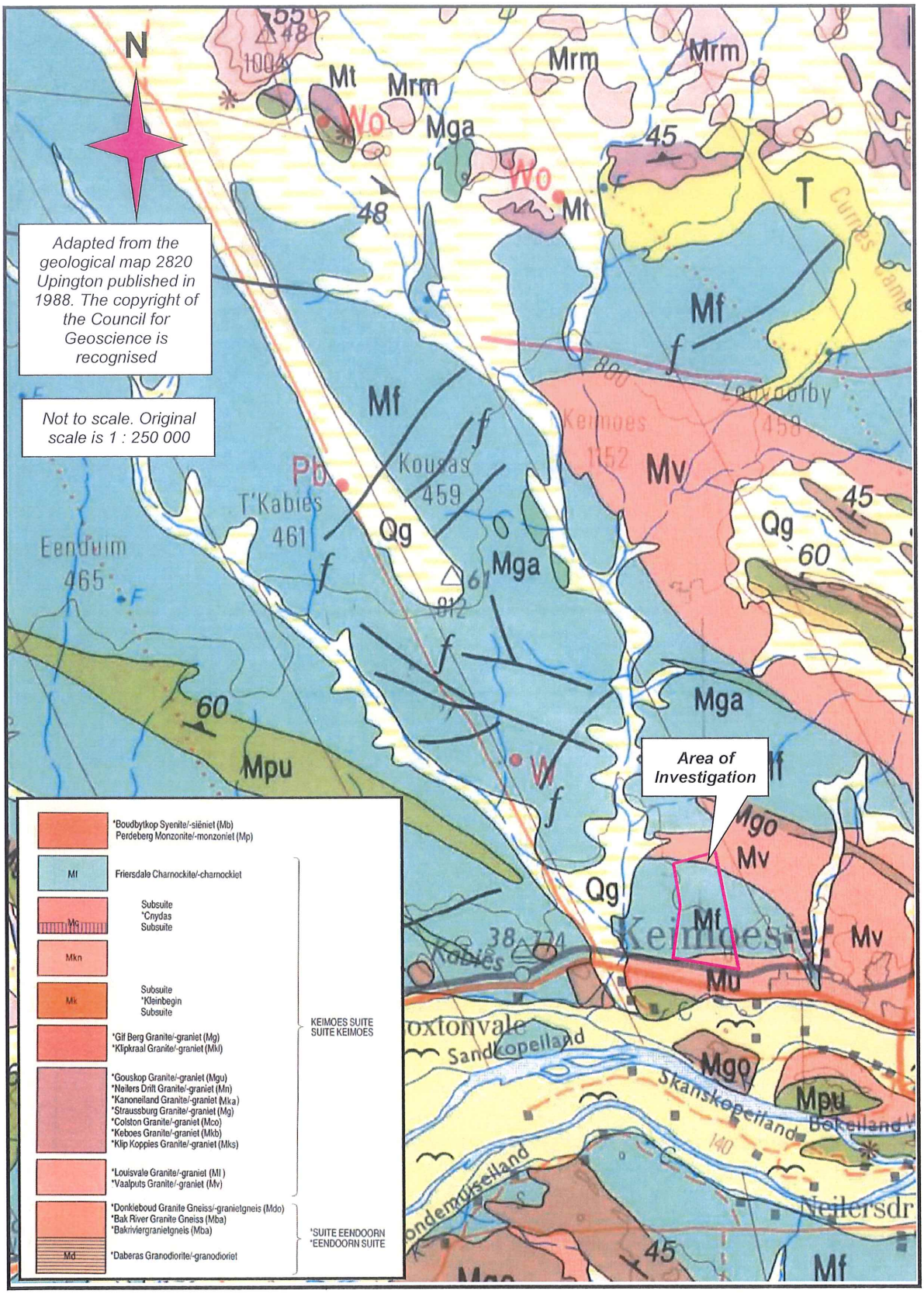
6.2 Site Geology

Moen as well as the official geology map 2280 describe the presence of both Vaalputs granite-gneiss and Friersdale charnockite in the area of investigation. Cornell does not differentiate between the two and regards both as charnockite.

On site it was found that Moen's distinction between the two rock types can be applied as follows :

6.2.1 Vaalputs Granite-gneiss

The Vaalputs granite-gneiss was encountered in the north eastern and southern parts of the site. It is regarded as an acid igneous rock, consisting of quartz, feldspars and subordinate



C.L.G.C.

REGIONAL GEOLOGY

FIGURE 4

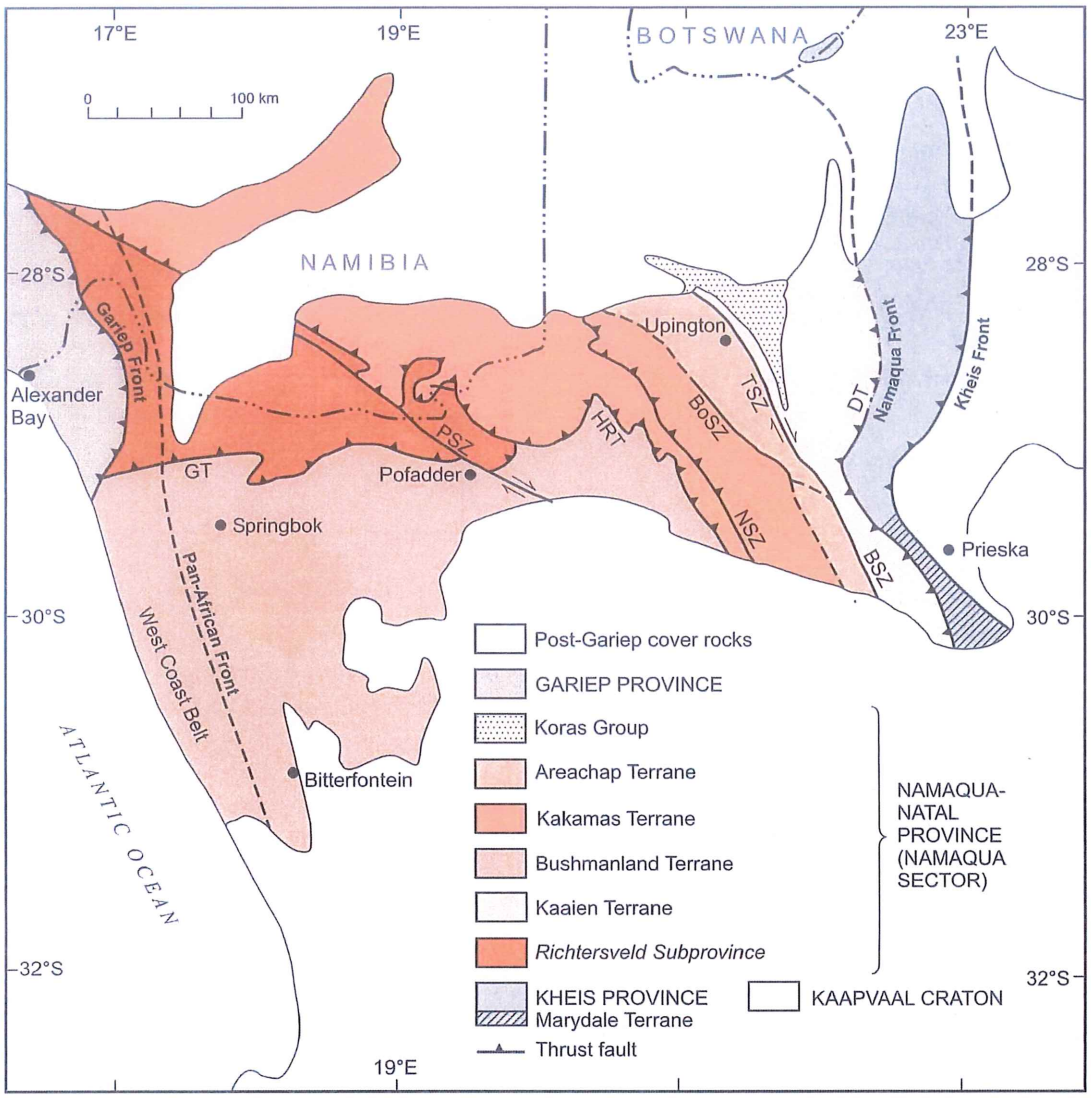


FIGURE 5 : TECTONIC SUBDIVISION OF THE NAMAQUA SECTOR

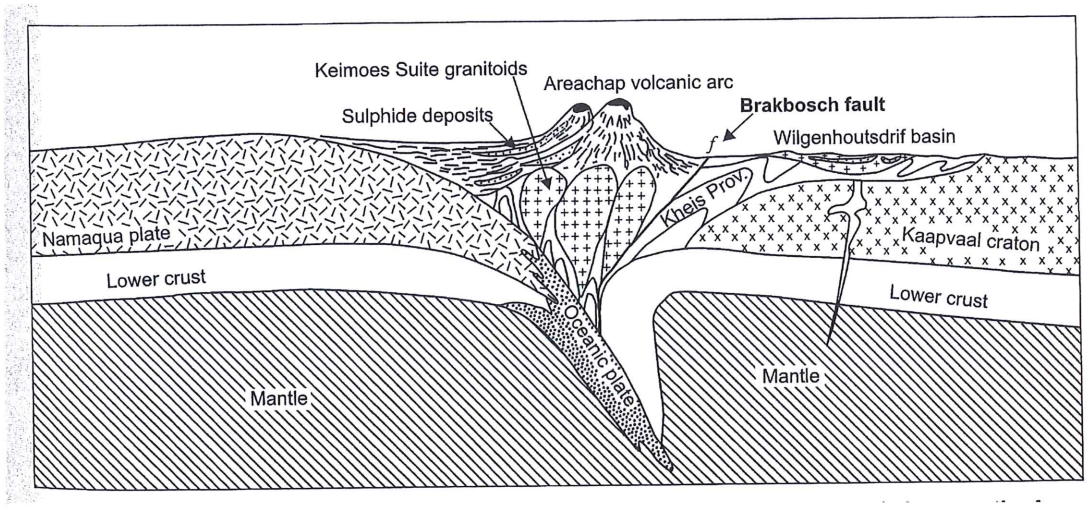


FIGURE 6 : SCHEMATIC PLATE TECTONIC MODEL SHOWING THE GRANITOIDS OF THE KEIMOES SUITE

biotite. It is light grey in colour, with medium grained, equigranular texture and well developed foliation.

The Vaalputs granite-gneiss contains numerous inclusions. The most common are concordant lenses and bands of white quartz. Such inclusions are visible in the southern parts of the site where the Vaalputs granite is present as outcrops.

6.2.2 Friersdale Charnockite

The Friersdale charnockite is the most widely distributed rock material on site. It is regarded as an acid igneous rock and tend to form dark grey exfoliating boulders. The charnockite is described as dark grey, unfoliated rock. The texture is fine to medium and uneven grained. Many of the quartz grains have an opalescent blue colour. Charnockite consists of a fine grained groundmass of quartz, feldspar, minor plagioclase and biotite, with larger biotite, hypersthene and augite grains and can actually be regarded as a charnockitic adamellite porphyry.

6.2.3 Distinguishing between the Friersdale Charnockite and Vaalputs Granite-gneiss

From the above discussion it is clear that visually there are not many features to make a first order distinction between the two materials without reverting to a petrological analysis. Although Cornell in the latest stratigraphic work combines the Vaalputs granite and the Friersdale charnockite under the latter, a clear distinction could be made on site based on a visual appraisal of the rock, and the differentiation between the rock types are maintained on Figure 7 : Site Geology.

The principles relied upon in the identification of the rock material were thus the following based on the characteristics as discussed above in subparagraphs 6.2.1 and 6.2.2 :

- *Foliation* : Foliation was considered as a characteristic of the Vaalputs granite-gneiss and not of the Friersdale charnockite.
- *Lenses and Bands of Quartz* : Lenses and bands of quartz were considered a characteristic of the Vaalputs granite-gneiss and not of the Friersdale charnockite.
- *Presence of Biotite* : The visible presence of large flakes of mica (biotite) was considered as a characteristic of the Friersdale charnockite and not of the Vaalputs granite-gneiss.
- *Colour and Grain Size* : The charnockite is regarded as darker of colour and coarser grained than the granite-gneiss.

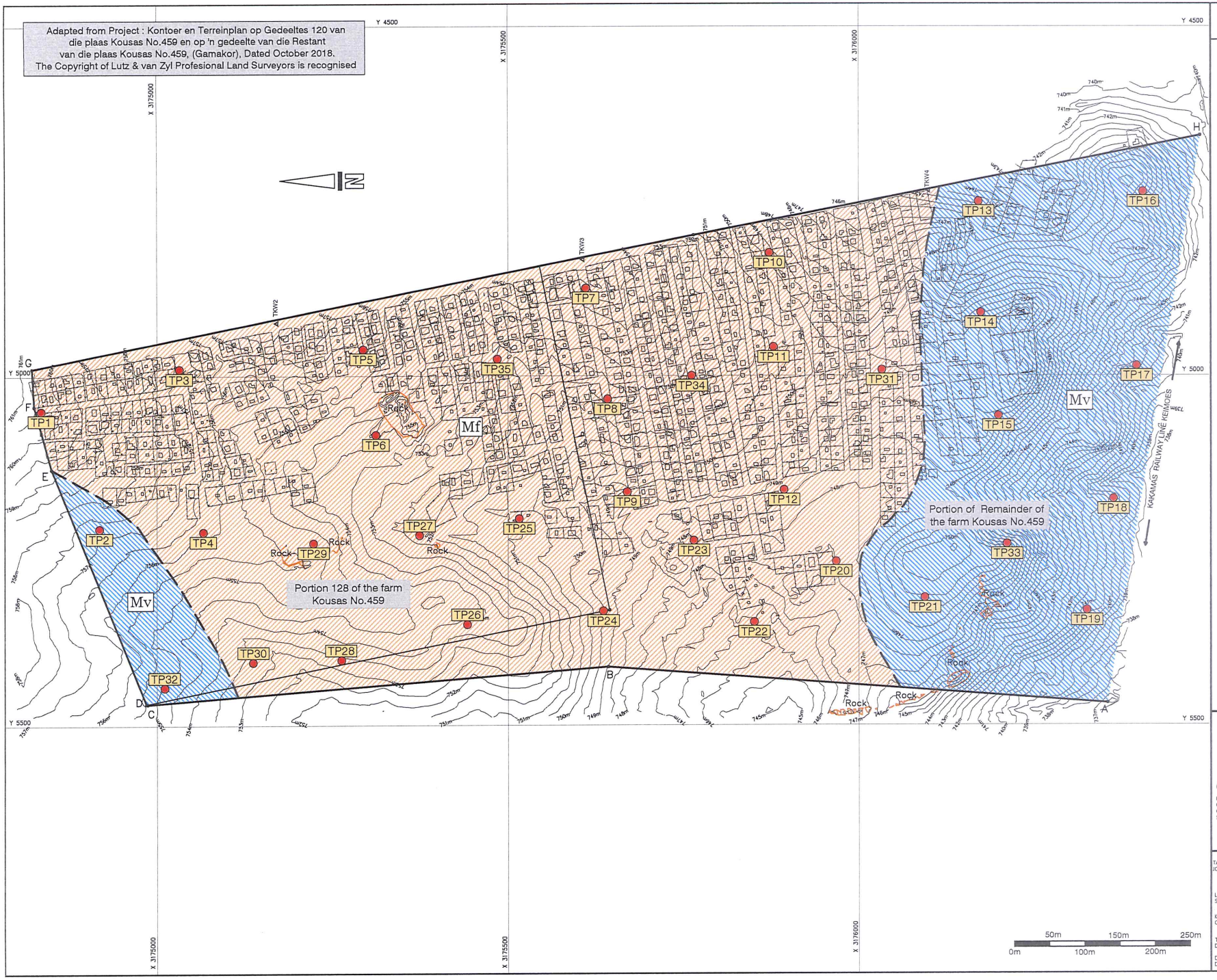


FIGURE 7 :
SITE GEOLOGY

LEGEND

TP1 TEST PIT POSITION

INFERRED MATERIAL BOUNDARY

Mf FRIERSDALE CHARNOKITE : WHITE AND GREY CHARNOCKITIC ADAMELLITE

Mv VAALPUTS GRANITE : MESOCRATIC, WELL-FOLIATED ADAMELLITIC GRANITE-GNEISS

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: JOB NAME:	Gamakor
LIGGING: SITE:	Portion 128 and a Portion of the Remainder of the Farm Kousas 459
KLIENT: CLIENT:	Mun Kai !Garib!
TEKENING NO: DRAWING NO:	Figure 7 : Site Geology
DATUM: DATE:	1 April 2020

6.3 Soil Profile

6.3.1 Colluvium

Colluvial deposits were encountered in TP's 1 to 11 ; 13 to 16 ; 19 to 24 ; 26 to 29 ; and 31 to 35 as a surface horizon between 100mm to 800mm thick. It consists of fine sands with variable contents of gravels in variable proportions, but mostly matrix supported. In the northern parts of the site the gravels consist of quartz and granite ; while in the south abundant banded ironstone, calcrete and quartz gravels are present in the soil matrix. The sand is dry to slightly moist, light brown to red brown in colour. The consistency of the stratum depends on the composition thereof : Mostly arenaceous material tend to be of very loose to loose consistency, but with an increase in gravel content it becomes medium dense.

6.3.2 Alluvium

Alluvium was encountered in TP's 17, 18, 25 and 30 in the alluvial plumes as a surface horizon of minimum 1100mm thick, extending to deeper than 2700mm.It consists of light brown, fine sand containing some matrix supported gravels of quartz. In TP's 25 and 30 the alluvium became calcified at depth, indicating the water courses to be of considerable age. During the investigation the alluvium was dry to slightly moist. The consistency of the alluvium varied between very loose and loose in the test pits. In TP 18 excavation was abandoned at a depth of 2700mm due to collapse of the excavation side walls.

6.3.3 Pebblestone Marker

The pebblestone marker was encountered in TP 20 only, underlying the colluvium. The pebblestone marker was 100mm thick in the test pit. It is described as clast supported coarse gravels of banded ironstone in a matrix of fine, light brown sand. The consistency was loose.

6.3.4 Residual Charnockite

Residual charnockite was encountered in TP's 3, 5, 7, 9, 10 to 11, 17, 20, 22, 24 and 34 to 35. It underlies the colluvium and in some instances the pedogenic deposits, occurring from depths between 200mm and 1100mm minimum, extending to 300mm to 1900mm maximum. The thickness of the horizon varied between 100mm and 1200mm in the test pits. The residual charnockite can be described as dirty white speckled dark grey varying to light brown coarse sand containing fine gravels. The presence of flakes of biotite was occasionally encountered in the charnockite soil profile. The consistency of the residual charnockite varied between loose and very dense in the test pits.

6.3.5 Residual Granite-gneiss

Residual granite-gneiss was encountered in TP's 2, 16 and 17, 19, 21, 32 and 33. It underlies the colluvium, occurring from depths between 200mm and 1100mm minimum, extending to 700mm to 1600mm maximum. The thickness of the horizon varied between 400mm and 1200mm in the test pits. The residual granite can be described as dirty white speckled dark grey varying to dark grey speckled white coarse sand containing fine gravels. The consistency of the residual granite-gneiss varied between dense and very dense in the test pits.

6.3.6 Mokalanen Formation

Pedogenic deposits associated with the Mokalanen Formation of the Kalahari Group are present on site, both as hardpan and nodular calcrete. The Mokalanen Formation was deposited under the arid climatic conditions straddling the boundary of the Pliocene and the Quaternary epochs. The deposition of the calcrete possibly reflects an interval of global aridification which occurred some 2,6 to 2,8 million years ago.

6.3.6(i) Hardpan Calcrete

Hardpan calcrete was encountered in TP's 34 and 35 only. It underlies the colluvium, occurring from depths between 100mm and 200mm minimum, extending to 300mm to 400mm maximum. The thickness of the horizon varied between 100mm and 300mm in the test pits. The hardpan calcrete can be described as dirty white, very fine grained and very dense. It was possible to penetrate the calcrete in the test pits as the horizon is fairly thin and it overlies residual soil material of lesser dense consistency.

6.3.6(ii) Nodular Calcrete

Nodular calcrete was encountered in TP's 2, 6, 9, 11, 13 to 15, 20, 23 and 24, 26 and 31. It occurs in variable conditions on site : from underlying the colluvium directly as a pure pedocrete ; to a sub-horizon contained within a horizon of residual soil ; or as an extensively calcified and nodular horizon, especially in the alluvium. It was present between 100mm and 800mm deep minimum, extending to 300mm to 1600mm maximum. The thickness of the horizon varied between 100mm and 1300mm in the test pits. The nodular calcrete can be described as dirty white, rounded fine to medium coarse, concretions contained in a matrix of fine sand. The consistency varies from loose to very dense.

6.4 Groundwater

6.4.1 Perched Water

Perched groundwater was encountered in TP 3 at a depth of 1500mm and in TP 35 at 1400mm during the investigation. In both cases the presence of the water can be associated with the existing major drainage course through the site.

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 major water course almost on a permanent basis ; and in the lesser drainage courses 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 14.6] 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 less than 10%. Groundwater is expected to occur at depths between 20 meters and 30 meters in fractures restricted to a zone directly below the water table.

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 1% for all the samples tested, except Sample CLG 04-17 consisting of nodular calcrete from TP 23.

TABLE 3 : SUMMARY OF ENGINEERING PROPERTIES

TEST PIT NO	SAMPLE NO	DEPTH (mm)	SOIL ORIGIN	SOIL TYPE	SOIL CLASS PRA	SOIL CLASS UNIFIED	COHESION[1] (kNm^{-2})	FRICTION ANGLE (°)[1]	COMPRESSIBILITY[2]	EROSION RESISTANCE[2,5]	PERMEABILITY[4] k (cms^{-1})	SPECIFICATIONS FOR UNPAVED ROADS[3] MAXIMUM SIZE	OVERSIZE INDEX (I_o)	GRADING COEFFICIENT (G_c)	SHRINKAGE PRODUCT (S_p)	CBR @ 95% MOD	SUITABILITY FOR ROAD CONSTRUCTION[4] PAVED	UNPAVED
3	04-13	500-1500	Residual charnokite	Gravelly sand	A-1-b(0)	SW-SM	1 to 22	32° to 38°	Fair to excellent	6 to 8	$(7,5\pm4,8)X10^{-6}$	4,75	0,0	20,8	0,0			Ravels & corrugates
13	04-15	0-800	Colluvium	Sand	A-2-4(0)	SM	20 to 22	32° to 35°	Fair	8	$(7,5\pm4,8)X10^{-6}$	4,75	0,0	3,0	0,0			Ravels & corrugates
17	04-16	0-1100	Alluvium	Gravelly sand	A-2-4(0)	SP-SM	0 to 22	30° to 39°	Fair	7 to 8	$>1.5X10^{-5}$	26,5	0,0	11,8	0,0	17	Lower selected	Ravels & corrugates
23	04-17	300-1600	Nodular calcrete	Sandy gravel	A-2-7(0)	SC	5 to 10	30° to 35°	Low	5	$(3\pm2)X10^{-7}$	26,5	0,0	29,3	288,0	20	Roadbed	Good but dusty
26	04-18	200-600	Nodular calcrete	Sandy gravel	A-1-a(0)	SP-SM	0 to 22	30° to 39°	Fair	7 to 8	$>1.5X10^{-5}$	37,5	5,0	37,7	0,0			Ravels & corrugates
27	04-19	300-600	Residual charnokite	Weathered rock as sandy gravel	A-2-4(0)	SW	1 to 5	33° to 38°	Negligible	6	Pervious (undetermined)	53,0	23,0	15,5	48	45	Upper selected	Ravels & corrugates
29	04-20	0-300	Colluvium	Gravels in sand	A-1-b(0)	SC-SM	5 to 22	30° to 35°	Low	5 to 8	$2,7X10^{-5}$ to $5,0X10^{-7}$	37,5	2,0	25,5	123			Good
31	04-21	700-1400	Residual charnokite	Weathered rock as gravelly sand	A-1-b(0)	SW-SM	1 to 22	32° to 38°	Fair to excellent	6 to 8	$(7,5\pm4,8)X10^{-6}$	37,5	4,0	18,0	0,0			Ravels & corrugates
33	04-22	300-700	Residual gneiss	Gravelly sand	A-1-b(0)	SW-SM	1 to 22	32° to 38°	Fair to excellent	6 to 8	$(7,5\pm4,8)X10^{-6}$	9,5	0,0	30,0	0,0			Ravels & corrugates
34	04-23	300-1500	Residual gneiss	Fine sand & gravel	A-1-a(0)	SW-SM	1 to 22	32° to 38°	Fair to excellent	6 to 8	$(7,5\pm4,8)X10^{-6}$	13,2	0,0	39,9	0,0			Ravels & corrugates
35	04-24	400-1500	Residual charnokite	Fine sand & gravel	A-2-4(0)	SP-SC	0 to 10	30° to 39°	Fair to good	5 to 7	$>1.5X10^{-5}$	53,0	29,0	13,2	108,5			Erodible

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 Properties of Settlement

7.1.2(i) Colluvium

Colluvial deposits were encountered in TP's 1 to 11 ; 13 to 16 ; 19 to 24 ; 26 to 29 ; and 31 to 35 as a surface horizon between 100mm to 800mm thick. The colluvium is generally described as sandy material, often containing some gravels and being of loose to medium dense consistency. Seldom can the consistency be described as very loose, and voided soil matrices were not encountered in the colluvial horizons. The horizon extended generally to less than 500mm thick and only in a few instances were thicker up to 800mm. The properties of the colluvium are thus such that it does not tend to excessive settlement.

7.1.2(ii) Alluvium

Alluvium was encountered in TP's 17, 18, 25 and 30 in the alluvial plumes as a surface horizon of minimum 1100mm thick, extending to deeper than 2700mm.It consists of light brown, fine sand containing some matrix supported gravels of quartz. The consistency of the alluvium varied between very loose and loose in the test pits. The soil matrices are described as intact and not voided. Although the soil composition of the alluvium is such that it is not specially subject to settlement, it can be regarded as recent, unconsolidated deposits. Considering the vertical extent of the alluvial deposits, it is regarded as the soil material on site most subject to settlement.

7.1.2(iii) Residual Soils

Residual charnockite was encountered in TP's 3, 5, 7, 9, 10 to 11, 17, 20, 22, 24 and 34 to 35 ; and residual granite-gneiss was encountered in TP's 2, 16 and 17, 19, 21, 32 and 33 in horizons 100mm to 800mm thick. Both materials consist predominantly of sand with a high gravel content and medium dense to very dense consistency. The soil 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.

7.1.2(iv) Pedocretes

Hardpan calcrete was encountered in TP's 34 and 35 only and nodular calcrete in TP's 2, 6, 9, 11, 13 to 15, 20, 23 and 24, 26 and 31 in horizons between 100mm and 800mm thick. Both materials are of medium dense to very dense consistency. The soil 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.

7.1.3 Corrosivity

When discussing soil corrosivity, it is applicable to consider the guidelines as proposed by EvansReference [14.7]. 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 $0,01Sm^{-1}$, 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 $0,05Sm^{-1}$, 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 7,6 and 8,9. 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 between $0,009Sm^{-1}$ for the residual gneiss to $0,047Sm^{-1}$ for the colluvium. The soluble salt content does therefore not contribute to the corrosivity of the soils.

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 encountered in TP's 3 and 35 in the unlined stormwater course.

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.

All other materials, that is the alluvium, colluvium, nodular calcrete and residual soils 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 soil samples show the in-situ materials to be generally of G7 to G8 quality and the calcrete unclassified for purposes of paved road or segmental block road construction. This type of construction is applicable to access roads to townships. The soil materials are therefore suitable only for the construction of in-situ selected layerworks and not for subbase and base course construction.

The case of Sample CLG 04-17 from TP 23 is typical of calcrete. Although the CBR is fairly high, typical of G8 material, the plasticity index of 28 is very high, reducing the classification of the calcrete to non-classifiable.

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. In contradiction to the construction of paved roads, calcrete appears to be the material more suitable for gravel wearing course construction, although experience has taught that if a calcrete with a high PI is used for this purpose, the road surface can become slippery in wet conditions.

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 14.8] 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.

- *Colluvium* : The colluvium is regarded as low to fairly compressible with cohesion (c_0) of 5,0kNm^{-2} to 22Nm^{-2} and the effective stress envelope approximately 30° to 35°.
- *Alluvium* : The alluvium is regarded as fairly compressible with cohesion (c_0) of zero to 22Nm^{-2} and the effective stress envelope approximately 30° to 39°.
- *Nodular Calcrete* : The nodular calcrete is regarded as low to fairly compressible with cohesion (c_0) of zero to 22Nm^{-2} and the effective stress envelope approximately 30° to 39°.
- *Residual Charnockite* : The residual charnockite is regarded as non-compressible to fairly compressible with cohesion (c_0) of zero to 22Nm^{-2} and the effective stress envelope approximately 30° to 39°.
- *Residual Gneiss* : The residual gneiss is regarded as non-compressible to fairly compressible with cohesion (c_0) of 1Nm^{-2} to 22Nm^{-2} and the effective stress envelope approximately 30° to 39°.

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.

- *Colluvium* : The colluvium is regarded as semi-pervious to impervious. The soil permeability coefficient varies between $2,7X10^{-6}cms^{-1}$ to $5,0X10^{-7}cms^{-1}$.
- *Alluvium* : The permeability of the alluvium is highly variable and regarded as pervious to impervious. The soil permeability coefficient varies between $2,7X10^{-6}cms^{-1}$ to $5,0X10^{-7}cms^{-1}$.
- *Calcrete* : The permeability of the calcrete is highly variable depending on the mode of deposition and regarded as pervious to impervious. The soil permeability coefficient varies between more permeable than $1,5X10^{-5}cms^{-1}$ to $5,0X10^{-7}cms^{-1}$.
- *Residual Charnockite* : The residual charnockite is regarded as pervious to impervious. The soil permeability coefficient varies between highly permeable (undetermined) to $12,3X10^{-6}cms^{-1}$.
- *Residual Gneiss* : The residual gneiss is regarded as pervious to impervious. The soil permeability coefficient varies between $(7,5\pm4,8)X10^{-6}cms^{-1}$.

7.1.5(iii) Erosion Potential

All soil materials encountered during the investigation can be regarded as moderately to poorly resistant against erosion. The aspect of erosion potential is important in the area. The thin soil cover of colluvium and residual soils in comparison with the substantially thicker deposits of alluvium 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 poor founding conditions on the unconsolidated alluvial deposits and favourable founding conditions on the thin horizons of colluvium and residual soil.

7.2 Properties of Bedrock Granite-gneiss and Charnockite

The TLB used to excavate the test pits did not penetrate bedrock to any significant extent and refusal of excavation occurred within millimeters after encountering bedrock. 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.

As discussed in subparagraph 6.2 above there is very little difference between the granite-gneiss and the charnockite, and that such differences that do occur are mostly regarded as minor in the latest stratigraphic reference work. Difference consist mostly of minor variations in petrology and some physical properties. For purposes of rock strength calculations these properties are not important and the charnockite and granite-gneiss can be treated as similar material.

Parametric calculations with Roclab software results for slightly weathered, moderately to widely jointed, hard rock to very hard rock result in the following properties :

- Cohesion : 26,1MPa
- Friction Angle : 48°
- Tensile Strength : 2,0MPa
- Uni-axle Compressive Strength : 82,2MPa
- Young's Modulus : 115545,7 MPa

All which show a very sound rock.

7.3 Excavation Classification with Respect to Services

7.3.1 Hand Excavation

7.3.1(i) Colluvium, Alluvium and Pebblestone Marker

The colluvium and pebblestone marker can be considered as suitable to be excavated by swing tools. However, especially in the alluvium and water courses the sidewalls of excavations can be prone to collapse.

7.3.1(ii) Pedogenic Deposits

The nodular and hardpan calcrete are of dense to very dense consistency, although occasionally of loose consistency. Such material cannot be considered as suitable to be manually excavated and may as minimum require the use of a 55kW TLB.

7.3.1(iii) Residual Soils

Both the residual charnockite and granite-gneiss are of medium dense to very dense consistency. In a condition of medium dense consistency it will be possible to excavate these materials manually ; in a state of dense consistency it will be possible to excavate it manually with considerable effort ; and if very dense, not at all and may as minimum require the use of a 55kW TLB.

7.3.1(iv) Bedrock

Bedrock of charnockite and granite-gneiss 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* : All soil strata and the pedocretes can be regarded as soft excavation. The combined thickness of these strata varied between 200mm and 2700mm in the test pits, averaging 1060mm prior to encountering conditions of intermediate or hard rock excavation.
- *Intermediate Excavation* : Refusal of excavation with a TLB occurred in most cases once bedrock of slightly weathered to unweathered rock was encountered. However, the exception was encountered in TP's 6, 12, 13, 21, 23, 26, 27 and 31 where medium weathered to slightly weathered rock was encountered from depths varying between 300mm to 1600mm minimum to 600mm to 2100mm maximum. In these test pits medium to slightly weathered rock can be regarded as intermediate excavation. It was possible to penetrate between 300mm and 800mm into weathered rock, both charnockite and granite-gneiss, averaging 525mm thick, prior to encountering hard rock excavation.
- *Hard Rock Excavation :* Refusal of excavation occurred in all the test pits except TP's 18, 25 and 35 which were abandoned due to unstable sidewall conditions resulting in collapse of the sidewalls. Refusal of excavation occurred in the remainder of the test pits on slightly weathered to unweathered rock at depths varying between 300mm and 2100mm, averaging 1160mm.

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

7.4.1 Historical Seismic Data

An increase in the occurrence of tremors in the Kai !Garib was encountered up to late 2011. The Council of Geoscience was therefore appointed to compile a desktop study of the available information and to provide indications of the probability and intensity of tremors that may occur in the area. Such a report[Reference 14.9] was made available on 25 July 2012.

The seismicity in the area is dominated by a cluster of seismic events. The events are of low to moderate magnitude with the highest having a magnitude of M_L 5,8 (M_L = Local Magnitude)

which occurred on 21 February 1976. The largest events within the cluster near Augrabies were two M_L 4,9 earthquakes which occurred on 12 and 25 January 2011. Although Keimoes falls outside the cluster, it is within the sphere of influence.

The earliest recorded event in the area occurred in1914 with a magnitude of M_L 3,0. Since then more than 1100 earthquakes have been recorded. Most of the events were recorded since 1979. The highest number of earthquakes was recorded in 2011 when 760 earthquakes were recorded within a swarm located in the in the Augrabies area. The earthquakes vary in magnitude from events of magnitude less than one to moderately sized events of which the largest had a magnitude M_L of 5,8. Most of the earthquakes had small magnitude values around 1,8.

Figure 2.2 from the report of the Council for Geoscience is reproduced here as Figure 8 : Historic Occurrences of Earthquakes in the Kai !Garib Area.

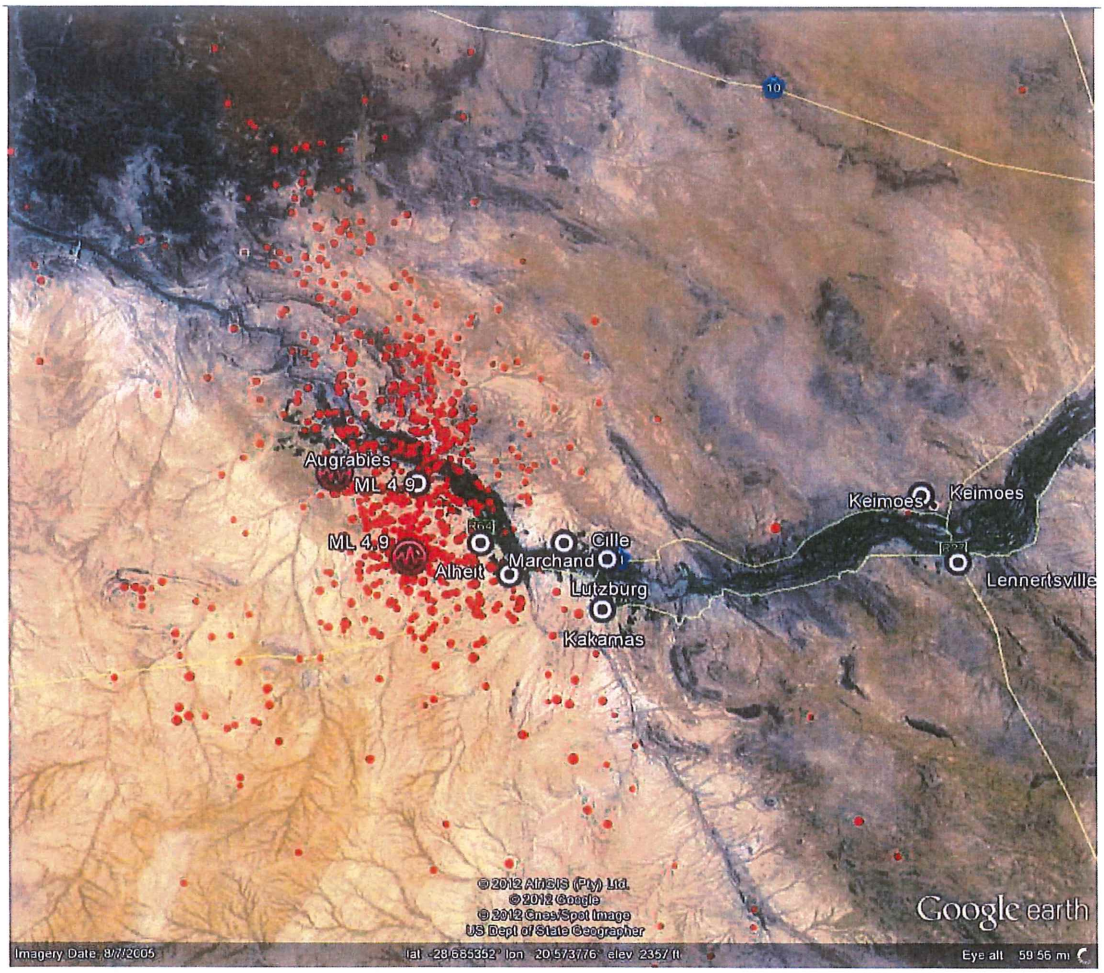


FIGURE 8 : HISTORIC OCCURRENCES OF ERATHQUAKES IN THE KAI !GARIB AREA

7.4.2 Site Specific Information

The closest source of seismic measurements to Keimoes under control of the Council for Geoscience is Tontelbos at 31° 10' 12"S and 20' 30' 00"E. Kijko[Reference 14.10] indicates the following :

- 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 $10^{-3,8}$.
- A 10% probability exists that an earthquake with Peak Ground Acceleration exceeding of 0,09g may take place once in 50 years.

A 10% probability of an event with magnitude less than 100cms^{-2} to take place once in 50 years is regarded as most favourable ; natural seismic activity with magnitude exceeding 100cms^{-2} is regarded as unfavourable.

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 seven zones characterized as follows as per the guidelines posted by SANS 10400 : Section H[Reference 14.11]. The zonation is indicated on Figure 9 : Site Class Designation.

8.1 Geotechnical Zone I

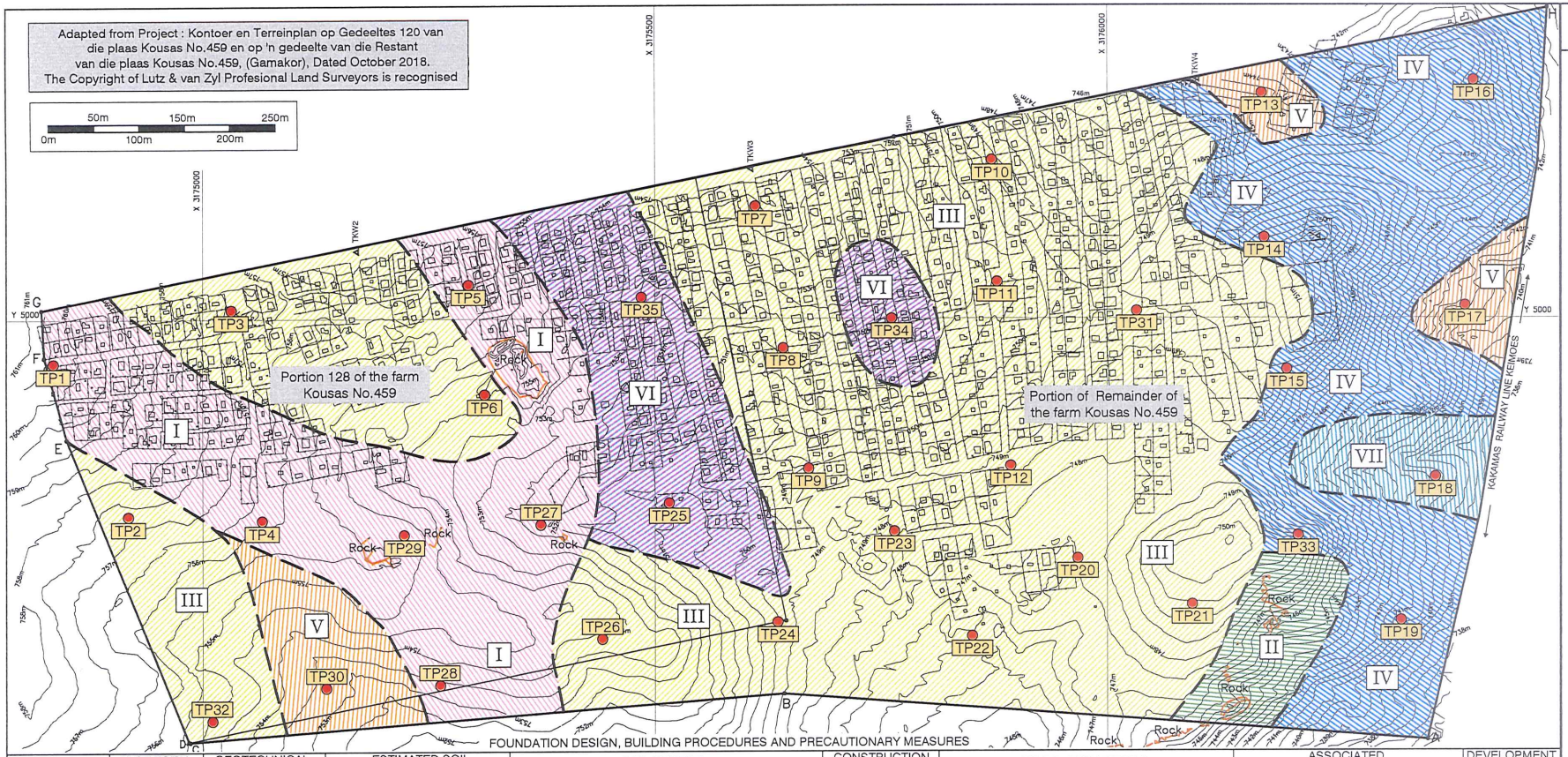
This zone comprises 15% of the area investigated. It is characterized by the materials profiles of TP's 1, 4, 5 and 27 to 29. It consists of a superficial horizon of colluvium and residual soil

less than 400mm thick overlying bedrock of granite-gneiss or charnockite. Several rocky outcrops occur in the area. Slope across the land is less than 2,5%. 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. 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 filling 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

FIGURE 9 :
SITE CLASS DESIGNATION



LEGEND

TP1 TEST PIT POSITION

INFERRED MATERIAL BOUNDARY

FOUNDATION DESIGN, BUILDING PROCEDURES AND PRECAUTIONARY MEASURES

AREA	% OF TOTAL AREA	GEOTECHNICAL CLASS	ESTIMATED SOIL MOVEMENT (mm)	SOIL PROFILE	CONSTRUCTION TYPE	FOUNDATION DESIGN	ASSOCIATED PROBLEMS	DEVELOPMENT POTENTIAL
I	15,36	R	Negligible	Less than 400mm of colluvium and residual soil overlying bedrock and outcrops of rock	Normal	Normal construction (strip footing or slab-on-the-ground) foundation.	Conditions of hard rock excavation	Intermediate
II	2,19	R	Negligible	Less than 400mm of colluvium and residual soil overlying bedrock and outcrops of rock	Normal	Normal construction of strip footings.	Conditions of hard rock excavation. Landslope ±5% does not favour slab-on-the-ground foundations.	Intermediate
III	50,64	S	0mm to 10mm compression and collapse settlement	Superficial surface horizon of colluvial sand overlying medium dense and dense nodular calcrete and residual soil sand and gravel	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Foundation bearing pressure not to exceed 50kPa. Good site drainage.	Occasional presence of hard rock excavation.	Favourable
IV	16,94	S	0mm to 10mm compression and collapse settlement	Superficial surface horizon of colluvial sand overlying medium dense and dense nodular calcrete and residual soil sand and gravel	Normal	Normal construction of strip footings Foundation bearing pressure not to exceed 50kPa. Good site drainage.	Occasional presence of hard rock of hard rock excavation. Landslope ±5% does not favour slab-on-the-ground foundations.	Favourable
V	4,64	S1	10mm to 20mm compression and collapse settlement	Surface horizon of colluvial sand overlying loose to medium dense residual soil or nodular calcrete to depths exceeding 1000mm	Modified normal	Reinforced strip foundations with articulation joints at some internal doors and all external doors and light reinforcement in masonry. Site drainage and service and plumbing precautions. Foundation bearing pressure not to exceed 50kPa.	Occasional presence of hard rock excavation or perched water.	Intermediate
					Compaction of in-situ soils below individual footings	Reinforced in-situ material below foundations to a depth and width of 1,5 times the foundation width or to a suitable soil horizon and replace with material compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content. Normal construction with lightly reinforced strip foundations and light reinforcement in masonry.		
VI	8,18	S2	>20mm compression and collapse settlement	Loose colluvial soils and alluvial sand exceeding 1500mm deep	Stiffened strip footings, stripped or cellular raft	Stiffened strip footings or stiffened or cellular raft with lightly reinforced or articulated masonry. Foundation bearing pressure not to exceed 50kPa. Mesh reinforcement in floor slabs. Site drainage and services and plumbing precautions.	Collapse of excavation sidewalls. Zoning may possible be affcted by seasonal water. Occasional presence of perched water.	Intermediate
VII	2,05	S2	>20mm compression and collapse settlement	Loose colluvial soils and alluvial sand exceeding 1500mm deep	Stiffened strip footings	Stiffened strip footings with lightly reinforced or articulated masonry. Foundation bearing pressure not to exceed 50kPa. Mesh reinforcement in floor slabs. Site drainage and service and plumbing precautions.	Collapse of excavation sidewalls. Zoning may possible be affected by seasonal water. Landslope ±5% does not favour raft foundations.	Intermediate

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: JOB NAME:	Gamakor
LIGGING: SITE:	Portion 128 and a Portion of the Remainder of the Farm Kousas 459
KLIENT: CLIENT:	Mun Kai !Garib!
TEKENING NO: DRAWING NO:	Figure 9 : Site Class Designation
DATUM: DATE:	09 April 2020

8.2 Geotechnical Zone II

This zone comprises 2% of the area investigated. It is characterized by the presence of rocky outcrops of granite-gneiss. Test pitting in such conditions is not feasible. Slope across the land is in excess of 5%. 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. The area is thus zoned as "R" and regarded as stable.

8.3 Geotechnical Zone III

This zone comprises 51% of the area investigated. The zone is present in three separate areas on the property. It is characterized by the materials profiles of TP's 2, 3, 6 to 12, 20 to 24, 26, 31 and 32. It consists of a horizon of colluvium approximately 400mm thick overlying medium dense residual sand on nodular calcrete and at depth bedrock of either charnockite or granite-gneiss. Slope across the land is less than 2,5%. 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, nodular calcrete or residual soil. As per the materials profile encountered in the test pits the combined thickness of the strata of nodular calcrete and residual 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 Geotechnical Zone IV

This zone comprises 17% of the area investigated. The zone is present along the southern perimeter of the site. It is characterized by the materials profiles of TP's 14 to 16, 19 and 33. It consists of a horizon of colluvium approximately 400mm thick overlying medium dense residual sand on nodular calcrete and at depth bedrock of granite-gneiss. Isolated, minor outcrops of granite-gneiss may be present. Slope across the land is in excess of 5%. 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 nodular calcrete or residual soil. As per the materials profile encountered in the test pits the combined thickness of the strata of nodular calcrete and residual 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.

8.5 Geotechnical Zone V

This zone comprises 5% of the area investigated. The zone is present in three separate areas across the site. It is characterized by the materials profiles of TP's 13, 17 and 30. It consists of a surface horizon of colluvium or alluvium in excess of 800mm thick overlying medium dense nodular calcrete or very dense residual sand at depth. Localised, ill-defined, non-perennial water courses define the characteristics of these areas and surface disposal of water may occur for very shorts periods after events of rain. Foundation stresses induced by conventional strip foundations for single and double storey structures will result in compression settlement between 10mm and 20mm if founded directly on the loose transported soil. As per the materials profile encountered in the test pits the thickness of the transported soil is such that stresses induced by the foundations will be dissipated in this material. The area is thus zoned as "S1" and the materials strata can be regarded as compressible to a maximum of 20mm.

8.6 Geotechnical Zone VI

This zone comprises 8% of the area investigated. The zone is present in two separate areas on the property. It is characterized by the materials profiles of TP's 25, 34 and 35. It consists of a horizon of loose and very loose colluvium or alluvium exceeding 1500mm thick. A thin lens of 100mm thick very dense, hardpan calcrete may be contained in the materials profile. Slope across the land is less than 2,5%. Foundation stresses induced by conventional strip foundations for single and double storey structures will result in compression settlement exceeding 20mm if founded directly on the transported material. Founding on the hardpan calcrete will not contribute in a positive way to reduce the settlement due to the limit vertical extent thereof. As per the materials profile encountered in the test pits the foundation stresses will be dissipated in the loose and very loose soil strata. The area is thus zoned as "S2" and the materials strata can be regarded as compressible exceeding 20mm settlement.

Cognisance must be taken of the presence of the drainage gulley in the area identified by TP's 25 and 35. Perched groundwater was encountered in this area at 1400mm. What is misleading about the conditions that once the horizon of hardpan calcrete is encountered conditions appear to be stable, but should one penetrate the calcrete, conditions of very moist to wet soil prevail and side walls of excavations may collapse. However, one should be careful not to condemn the entire area as problematic, but exclude development only from the identified water course.

8.7 Geotechnical Zone VII

This zone comprises 2% of the area investigated. The zone is present along the southern

perimeter of the site. It is characterized by the materials profiles of TP 18. It consists of a horizon of alluvium exceeding 2700mm thick. The alluvium is of very loose consistency and sidewalls of the test pit tended to collapse during the investigation. The area is located in a well-defined, non-perennial water course, disposing surface water after events of precipitation. Slope across the land is in excess of 5%. As per the materials profile encountered in the test pits the foundation stresses will be dissipated in the loose and very loose soil strata. The area is thus zoned as "S2" and the materials strata can be regarded as compressible exceeding 20mm settlement.

9 FOUNDATION RECOMMENDATIONS AND SOLUTIONS

The foundation design alternatives and ancillary issues as discussed in subparagraphs 9.1 and 9.2 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 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. Considering the limited slope across the land of approximately 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 :

9.1.1 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 200m^2 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

The solution of slab-on-the-ground foundations may only be used for dwellings less than 200m^2 in area. Edge beams shall be placed directly on the very dense hardpan calcrete.

TABLE 5 : FOUNDATION DESIGN, BUILDING PROCEDURES AND PRECAUTIONARY MEASURES

AREA	AREA OF PROPERTY (%)	GEOTECH NICAL CLASS	ESTIMATED SOIL MOVEMENT (mm)	SOIL PROFILE	CONSTRUCTION TYPE	FOUNDATION DESIGN AND BUILDING PROCEDURES	ASSOCIATED PROBLEMS	DEVELOPMENT POTENTIAL
I		R	Negligible	Less than 400mm of colluvium and residual soil overlying bedrock and outcrops of rock	Normal	Normal construction (strip footing or slab-on-the-ground) foundation.	Conditions of hard rock excavation	Favourable
II		R	Negligible	Less than 400mm of colluvium and residual soil overlying bedrock and outcrops of rock	Normal	Normal construction of strip footings	Conditions of hard rock excavation. Landslope ±5% does not favour slab-on-the-gound foundations.	Favourable
III		S	0mm to 10mm compression settlement	Superficial surface horizon of colluvial sand overlying medium dense and dense nodular calcrete and residual soil sand and gravel	Normal	Normal construction (strip footing or slab-on-the-ground) foundation. Foundation bearing pressure not to exceed 50kPa Good site drainage	Occasional presence of hard rock excavation	Favourable
IV		S	0mm to 10mm compression settlement	Superficial surface horizon of colluvial sand overlying medium dense and dense nodular calcrete and residual soil sand and gravel	Normal	Normal construction of strip footings Foundation bearing pressure not to exceed 50kPa Good site drainage	Occasional presence of hard rock excavation Landslope ±5% does not favour slab-on-the-gound foundations.	Favourable
V		S1	10mm to 20mm compression settlement	Surface horizon of colluvial sand overlying loose to medium dense residual soil or nodular calcrete to depths exceeding 1000mm.	Modified normal	Reinforced strip foundations with articulation joints at some internal doors and all external doors and light reinforcement in masonry. Site drainage and service and plumbing precautions. Foundation bearing pressure not to exceed 50kPa	Occasional presence of hard rock excavation or perched water.	Intermediate
					Compaction of in-situ soils below individual footings	Remove in-situ material below foundations to a depth and width of 1,5 times the foundation width or to a suitable soil horizon and replace with material compacted to 93% MOD AASHTO density at -1% to +2% of optimum moisture content. Normal costruction with lightly reinforced strip foundations and light reinforcement in masonry.		
VI		S2	>20mm compression settlement	Loose colluvial soils and alluvial sand exceeding 1500mm deep	Stiffened strip footings, stiffened or cellular raft	Stiffened strip footings or stiffened or cellular raft with lightly reinforced or articulated masonry Foundation bearing pressure not to exceed 50kPa Mesh reinforcement in floor slabs Site drainage and service and plumbing precautions.	Collapse of excavation sidewalls. Zoning may possibly be affected by seasonal surface water. Occassional presence of perched water.	Intermediate
VII		S2	>20mm compression settlement	Loose colluvial soils and alluvial sand exceeding 1500mm deep	Stiffened strip footings	Stiffened strip footings with lightly reinforced or articulated masonry Foundation bearing pressure not to exceed 50kPa Mesh reinforcement in floor slabs Site drainage and service and plumbing precautions.	Collapse of excavation sidewalls. Zoning may possibly be affected by seasonal surface water. Landslope ±5% does not favour raft foundations	Intermediate

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. Founding by means of strip footings is therefore the only feasible alternative for founding the future structures.

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 slope across the land of approximately 5% 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. This latter option of additional earthworks may be costly and hence is not recommended. Based on the favourable geotechnical site classification as per Section 8 above only one founding alternative can be considered, as described below.

Foundations of 400mm wide placed directly on bedrock may be used. Should the areas of the proposed dwellings not exceed 200m^2 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 Geotechnical Zone III

The zone is classed as S, meaning that less than 10mm of compression settlement may occur. Considering the limited slope across the land of approximately 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 :

9.3.1 Strip Foundations

Foundations of 400mm wide placed directly on the medium dense to dense nodular calcrete or residual soil may be used. Should the areas of the proposed dwellings not exceed 200m^2 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

The solution of slab-on-the-ground foundations may only be used for dwellings less than 200m^2 in area. Edge beams shall be placed directly on the medium dense to dense nodular

calcrete or residual soil. 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.

9.4 Geotechnical Zone IV

The zone is classed as S, meaning that less than 10mm of compression settlement may occur. Considering the slope across the land of approximately 5% 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. This latter option of additional earthworks may be costly and hence is not recommended. Based on the favourable geotechnical site classification as per Section 8 above only one founding alternative can be considered, as described below.

Foundations of 400mm wide placed directly on bedrock may be used. Should the areas of the proposed dwellings not exceed 200m^2 foundations for internal non-loadbearing walls may consist of thickened floorslabs. Should this option be adopted the floorslabs shall be reinforced steel mesh.

9.5 Geotechnical Zone V

The zone is classed as S1, meaning that between 10mm and 20mm of compression settlement may occur. Considering the limited slope across the land of approximately 2% only and the intermediate 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 :

9.5.1 Modified Normal Construction

The minimum founding depth shall be 500mm. Footings of 600mm wide and reinforced with three Y12 bars shall be used as foundations for load bearing walls. Footings of 450mm wide and reinforced with two Y12 bars shall be used as foundations for non-load bearing walls. Articulation joints shall be provided at some internal doors and all external doors. Light reinforcement (brickforce) shall be installed in the masonry. The site around the structure shall be sloped to allow surface water to drain away from the house. Foundation pressures shall not exceed 50kPa.

9.5.2 Compaction of In-situ Soils Below Individual Footings

This alternative provides for the removal of the in-situ material below foundations to a depth and width of 1,5 times the foundation width or to a suitable horizon and replace with competent material compacted to a density of 93% Modified AASHTO at -1% to +2% of optimum moisture content. In this case "a suitable horizon" is regarded as medium dense to very dense residual soil or pedocrete. "Competent material" is regarded as natural gravel of G6 quality in the COLTO classification system. Normal construction methods shall be applied with lightly reinforced strip foundations and light reinforcement in the masonry.

9.6 Geotechnical Zone VI

The zone is classed as S2, meaning that in excess of 20mm of compression settlement may occur. Considering the limited slope across the land of approximately 2% only and the intermediate 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 :

9.6.1 Stiffened Strip Footings

The minimum founding depth shall be 500mm. Reinforced footings shall be used as foundations for both load bearing and non-load bearing walls. The foundations shall be designed by a suitably qualified and experienced professional engineer. Articulation joints shall be provided at some internal doors and all external doors. Light reinforcement (brickforce) shall be installed in the masonry. The site around the structure shall be sloped to allow surface water to drain away from the house. Foundation pressures shall not exceed 50kPa.

9.6.2 Concrete Raft Foundations

The use of a stiffened, reinforced concrete raft or cellular raft may be considered. The foundations shall be designed by a suitably qualified and experienced professional engineer. Articulation joints shall be provided at some internal doors and all external doors. Light reinforcement (brickforce) shall be installed in the masonry. The site around the structure shall be sloped to allow surface water to drain away from the house. Foundation pressures shall not exceed 50kPa.

9.7 Geotechnical Zone VII

The zone is classed as S2, meaning that in excess of 20mm of compression settlement may occur. Considering the slope across the land of approximately 5% the use of reinforced concrete rafts will require additional works in the form of the construction of an engineered fill or cutting to establish a level platform for construction. This latter option of additional earthworks may be costly and hence is not recommended. Based on the intermediate geotechnical site classification as per Section 8 above only one founding alternative consisting of reinforced strip foundations can be considered.

The minimum founding depth shall be 500mm. Reinforced footings shall be used as foundations for both load bearing and non-load bearing walls. The foundations shall be designed by a suitably qualified and experienced professional engineer. Articulation joints shall be provided at some internal doors and all external doors. Light reinforcement (brickforce) shall be installed in the masonry. The site around the structure shall be sloped to allow surface water to drain away from the house. Foundation pressures shall not exceed 50kPa.

10 DRAINAGE

In subparagraph 2.4 and Figure 2 reference is made to the presence of three drainage features. The northern and southern drainage features are regarded as minor features of localised extent. During the time of investigation these gullies were dry and it is clear that they are subjected to the disposal of surface water only during and shortly after during events of rainfall.

The third drainage feature located in the central part of the site and extending northeast to southwest is of more substantial extent. Although standing water could not be identified during the investigation, the presence of water-loving vegetation, high soil moisture contents and the presence of perched water at levels shallower than 1500mm in the water course are all indicative of a more general presence of water in this course than elsewhere. Whether the source of such water is of natural origin, or released as treated water from the waste water treatment facility located upstream falls outside the scope of this geotechnical investigation. However, cognizance must be taken of the fact that in comparison with the surrounding area, raised perched water levels occur in close proximity of the gully, although it does not necessarily occur over the entire area zoned as S2.

Although it cannot be regarded as issues related to the geotechnical conditions on site, the following two drainage issues may influence the development of the property negatively ;

- *Land Slope* : The slope of 1% across 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.
- *Presence of the Gullies* : If not designed for, the presence of the gullies as discussed above can result in inundation of dwellings during flooding. The presence of these gullies traversing the site may be regarded as less desirable and the flood characteristics thereof must be considered.

11 SPECIAL PRECAUTIONARY MEASURES

No extraordinary features requiring special precautionary measures to decrease the impact thereof are present on site.

12 CONCLUSIONS

The property is regarded as being of favourable to intermediate suitability for residential development. The only factors that reduce the suitability of the land for development are :

- The presence of hard rock 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.
- Except for the southern part of the site, slope across the land is limited to less than 2%. This will have a detrimental influence on the design of stormwater disposal systems and sewerage reticulation.
- The presence of the drainage features will require design considerations to lessen the impact thereof on the development of the site.
- The alluvium and colluvium can be regarded as moderately compressible soil. This property can be addressed by adopting a suitable foundation design for the structures.

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 Kakamas Terrane and the site is located on Friersdale

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	IV	V	VI	VII
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 stope 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 collapse. Anticipated Inherent Risk Classes 6 to 8							
Steep slopes*	Between 2° and 5° in all regions	Slopes between 6° and 18° and less than 2° (Natal and Western Cape) Slopes between 6° and12° and less than 2° (all other regions)	More than 12° (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							

charnockite and Vaalputs granite-gneiss of the Keimoes Suite that is intrusive into the terrane, as described by Moen. Cornell, in the latest stratigraphic reference work includes the granite-gneiss into the charnockite and describes the presence of the latter material only. The charnockite is described as dark grey, unfoliated rock. The texture is fine to medium and uneven grained. Many of the quartz grains have an opalescent blue colour. Charnockite consists of a fine grained groundmass of quartz, feldspar, minor plagioclase and biotite, with larger biotite, hypersthene and augite grains

12.2 Soil Profile

12.2.1 Colluvium

The soil profile consists of a surface horizon of colluvium comprising of coarse sand to fine sand containing occasional gravels of banded ironstone, quartz and quartzite. The horizon extended to a maximum depth of 800mm. The colluvium is not expansive or collapsible, but compressible due to its general loose consistency.

12.2.2 Alluvium

A surface horizon of alluvium is present in the drainage gullies on site, comprising of fine sand containing gravels of quartz. Calcification may occur with depth. The horizon extended to a maximum depth of 2700mm. The alluvium is not expansive or collapsible, but highly compressible due to it's very loose to loose consistency.

12.2.3 Pebblestone Marker

Only a minor occurrence of the pebblestone marker was encountered in one test pit only. It was 100mm thick maximum, consisting predominantly of gravels of banded ironstone in a matrix of fine sand. The pebblestone marker is not expansive or collapsible and only negligibly compressible and erodible.

12.2.4 Residual Charnockite

Residual charnockite underlies the colluvium and in some instances the pedogenic deposits, occurring from depths between 200mm and 1100mm minimum, extending to 300mm to 1900mm maximum. It can be described as dirty white speckled dark grey varying to light brown gravelly sand. The presence of flakes of biotite was occasionally encountered in the charnockite soil profile. The consistency of the residual charnockite varied between loose and very dense in the test pits. The residual charnockite is not expansive or collapsible and only negligibly compressible and erodible.

12.2.5 Residual Granite-gneiss

Residual granite-gneiss underlies the colluvium, occurring from depths between 200mm and 1100mm minimum, extending to 700mm to 1600mm maximum. The residual granite-gneiss can be described as dirty white speckled dark grey varying to dark grey speckled white gravelly sand. The consistency of the residual granite-gneiss varied between dense and very dense in the test pits. The residual granite-gneiss is not expansive or collapsible and only negligibly compressible and erodible.

12.2.6 Mokalanen Formation

12.2.6(i) Hardpan Calcrete

Hardpan calcrete underlies the colluvium, occurring from depths between 100mm and 200mm minimum, extending to 300mm and 400mm maximum in isolated occurrences. The hardpan calcrete can be described as dirty white, very fine grained and very dense. It was possible to penetrate the calcrete in the test pits as the horizon is fairly thin and it overlies residual soil material of lesser dense consistency.

12.2.6(ii) Nodular Calcrete

Nodular calcrete was encountered in variable conditions on site : from underlying the colluvium directly as a pure pedocretes ; to a sub-horizon contained within a horizon of residual soil ; or as an extensively calcified and nodular horizon, especially in the alluvium. It was present between 100mm and 800mm minimum, extending to 300mm to 1600mm maximum. The nodular calcrete can be described as dirty white, rounded fine to medium coarse, concretions contained in a matrix of fine sand. The consistency varies from loose to very dense.

12.3 Groundwater

12.3.1 Perched Water

Perched groundwater was encountered in TP 3 at a depth of 1500mm and in TP 35 at 1400mm during the investigation. In both cases the presence of the water can be associated with the existing major drainage course through the site. Perched water was not encountered in any of the other test pits on site. It is anticipated that perched water will generally not prove problematic on the site, except in the major water course almost on a permanent basis ; and in the lesser drainage courses after events of inundation. However, it is concluded that the

presence of perched water in the water course is of such extent that it will influence conditions detrimentally only in the direct vicinity thereof and not over the whole area classified as S2.

12.3.2 Permanent Groundwater

Groundwater is expected to occur at depths between 20 meters and 30 meters in fractures restricted to a zone directly below the water table. The presence of permanent water has no influence on the geotechnical conditions on site.

12.4 Conditions of Excavation

On average over the entire site bedrock was encountered at depths between 200mm minimum exceeding 3000mm maximum, averaging 950mm deep. The implication of this is that should trenches require excavated depths to 1000mm, 5% of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 37% of the excavation may be classified as hard.

Irrespective of which method of excavation is considered, the most important issue is that across the entire site the depth to bedrock that can be regarded as hard rock excavation that is highly variable as follows :

12.4.1 Geotechnical Zones I and II

These zones are classified as R. The average depth to bedrock is 300mm. Refusal of excavation occurred at an average depth of 400mm. The implication of this is that should trenches require excavated depths to 1000mm, 70% of the excavation may be classified as hard, requiring drilling and blasting. Should the required depth of excavation increase to 1500mm, 80% of the excavation may be classified as hard.

12.4.2 Geotechnical Zones III and IV

These zones are classified as S. The average depth to bedrock is 1090mm. Refusal of excavation occurred at an average depth of 1190mm. The implication of this is that should trenches require excavated depths to 1000mm, 100% of the excavation may be classified as soft, suitable for TLB excavation. Should the required depth of excavation increase to 1500mm, 27% of the excavation may be classified as hard, requiring drilling and blasting.

12.4.3 Geotechnical Zone V

This zone is classified as S1. The average depth to bedrock is 1500mm. Refusal of

excavation occurred at an average depth of 1800mm. The implication of this is that should trenches require excavated depths to 1000mm, 100% of the excavation may be classified as soft, suitable for TLB excavation. Should the required depth of excavation increase to 1500mm, 100% of the excavation may still be classified as soft, suitable for TLB excavation.

12.4.4 Geotechnical Zones VI and VII

These zones are classified as S2. In two of the four test pits excavated in the S2 zones, collapse of sidewalls occurred at depths exceeding 2000mm prior to encountering refusal or bedrock. One can thus state that the average depth to bedrock exceeds 1500mm. The implication of this is that should trenches require excavated depths to 1000mm, 100% of the excavation may be classified as soft, suitable for TLB excavation. Should the required depth of excavation increase to 1500mm, 100% of the excavation may still be classified as soft, suitable for TLB excavation. However, one must also expect the presence of perched water in the proximity of the major non-perennial water course and collapse of the excavation sidewalls.

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 15% of the proposed area for development. Slope across the land is less than 2%. Considering the limited slope and the favourable geotechnical site classification as per Section 8 above, two foundation design alternatives are applicable to the zone, namely conventional strip foundations or slab-on-the-ground foundations placed directly on bedrock of granite-gneiss or charnockite.

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 2% of the proposed area for development. Slope across the land is approximately 5%. 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.

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 51% of the proposed area for development. Slope across the land is less than 2%. Considering the limited slope and the favourable geotechnical site classification as per Section 8 above, two foundation design alternatives are applicable to the zone, namely conventional strip foundations or slab-on-the-ground foundations placed directly on medium dense to very dense residual soil or pedocretes.

12.5.4 Geotechnical Zone IV

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 17% of the proposed area for development. Slope across the land is approximately 5%. 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 placed directly on medium dense to very dense residual soil or pedocretes.

12.5.5 Geotechnical Zone V

The zone is classed as S1, meaning that the proposed horizon for founding is moderately compressible and rapid settlement between 10mm and 20mm is expected. The distribution thereof encompasses 5% of the proposed area for development. Slope across the land is less than 2%. Considering the limited slope and the intermediate geotechnical site classification as per Section 8 above, structures can be founded by reinforced strip foundations. Alternatively the loose overburden soil can be excavated and replaced with a compacted horizon supporting lightly reinforced strip foundations.

12.5.6 Geotechnical Zone VI

The zone is classed as S2, meaning that the proposed horizon for founding is highly compressible and rapid settlement in excess of 20mm is expected. The distribution thereof encompasses 8% of the proposed area for development. Slope across the land is less than 2%. Considering the limited slope and the intermediate geotechnical site classification as per Section 8 above, structures can be founded by reinforced strip foundations or concrete rafts. The foundations shall be designed by a suitably qualified and experienced professional engineer.

12.5.7 Geotechnical Zone VII

The zone is classed as S2, meaning that the proposed horizon for founding is highly compressible and quick settlement in excess of 20mm is expected. The distribution thereof encompasses 2% of the proposed area for development. Slope across the land is approximately 5%. The use of reinforced raft foundations will require additional works in the form of the construction of an engineered fill or cutting to establish a level platform for construction. Structures can thus be founded by reinforced strip foundations. The foundations shall be designed by a suitably qualified and experienced professional engineer.

12.6 Land Slope

The average slope across the larger part of the land is less than 2%. Only in the southern extreme of the property is the slope approximately 5%. 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

Three areas that may possibly be subject to flooding have been identified from satellite imagery and the presence of alluvial deposits in these areas confirm the possibility that they serve to dispose of stormwater. In all cases the stormwater is of seasonal nature in an arid area, which may lessen the impact thereof on residential development. Although the gullies located in the northern and southern extremes of the site may be regarded as being of lesser importance, the gully in the central part of the site may also accommodate possible treated effluent from the waste water disposal works.

It is thus concluded that attention be given to the presence of these gullies through the residential area and the influence they may have on the future development thereof.

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 residual soils are suitable for the construction of in-situ selected layerworks. The plasticity index of the calcrete exceeds the

upper limit applicable for classification its suitability as road construction material. It can therefore be considered suitable only as roadbed only.

- *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 0,09g. 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 or a high soluble salts content.
- *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.

In Geotechnical Zones I, III and VI where more than one alternative for foundation design is provided, the property developer can base his choice on financial constraints.

13.2 Areas Subject to Flooding

Three gully areas have been identified. Although these areas are not subject to continuous flooding, such events may result in damage to infrastructure if not designed for. Of concern is the water course through the central part of the site in which surface water is often present, also resulting in the presence of perched groundwater. As it stands localized puddles of water develop with water-loving plants etc. In some instances it has been found that household waste is dumped in the course of this gully in the informal township.

It is recommended that the flood characteristics of this water course be determined and the water be confined to a suitably designed open concrete channel. Having stated this, it is recognized that a geotechnical document is not a guideline for hydraulic design for urban

development. However, limiting the water course to a lined channel will reduce seepage into the surrounding land and overall reduce detrimental effects resulting from the uncontrolled water course. This is especially applicable to the S2 geotechnical zone which is especially detrimentally affected by the ingress of perched water.

13.3 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 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 construction must be obtained from commercial sources. Depending on the pavement design, G6 or G7 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 commercial sources.

13.4 Conditions of Excavation

Although manual excavation is possible through the colluvium and alluvium, and to some extent through the residual soil, 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. In the S2 geotechnical provision must be made for excavation in wet conditions. Workers in the trenches shall be protected against collapse by either reducing slopes of the excavations to 1(V) : 2(H) or the provision of shoring.

13.5 Land Slope

Slope across the larger part 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 5% of the land in the south 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.

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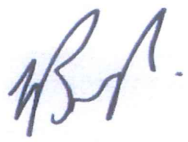


FJ Breytenbach, Pr Eng 28 May 2020

For Cedar Land Geotechnical Consult (Pty) Ltd

REPORT ON THE GEOTECHNICAL CONDITIONS ON PORTION 128 AND A PORTION OF THE RESTANT OF THE FARM KOUSAS 459, KEIMOES

2020/J032/MCP_01

ADDENDUM A: TEST PIT PROFILES

TRIAL HOLE: 1

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'21,5" S 20°56'54,0" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				
		Slightly moist, light brown, medium dense, intact, fine *SAND* with matrix supported, medium coarse, angular gravels of gneiss. Colluvium.				
0.20						
		Dirty white speckled light grey, slightly weathered, hard rock, micaceous *CHARNOCKITE*.				
0.40						
0.60						
0.80						
1.00						
1.20						
1.40						
1.60						
1.80						
2.00						

NOTES:

1 Refusal of excavation at 400 mm on hard rock, charnockite.

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

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 1

FIGURE: A1

TRIAL HOLE: 2

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

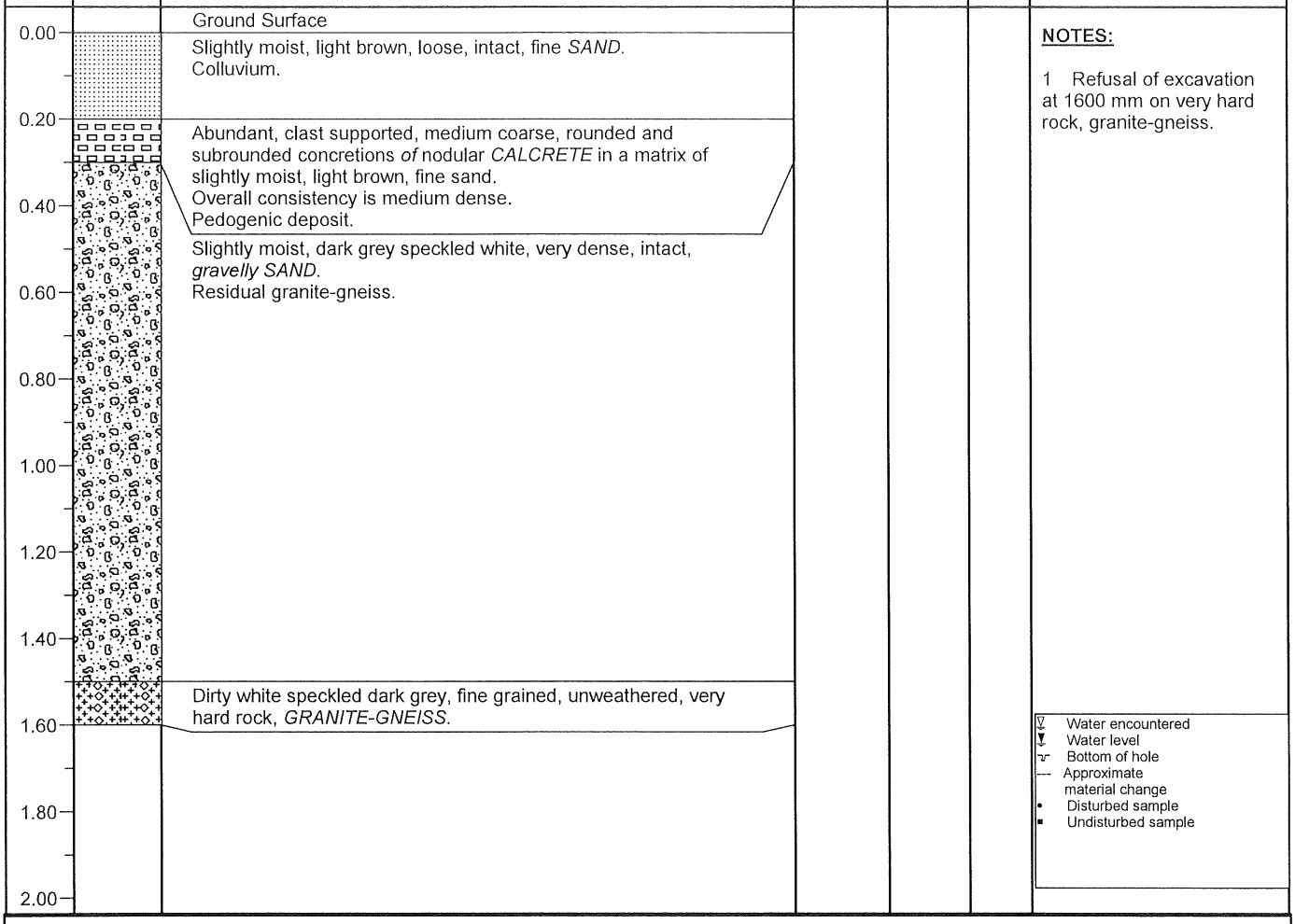
SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'24,2" S 20°56'47,8" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za



Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 2

FIGURE: A2

TRIAL HOLE: 3

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'27,9" S 20°56'56,2" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				
		Moist, dark red brown, loose, intact, medium coarse *SAND*. Colluvium.				
0.40						
		Moist, dirty white speckled dark grey, very dense, micaceous *gravelly SAND*. Residual charnockite.				
0.60						
0.80						
1.00			CLG-04-13	0,5-1,5	●	
1.20						
1.40						
1.60						
1.80						
2.00						

NOTES:

1 Refusal of excavation at 1500 mm due to very slow penetration.

2 Seepage water encountered at 1500 mm.

▽ Water encountered
▼ Water level
⊥ Bottom of hole
--- Approximate material change
• Disturbed sample
▪ Undisturbed sample

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 3

FIGURE: A3

TRIAL HOLE: 4

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'29,0" S 20°56'47,6" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				**NOTES:**
		Slightly moist, light brown, loose intact, fine *SAND*. Colluvium.				1 Refusal of excavation at 300 mm on very hard rock, granite-gneiss.
0.20		Dirty white speckled dark grey, fine grained, unweathered, very hard rock, *GRANITE-GNEISS*.				
0.40						
0.60						
0.80						
1.00						
1.20						
1.40						
1.60						Water encountered Water level Bottom of hole Approximate material change Disturbed sample Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 4

FIGURE: A4

TRIAL HOLE: 5

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'36,4" S 20°56'57,2" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				**NOTES:**
		Slightly moist, light brown, loose, intact, fine *SAND* with matrix supported, subrounded gravels of calcrete. Colluvium.				1 Refusal of excavation at 400 mm on hard rock, charnockite.
0.20		Slightly moist, light grey speckled white, medium dense, intact, *gravelly SAND* with lenses of red brown, fine sand. Residual charnockite.				
0.40		Light grey speckled white, medium grained, slightly weathered, hard rock, *CHARNOCKITE.*				
0.60						
0.80						
1.00						
1.20						
1.40						
1.60						Water encountered Water level Bottom of hole Approximate material change Disturbed sample Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 5

FIGURE: A5

TRIAL HOLE: 6

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'37,0" S 20°56'52,7" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				**NOTES:**
		Abundant, clast supported, medium coarse, angular, *GRAVELS* of quartz and medium coarse, subrounded *GRAVELS* of banded ironstone in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				1 Refusal of excavation at 1100 mm on hard rock, charnockite.
0.20		Abundant, clast supported, medium coarse, rounded concretions of nodular *CALCRETE* in a matrix of slightly moist, light brown, fine sand. Overall consistency is dense. Pedogenic deposit.				
0.40						
0.60		Dark grey speckled white, coarse grained, medium weathered becoming slightly weathered with depth, soft rock tending to medium hard rock at depth, *CHARNOCKITE.*				
0.80						
1.00						
1.20						
1.40						
1.60						Water encountered Water level Bottom of hole Approximate material change Disturbed sample Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 6

FIGURE: A6

TRIAL HOLE: 7

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'46,7" S 20°57'00,4" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				**NOTES:**
		Slightly moist, light brown, medium dense, intact, fine *SAND* with matrix supported, coarse, angular gravels of calcrete. Colluvium.				1 Refusal of excavation at 700 mm on hard rock, charnockite.
0.40		Slightly moist, dirty white speckled dark grey, very dense, micaceous *gravelly SAND.* Residual charnockite.				
0.60		Dirty white speckled light grey, coarse grained, slightly weathered, hard rock, micaceous *CHARNOCKITE.*				
0.80						
1.00						
1.20						
1.40						
1.60						Water encountered Water level Bottom of hole --- Approximate material change • Disturbed sample ▪ Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 7

FIGURE: A7

TRIAL HOLE: 8

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'47,7" S 20°56'54,6" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				
		Slightly moist, light brown, medium dense, intact, fine *SAND* with matrix supported, coarse, angular gravels of calcrete and subrounded cobbles of granite-gneiss. Colluvium.				
0.40		Dirty white speckled light grey, coarse grained, slightly weathered, hard rock, micaceous *CHARNOCKITE.*				
0.60						**NOTES:** 1 Refusal of excavation at 600 mm on hard rock, charnockite.
0.80						
1.00						
1.20						
1.40						
1.60						▽ Water encountered ▼ Water level ⊥ Bottom of hole --- Approximate material change • Disturbed sample ▪ Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 8

FIGURE: A8

TRIAL HOLE: 9

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'48,6" S 20°56'49,7" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				
		Slightly moist, light brown, medium dense, intact, fine *SAND* with matrix supported, coarse, angular gravels of calcrete. Colluvium.				
0.20		Dirty white speckled light grey, very fine grained, dense, intact, concretions of nodular *CALCRETE*. Pedogenic deposit.				
0.40						
0.60						
		Moist, light grey speckled white, very dense, micaceous, *gravelly SAND*. Residual charnockite.				
0.80						
1.00		Dirty white speckled light grey, very fine grained, slightly weathered, hard rock, micaceous *CHARNOCKITE*.				
1.20						
1.40						
1.60						
1.80						
2.00						

NOTES:

1 Refusal of excavation at 1100 mm on hard rock, charnockite.

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

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 9

FIGURE: A9

TRIAL HOLE: 10

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'55,2" S 20°57'02,3" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				NOTES:
		Slightly moist, light brown, loose, intact, fine *SAND* with matrix supported, fine, rounded gravels of quartz. Colluvium.				1 Refusal of excavation at 1000 mm on very dense, tightly packed boulders of charnockite.
0.20						
0.40		Slightly moist, dirty white speckled dark grey, medium dense, intact, *gravelly SAND* with pockets of pale light brown, silty sand and corestones of charnockite with diameter 300 mm - 500 mm. Residual charnockite.				
0.60						
0.80						
1.00						
1.20						
1.40						
1.60						Water encountered Water level Bottom of hole Approximate material change Disturbed sample Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 10

FIGURE: A10

TRIAL HOLE: 11

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'55,4" S 20°56'57,3" E*

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P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				NOTES:
		Slightly moist, light red brown, very loose, intact, fine *SAND*. Colluvium.				1 Refusal of excavation at 1300 mm on hard rock, charnockite.
0.20						
0.40		Abundant, clast supported, angular, coarse gravels and cobbles of nodular *CALCRETE* in a matrix of slightly moist, light brown, sand. Overall consistency is medium dense. Pedogenic deposit.				
0.60		Slightly moist, pale light brown, loose, intact, fine *SAND* with matrix supported, fine, rounded gravels of quartz. Residual charnockite.				
0.80		Dirty white speckled light grey, very fine grained, dense, intact, concretions of nodular *CALCRETE*. Pedogenic deposit.				
1.00						
1.20		Dirty white speckled light grey, slightly weathered, hard rock, micaceous *CHARNOCKITE*.				
1.40						
1.60						Water encountered Water level Bottom of hole Approximate material change Disturbed sample Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 11

FIGURE: A11

TRIAL HOLE: 12

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'55,9" S 20°56'49,8" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				**NOTES:**
		Abundant, clast supported, angular, coarse *GRAVELS* of quartz and medium coarse, subrounded *GRAVELS* of banded ironstone in a matrix of dry, light brown, fine sand. Overall consistency is loose. Colluvium.				1 Refusal of excavation at 1300 mm on medium hard rock, charnockite.
0.20						
0.40						
0.60						
0.80		Light grey speckled white, fine grained, medium weathered to slightly weathered, fine grained, medium hard rock, *CHARNOCKITE* with pockets of light red, fine sand.				
1.00						
1.20						
1.40						
1.60						Water encountered Water level Bottom of hole Approximate material change Disturbed sample Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 12

FIGURE: A12

TRIAL HOLE: 13

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°42'04,9" S 20°57'05,0" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				
		Slightly moist, light brown, loose, intact, *SAND*. Colluvium.				
0.40			CLG-04-15	0-0,8	●	
0.80		Abundant, clast supported, rounded, medium coarse to coarse, concretions of nodular *CALCRETE* in a matrix of dry, light brown, fine sand. Overall consistency is dense. Pedogenic deposit.				
1.20						
1.40		Dirty white speckled black, fine grained, medium weathered, foliated, soft rock, *GRANITE-GNEISS* with pockets of light brown, fine sand. Rock hardness improves to medium hard at depth.				
2.00						
2.20						

NOTES:

1 Refusal of excavation at 2100 mm on medium hard rock, granite-gneiss.

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

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 13

FIGURE: A13

TRIAL HOLE: 14

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°42'05,0" S 20°56'59,1" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				
0.20		Slightly moist, light brown, loose, intact, fine *SAND* with matrix supported, medium coarse, rounded gravels of banded ironstone. Colluvium.				
0.40		Abundant, clast supported, rounded, medium coarse to coarse, concretions of nodular *CALCRETE* in a matrix of dry, light brown, fine sand. Overall consistency is very dense. Pedogenic deposit.				
0.60						
0.80						
1.00						
1.20						
1.40						
1.60						
1.80						
2.00						

NOTES:

1 Refusal of excavation at 1200 mm on very dense, nodular calcrete.

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

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 14

FIGURE: A14

TRIAL HOLE: 15

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°42'05,8" S 20°56'53,7" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				NOTES:
		Slightly moist, light brown, loose, intact, fine *SAND* with matrix supported, medium coarse, rounded, gravels of banded ironstone. Colluvium.				1 Refusal of excavation at 700 mm on very hard rock, granite-gneiss.
0.20		Abundant, clast supported, very fine grained, rounded and subrounded concretions of nodular *CALCRETE* in a matrix of dry, pale light brown, fine sand. Overall consistency is medium dense. Pedogenic deposit.				
0.40						
0.60		Light grey speckled white streaked pink, very fine grained, unweathered, very hard rock, *GRANITE-GNEISS*.				
0.80						
1.00						
1.20						
1.40						
1.60						Water encountered Water level Bottom of hole Approximate material change Disturbed sample Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 15

FIGURE: A15

TRIAL HOLE: 16

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°42'12,5" S 20°57'05,5" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				NOTES:
		Abundant, clast supported, coarse, angular *GRAVELS* of quartz in a matrix of dry, light brown, fine sand. Overall consistency is loose. Colluvium. Abundant roots are present in the horizon.				1 Refusal of excavation at 900 mm on very hard rock, granite-gneiss.
0.20						
0.40		Dry, light grey mottled white, very dense, intact, *gravelly SAND*. Residual granite-gneiss.				
0.60						
0.80		Dark grey speckled white, medium coarse grained, unweathered, very hard rock, *GRANITE-GNEISS*.				
1.00						
1.20						
1.40						
1.60						Water encountered Water level Bottom of hole Approximate material change Disturbed sample Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 16

FIGURE: A16

TRIAL HOLE: 17

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°42'12,2" S 20°56'56,3" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				
		Dry, light brown, loose, intact, fine *SAND* with matrix supported, fine, subrounded gravels of quartz. Alluvium.				
0.40			CLG-04-16	0-1,1	●	
1.00		Dry, light grey mottled white, very dense, intact, *gravelly SAND*. Residual granite-gneiss.				
1.80		Dark grey speckled white, medium coarse grained, unweathered, very hard rock, *GRANITE-GNEISS*.				
2.00						
2.20						

NOTES:

1 Refusal of excavation at 2000 mm on very hard rock, granite-gneiss.

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

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 17

FIGURE: A17

TRIAL HOLE: 18

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°42'11,1" S 20°56'49,3" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				
		Dry, light brown, very loose, intact, fine *SAND* with matrix supported, fine, subrounded gravels of quartz. Alluvium. Abundant roots are present in the horizon.				NOTES: 1 Excavation unstable and sidewalls collapse.
0.20						
0.40						
0.60						
0.80						
1.00						
1.20						
1.40						
1.60						
1.80						
2.00						
2.20						
2.40						▽ Water encountered ▼ Water level ⊓ Bottom of hole --- Approximate material change • Disturbed sample ▪ Undisturbed sample
2.60						
2.80						
3.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 18

FIGURE: A18

TRIAL HOLE: 19

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°42'09,9" S 20°56'43,4" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				NOTES:
		Abundant, clast supported, coarse, angular *GRAVELS* of quartz and fine to medium coarse, subrounded *GRAVELS* of banded ironstone in a matrix of dry, light brown, fine sand. Overall consistency is loose. Colluvium.				1 Refusal of excavation at 1200 mm on very hard rock, granite-gneiss.
0.20						
0.40		Dry, light grey mottled white, very dense, intact, *gravelly SAND*. Residual granite-gneiss.				
0.60						
0.80						
1.00		Dark grey speckled white, medium coarse grained, unweathered, very hard rock, *GRANITE-GNEISS*.				
1.20						
1.40						
1.60						▽ Water encountered ▼ Water level ⌐ Bottom of hole --- Approximate material change • Disturbed sample ▪ Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 19

FIGURE: A19

TRIAL HOLE: 20

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

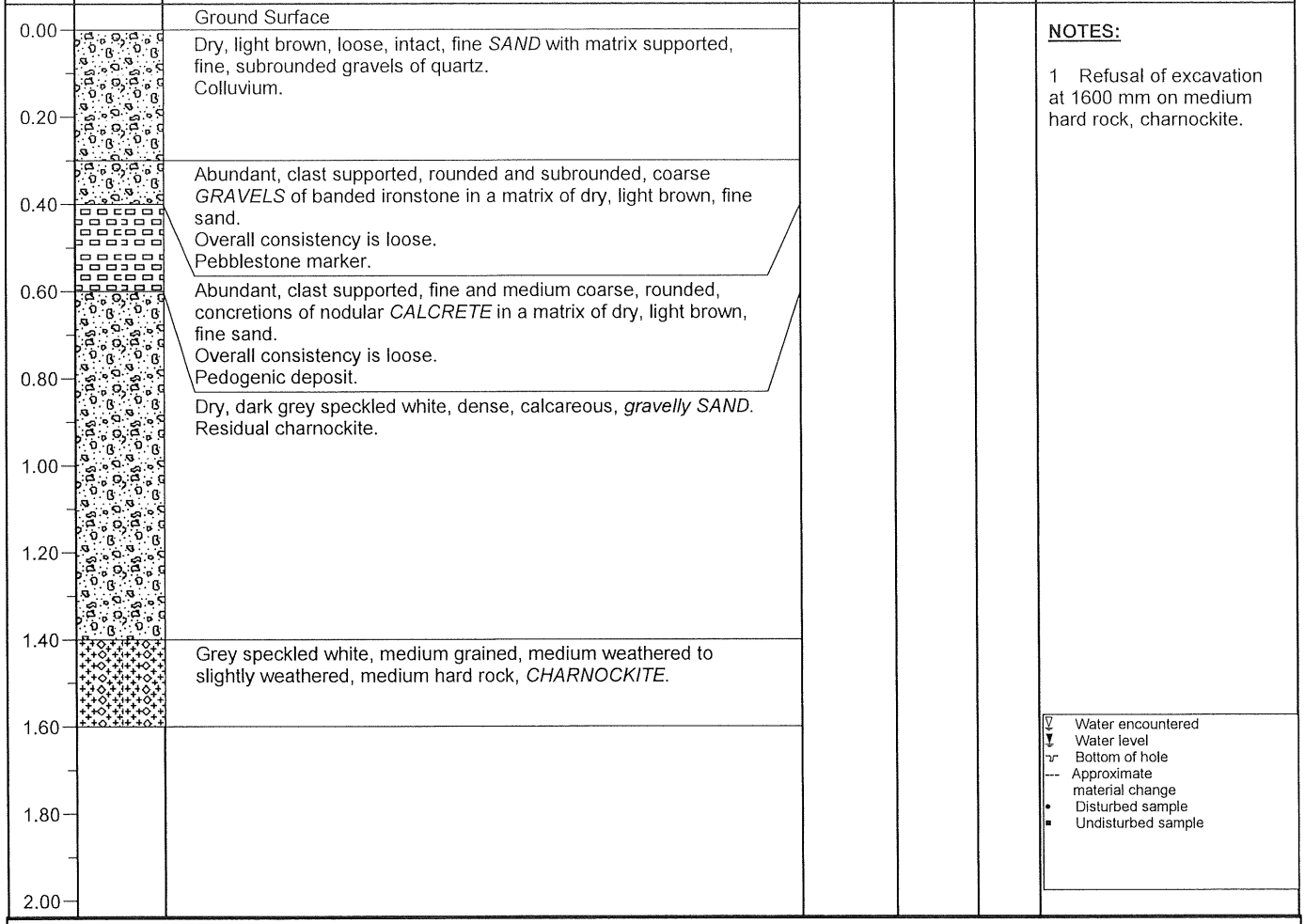
SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'58,3" S 20°56'46,0" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za



Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 20

FIGURE: A20

TRIAL HOLE: 21

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°42'02,4" S 20°56'44,1" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				NOTES:
		Abundant, clast supported, rounded and subrounded, *GRAVELS* of banded ironstone and coarse, angular, *GRAVELS* of quartz and coarse, subrounded concretions of nodular calcrete in a matrix of dry, light brown, sand. Overall consistency is loose. Colluvium.				1 Refusal of excavation at 2100 mm on medium hard rock, granite-gneiss.
0.40						
0.60		Dry, dark grey speckled white, dense, calcareous, *gravelly SAND*. Residual granite-gneiss.				
1.60		Grey speckled white, coarse grained, medium weathered to slightly weathered, medium hard rock, *GRANITE-GNEISS*.				
2.20						

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

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 21

FIGURE: A21

TRIAL HOLE: 22

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'54,5" S 20°56'42,8" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				
		Slightly moist, light brown, medium dense, intact, fine SAND with fine, subrounded and subangular, gravels of quartz. Colluvium.				
0.80		Dry, light brown, dense, intact, *gravelly SAND*. Residual charnockite.				
1.20		Dull light green stained light brown on discontinuities, very fine grained, slightly weathered, hard rock, feldspate-rich *CHARNOCKITE*. A feldspathic vein is present in the charnockite.				
2.20						

NOTES:

1 Refusal of excavation at 1200 mm on medium hard rock, charnockite.

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

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 22

FIGURE: A22

TRIAL HOLE: 23

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'51,7" S 20°56'47,1" E*

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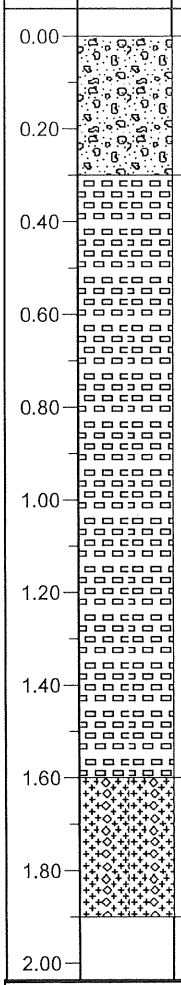
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za



Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
	Ground Surface				
	Slightly moist, light brown, medium dense, intact, fine SAND with fine, subrounded and subangular, gravels of quartz. Colluvium.				
	Abundant, clast supported, medium coarse, rounded, concretions of nodular *CALCRETE* in a matrix of slightly moist, light brown, fine sand. Overall consistency is medium dense. Pedogenic deposit.	CLG-04-17	0,3-1,6	●	**NOTES:** 1 Refusal of excavation at 1900 mm on medium hard rock, charnockite.
	Grey speckled white, coarse grained, medium weathered to slightly weathered, medium hard rock, *CHARNOCKITE*.				▽ Water encountered ▼ Water level ⊥ Bottom of hole --- Approximate material change • Disturbed sample ■ Undisturbed sample

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 23

FIGURE: A23

TRIAL HOLE: 24

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'47,5" S 20°56'43,4" E*

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P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				**NOTES:**
		Abundant, clast supported, angular, medium coarse *GRAVELS* of quartz and subrounded gravels of banded ironstone in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				1 Refusal of excavation at 2000 mm on medium hard rock, charnockite.
0.40		Abundant, clast supported, medium coarse, rounded, concretions of nodular *CALCRETE* in a matrix of slightly moist, light brown, fine sand. Overall consistency is medium dense. Pedogenic deposit.				
0.60		Dry, dark grey speckled white, dense, calcareous, *gravelly SAND.* Residual charnockite.				
1.80		Grey speckled white, coarse grained, medium weathered to slightly weathered, medium hard rock, *CHARNOCKITE.*				
2.00						

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

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 24

FIGURE: A24

TRIAL HOLE: 25

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'43,6" S 20°56'48,3" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				NOTES:
		Slightly moist, light brown, loose, intact, fine *SAND with fine,* subrounded gravels of quartz. Alluvium.				1 No refusal of excavation.
1.20		Slightly moist, light brown, loose, intact, fine *SAND* with fine, subrounded gravels of quartz with pockets of loose, white, nodular calcrete concretions. Calcified alluvium.				
2.60						

▽ Water encountered
▼ Water level
⌐ Bottom of hole
--- Approximate material change
• Disturbed sample
▪ Undisturbed sample

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 25

FIGURE: A25

TRIAL HOLE: 26

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'41,2" S 20°56'42,7" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				NOTES:
		Abundant, clast supported, angular, medium coarse *GRAVELS* of quartz and subrounded *GRAVELS* of banded ironstone in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				1 Refusal of excavation at 1400 mm on medium hard rock, charnockite.
0.20		Abundant, clast supported, medium coarse, rounded, concretions of nodular *CALCRETE* in a matrix of slightly moist, light brown, fine sand. Overall consistency is medium dense. Pedogenic deposit.				
0.40						
0.60			CLG-04-18	0,2-1,0	●	
0.80						
1.00		Grey speckled white, coarse grained, medium weathered to slightly weathered, medium hard rock, *CHARNOCKITE*.				
1.20						
1.40						
1.60						▽ Water encountered ▼ Water level ⌐ Bottom of hole --- Approximate material change • Disturbed sample ▪ Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 26

FIGURE: A26

TRIAL HOLE: 27

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'39,0" S 20°56'47,4" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				**NOTES:**
		Abundant, clast supported, angular, medium coarse *GRAVELS* of quartz and subrounded *GRAVELS* of banded ironstone in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.				1 Refusal of excavation at 600 mm on medium hard rock, charnockite.
0.20						
		Dirty white speckled dark grey stained light brown, fine grained, slightly weathered to medium weathered, soft rock to medium hard rock, *CHARNOCKITE.*	CLG-04-19	0,3-0,6	●	
0.40						
0.60						
0.80						
1.00						
1.20						
1.40						
1.60						
1.80						
2.00						

▽ Water encountered
▼ Water level
⌐ Bottom of hole
--- Approximate material change
• Disturbed sample
▪ Undisturbed sample

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 27

FIGURE: A27

TRIAL HOLE: 28

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'35,4" S 20°56'40,8" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				**NOTES:**
		Dry, light brown, loose, intact, fine *SAND* with matrix supported, fine to coarse, subrounded gravels of quartz. Colluvium.				1 Refusal of excavation at 500 mm on hard rock, charnockite.
0.20						
0.40		Dark grey speckled white, coarse grained, medium weathered becoming slightly weathered with depth, soft rock tending to medium hard rock at depth, *CHARNOCKITE.*				
0.60						
0.80						
1.00						
1.20						
1.40						
1.60						▽ Water encountered ▼ Water level ⊥ Bottom of hole --- Approximate material change • Disturbed sample ▪ Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 28

FIGURE: A28

TRIAL HOLE: 29

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'34,1" S 20°56'47,0" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				**NOTES:**
		Abundant, clast supported, angular, medium coarse *GRAVELS* of quartz and subrounded *GRAVELS* of banded ironstone in a matrix of dry, light brown sand. Overall consistency is medium dense. Colluvium.	CLG-04-20	0-0,3	●	1 Refusal of excavation at 300 mm on unweathered, very hard rock, charnockite.
0.20						
0.40						
0.60						
0.80						
1.00						
1.20						
1.40						
1.60						▽ Water encountered ▼ Water level ⌐ Bottom of hole --- Approximate material change • Disturbed sample ▪ Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 29

FIGURE: A29

TRIAL HOLE: 30

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'31,3" S 20°56'40,7" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				NOTES:
		Dry, light brown, loose, intact, fine *SAND* with matrix supported, fine, subrounded gravels of quartz and quartzite. Alluvium.				1 Refusal of excavation at 1300 mm on unweathered, very hard rock, charnockite.
1.00		Dry, pale light brown, very dense, calcareous, coarse *SAND*. Calcified alluvium.				
2.00						

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

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 30

FIGURE: A30

TRIAL HOLE: 31

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°42'00,4" S 20°56'56,1" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				NOTES:
		Slightly moist, light brown, loose, intact, fine *SAND* with matrix supported, fine, rounded gravels of quartz. Colluvium.				1 Refusal of excavation at 1400 mm on medium hard rock, charnockite.
0.20						
0.40		Abundant, clast supported, rounded, medium coarse to coarse, concretions of nodular *CALCRETE* in a matrix of dry, light brown, silty sand. Overall consistency is medium dense. Pedogenic deposit.				
0.60						
0.80		Dirty white speckled black, medium weathered, fine grained, foliated, soft rock, *CHARNOCKITE* with pockets of light brown, fine sand. At depth the rock is medium hard.				
1.00			CLG-04-21	0,7-1,4	●	
1.20						
1.40						
1.60						▽ Water encountered ▼ Water level ⌐ Bottom of hole --- Approximate material change • Disturbed sample ▪ Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 31

FIGURE: A31

TRIAL HOLE: 32

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

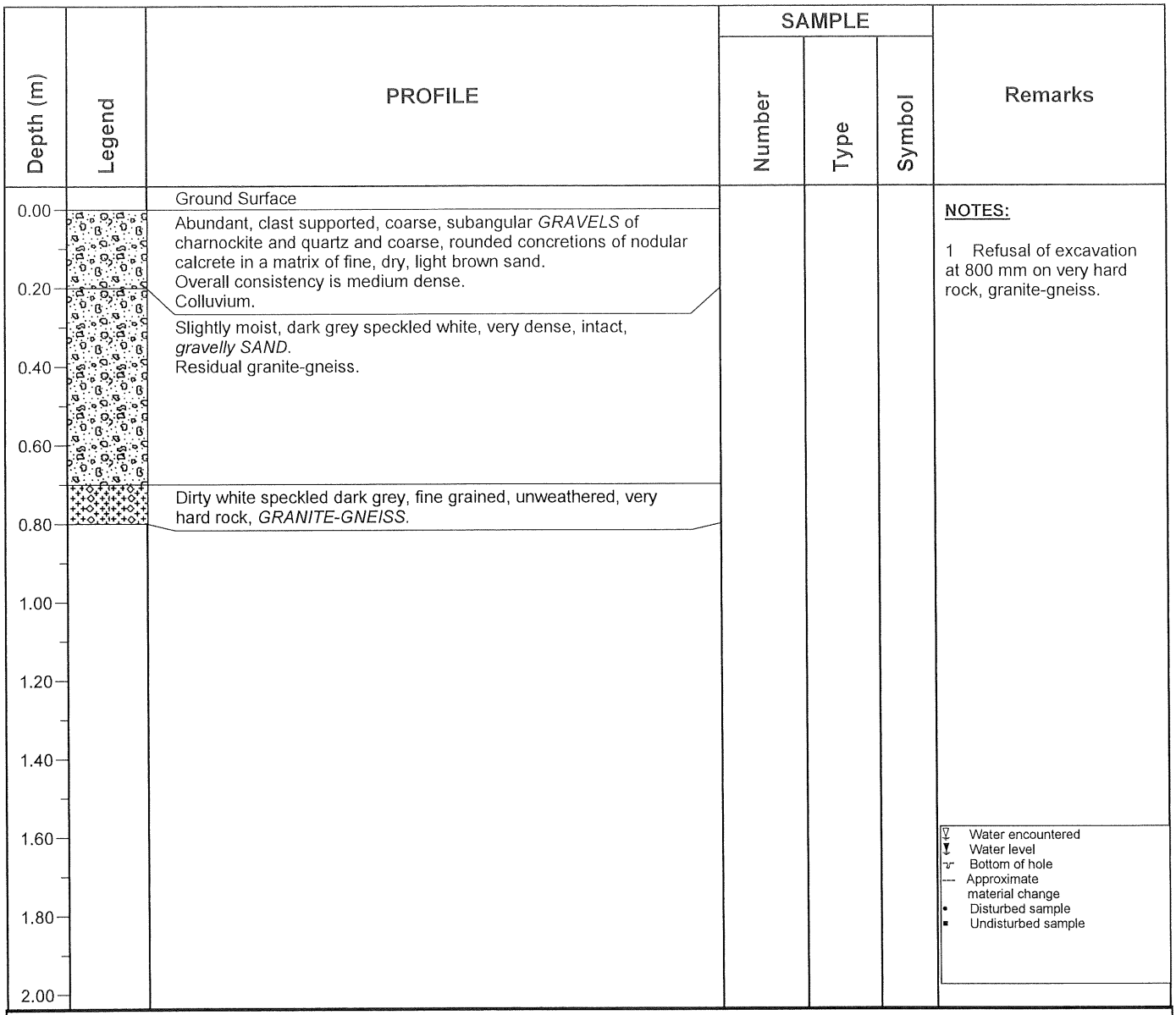
SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'27,2" S 20°56'39,4" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za



Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 32

FIGURE: A32

TRIAL HOLE: 33

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°42'06,2" S 20°56'46,9" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za

Depth (m)	Legend	PROFILE	SAMPLE Number	SAMPLE Type	SAMPLE Symbol	Remarks
0.00		Ground Surface				**NOTES:**
		Abundant, clast supported, coarse, angular *GRAVELS* of quartz in a matrix of dry, light brown, fine sand. Overall consistency is medium dense. Colluvium.				1 Refusal of excavation at 900 mm on very hard rock, granite-gneiss.
0.20						
0.40		Dry, light grey mottled white, very dense, intact, *gravelly SAND.* Residual granite-gneiss.	CLG-04-22	0,3-0,7	●	
0.60						
0.80		Dark grey speckled white, medium coarse grained, unweathered, very hard rock, *GRANITE-GNEISS.*				
1.00						
1.20						
1.40						
1.60						▽ Water encountered ▼ Water level ⌐ Bottom of hole --- Approximate material change • Disturbed sample ▪ Undisturbed sample
1.80						
2.00						

Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 33

FIGURE: A33

TRIAL HOLE: 34

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

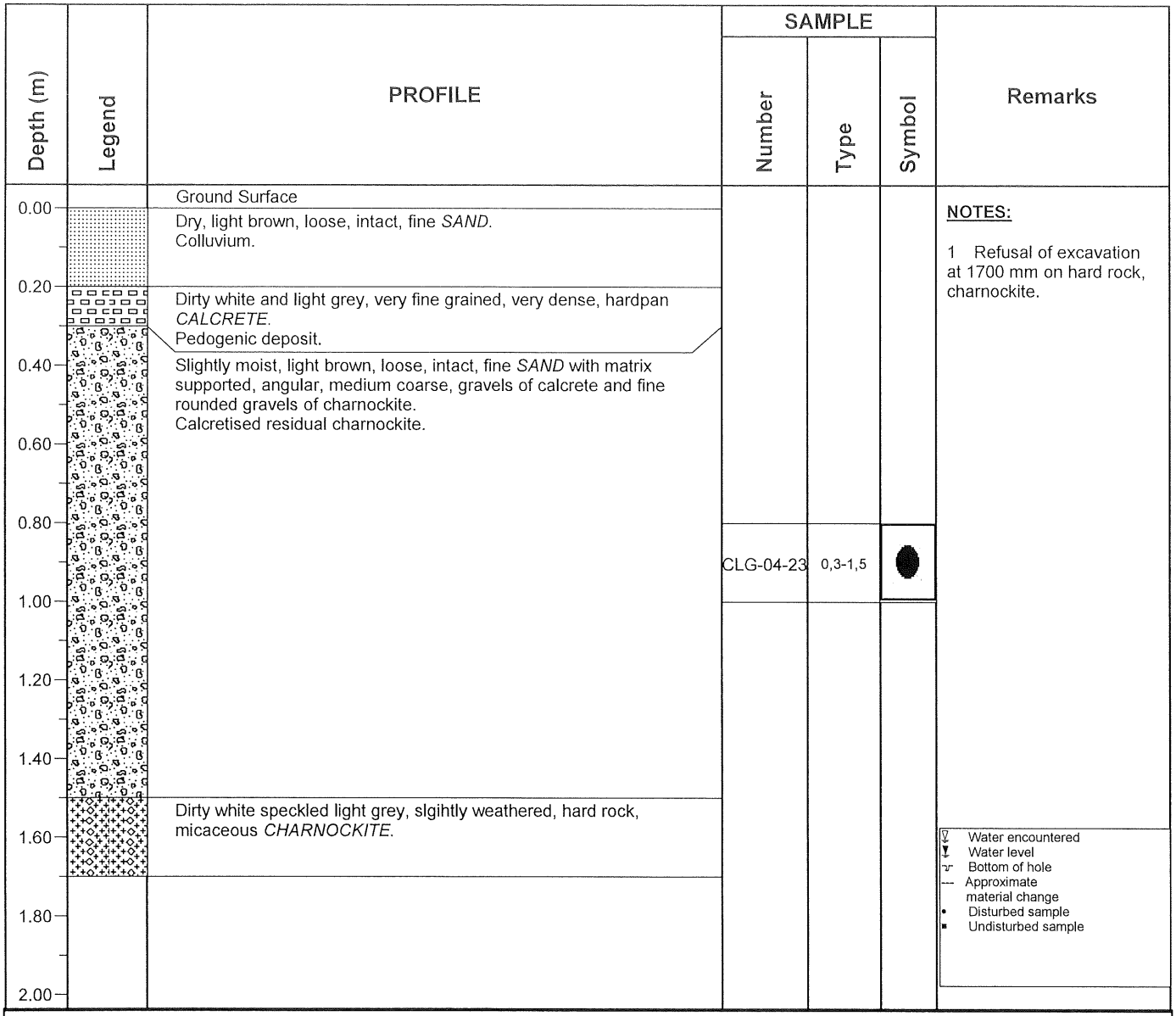
SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'51,6" S 20°56'55,8" E*

Cedar Land Geotechnical Consult (Pty) Ltd
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za



Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 34

FIGURE: A34

TRIAL HOLE: 35

PROJECT: *PROPOSED TOWNSHIP GAMAKOR 1500*

LOGGED BY: *FJB*

SITE: *PORTIONS 128 AND A PART OF THE RESTANT OF THE FARM KOUSAS NO 459*

DATE LOGGED: *11/3/2020*

CLIENT: *KAI !GARIB MUNICIPALITY*

LOCATION: *28°41'42,6" S 20°56'56,7" E*

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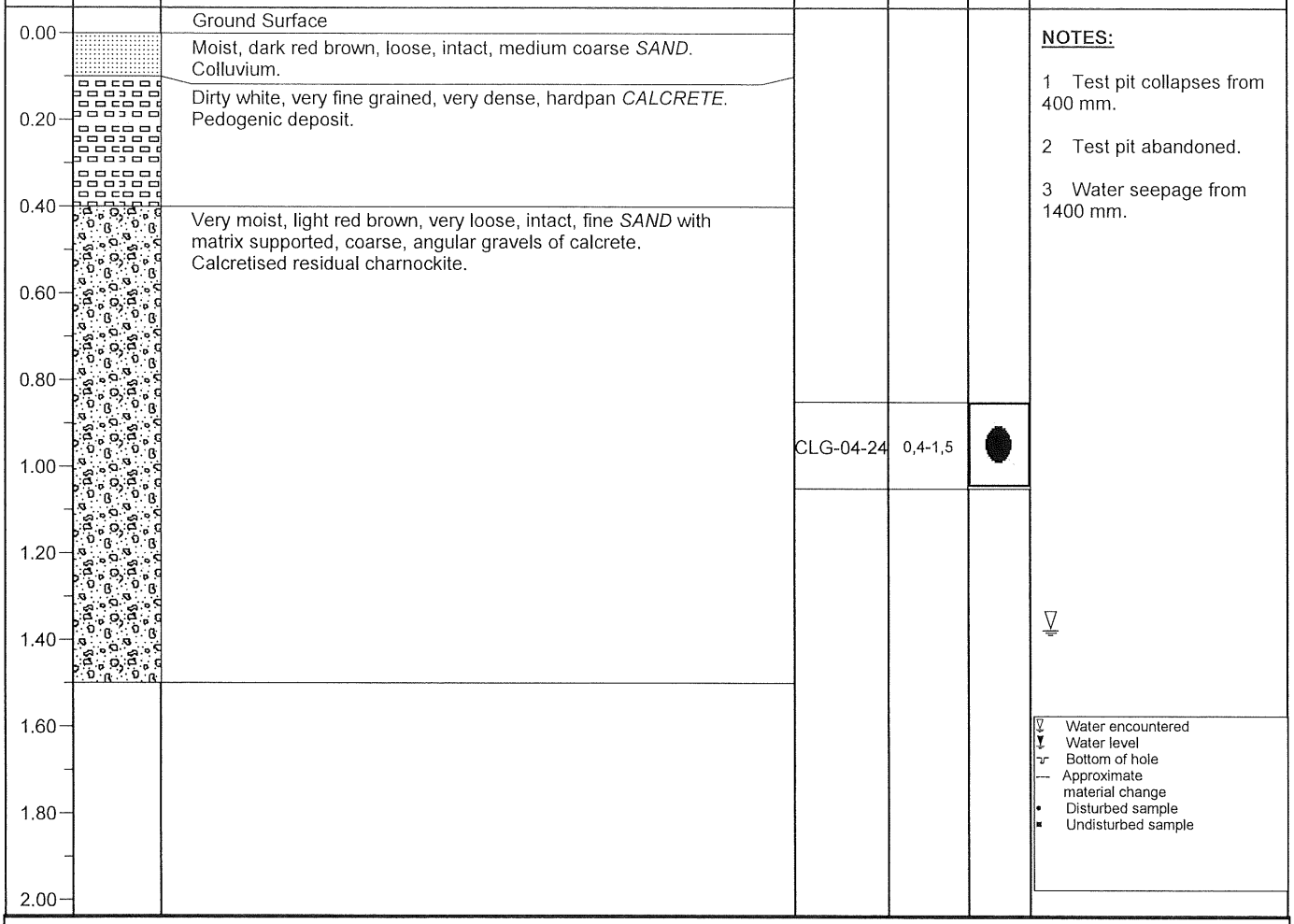
P O Box 607
Ceres
6830
Cell: 082 570 2767
Email:
cedarland.frans@breede.co.za



Contractor: ALS Plant Hire
Date Drilled: 11/3/2020
Machine: Case 580T

Hole Diameter: 700 mm
Water Depth:
Sheet: 1 of 1

SOIL PROFILE: TEST PIT 35

FIGURE: A35

REPORT ON THE GEOTECHNICAL CONDITIONS ON PORTION 128 AND A PORTION OF THE RESTANT OF THE FARM KOUSAS 459, KEIMOES

2020/J032/MCP_01

ADDENDUM B: RESULTS OF MATERIALS TESTING

Specialised Testing Laboratory (Pty) Ltd
Asphalt | Aggregate | Bitumen | Geotechnical
Quality | Excellence | On Time

Unit 1, 13 Bloubokkie Street, Koedoespoort 0186
Roelof | 072 674 6343 | roelof@stlab.co.za
Gerrie | 082 309 4448 | gerrie@stlab.co.za
www.stlab.co.za

Client Name: Cedar Land Geotechnical Consult (Pty) Ltd
Project Name: Gamakor
Job Number: CLG-04
Date: 27-May-20
Method: SANS 3001 GR1, GR3, GR10, GR12 GR20, GR30, GR31, GR40, GR50, GR53, GR54 & BS 1377 (where applicable)

SUMMARY OF TEST DATA

Grading & Hydrometer Analysis (% Passing)

Sample	TP 3	TP 13	TP 17	TP 23	TP 26	TP 27	TP 29	TP 31
Depth (mm)	500 - 1500	0 - 800	0 - 1100	300 - 1600	200 - 1000	300 - 600	0 - 300	700 - 1400
Lab No	CLG-04-13	CLG-04-15	CLG-04-16	CLG-04-17	CLG-04-18	CLG-04-19	CLG-04-20	CLG-04-21
53.0	100	100	100	100	100	92	100	100
37.5	100	100	100	100	95	77	98	96
26.5	100	100	96	97	93	66	90	96
19.0	100	100	93	82	91	59	89	95
13.2	100	100	93	74	89	52	83	93
9.5	100	100	92	70	87	49	79	92
6.7	100	100	92	65	80	41	74	91
4.75	99	99	91	61	77	36	67	90
2.00	79	97	83	49	44	23	52	76
1.00	52	85	70	39	31	16	46	52
0.425	34	60	51	32	25	12	41	34
0.250	20	46	38	27	20	9	33	23
0.150	14	34	26	21	15	6	26	16
0.075	8	16	11	15	10	4	19	10
0.060	5	8	5	10	6	2	11	8
0.050	4	6	4	9	5	2	9	7
0.035	2	3	3	7	3	1	6	5
0.020	2	2	2	6	2	1	4	4
0.006	1	2	1	4	1	1	2	2
0.002	1	1	1	3	1	1	1	1
GM	1.79	1.27	1.55	2.04	2.21	2.61	1.88	1.80

Atterberg Limits

LL (%)	-	-	-	49	-	26	21	-
PI (%)	NP	NP	NP	21	NP	7	6	NP
LS (%)	0.0	0.0	0.0	9.0	0.0	4.0	3.0	0.0

pH & Conductivity

pH	7.8						7.6	8.3
EC (S/m)	0.012						0.047	0.031

MDD / OMC

MDD (kg/m³)			2084	1997		2146		
OMC (%)			6.6	10.2		6.8		

CBR

100%			82	48		100		
98%			43	33		73		
97%			31	28		62		
95%			17	20		45		
93%			9	14		32		
90%			3	9		20		
Swell (%)			0.0	0.6		0.0		

UCS (MPa)

100%								
97%								
90%								

COLTO Classification

			G8	*		G7		

Remarks: * = Not Classifiable

Specialised Testing Laboratory (Pty) Ltd
Asphalt | Aggregate | Bitumen | Geotechnical

Unit 1, 13 Bloubokkie Street, Koedoespoort 0186
Roelof | 072 674 6343 | roelof@stlab.co.za
Gerrie | 082 309 4448 | gerrie@stlab.co.za
www.stlab.co.za

Quality | Excellence | On Time

Client Name: Cedar Land Geotechnical Consult (Pty) Ltd
Project Name: Gamakor
Job Number: CLG-04
Date: 27-May-20
Method: SANS 3001 GR1, GR3, GR10, GR12 GR20, GR30, GR31, GR40, GR50, GR53, GR54 & BS 1377 (where applicable)

SUMMARY OF TEST DATA

Grading & Hydrometer Analysis (% Passing)

Sample	TP 33	TP 34	TP 35					
Depth (m)	300 - 700	300 - 1500	400 - 1500					
Lab No	CLG-04-22	CLG-04-23	CLG-04-24					
53.0	**100**	**100**	**79**					
37.5	**100**	**100**	**71**					
26.5	**100**	**100**	**69**					
19.0	**100**	**100**	**67**					
13.2	**100**	**98**	**63**					
9.5	**94**	**93**	**60**					
6.7	**89**	**81**	**57**					
4.75	**81**	**70**	**55**					
2.00	**63**	**43**	**45**					
1.00	**46**	**28**	**37**					
0.425	**32**	**18**	**31**					
0.250	**22**	**13**	**24**					
0.150	**15**	**8**	**19**					
0.075	**9**	**5**	**12**					
0.060	**6**	**3**	**8**					
0.050	**5**	**3**	**7**					
0.035	**3**	**2**	**4**					
0.020	**2**	**1**	**3**					
0.006	**2**	**1**	**2**					
0.002	**1**	**1**	**1**					
GM	**1.96**	**2.34**	**2.12**					

Atterberg Limits

LL (%)	-	-	**26**					
PI (%)	**NP**	**NP**	**7**					
LS (%)	**0.0**	**0.0**	**3.5**					

pH & Conductivity

pH	**8.2**		**8.9**					
EC (S/m)	**0.009**		**0.02**					

MDD / OMC

MDD (kg/m^3)								
OMC (%)								

CBR

100%								
98%								
97%								
95%								
93%								
90%								
Swell (%)								

UCS (MPa)

100%								
97%								
90%								

COLTO Classification

Remarks: _____

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Project Name: Gamakor
Job Number: CLG-04
Date: 2020-05-27
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Sheet Ref: R-STL-011-Rev02

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	TP 3	TP 13	TP 17	Sample	TP 3	TP 13	TP 17
Depth (mm)	500 - 1500	0 - 800	0 - 1100	Depth (mm)	500 - 1500	0 - 800	0 - 1100
Lab No	CLG-04-13	CLG-04-15	CLG-04-16	Lab No	CLG-04-13	CLG-04-15	CLG-04-16
53.0	100	100	100	Liquid Limit (%)	-	-	-
37.5	100	100	100	Plastic Limit (%)	-	-	-
26.5	100	100	96	Plasticity Index (%)	NP	NP	NP
19.0	100	100	93	Linear Shrinkage (%)	0.0	0.0	0.0
13.2	100	100	93	PI of whole sample	-	-	-
9.5	100	100	92				
6.7	100	100	92	% Gravel	21	3	17
4.75	99	99	91	% Sand	74	89	78
2.00	79	97	83	% Silt	4	7	4
1.00	52	85	70	% Clay	1	1	1
0.425	34	60	51	Activity	0.0	0.0	0.0
0.250	20	46	38				
0.150	14	34	26	% Soil Mortar	79	97	83
0.075	8	16	11				
0.060	5	8	5	Grading Modulus	1.79	1.27	1.55
0.050	4	6	4	Moisture Content (%)	N / T	N / T	N / T
0.035	2	3	3	Relative Density (SG)*	2.65	2.65	2.65
0.020	2	2	2				
0.006	1	2	1	Unified (ASTM D2487)	SW-SM	SM	SP-SM
0.002	1	1	1	AASHTO (M145-91)	A - 1 - b	A - 2 - 4	A - 2 - 4

Remarks: *: Assumed
N / T: Not Tested

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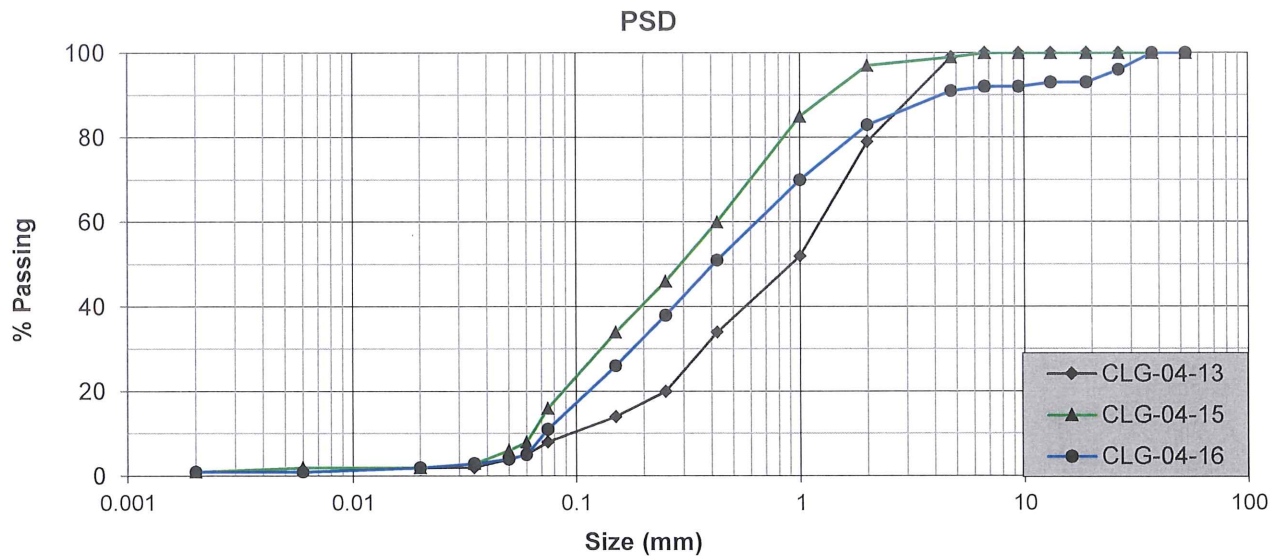
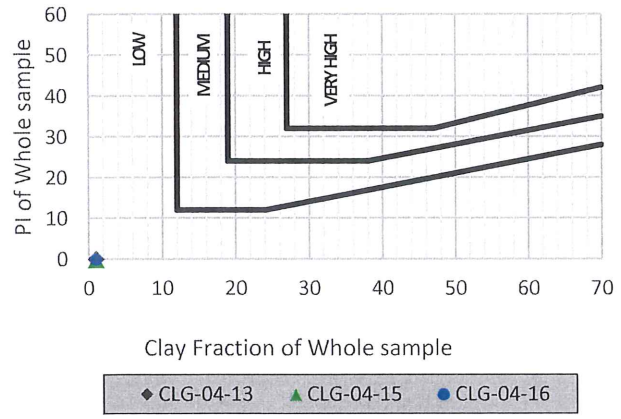
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

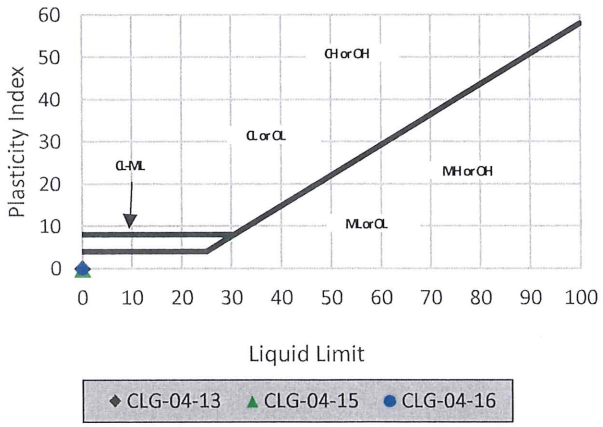
Sheet Ref: R-STL-011-Rev02



Potential Expansiveness



Casagrande Plasticity Chart



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Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Sheet Ref: R-STL-011-Rev02

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	TP 23	TP 26	TP 27	Sample	TP 23	TP 26	TP 27
Depth (mm)	300 - 1600	200 - 1000	300 - 600	Depth (mm)	300 - 1600	200 - 1000	300 - 600
Lab No	CLG-04-17	CLG-04-18	CLG-04-19	Lab No	CLG-04-17	CLG-04-18	CLG-04-19
53.0	**100**	**100**	**92**	Liquid Limit (%)	**49**	-	**26**
37.5	**100**	**95**	**77**	Plastic Limit (%)	**28**	-	**19**
26.5	**97**	**93**	**66**	Plasticity Index (%)	**21**	**NP**	**7**
19.0	**82**	**91**	**59**	Linear Shrinkage (%)	**9.0**	**0.0**	**4.0**
13.2	**74**	**89**	**52**	PI of whole sample	**7**	-	**1**
9.5	**70**	**87**	**49**				
6.7	**65**	**80**	**41**	% Gravel	**51**	**56**	**77**
4.75	**61**	**77**	**36**	% Sand	**39**	**38**	**21**
2.00	**49**	**44**	**23**	% Silt	**7**	**5**	**1**
1.00	**39**	**31**	**16**	% Clay	**3**	**1**	**1**
0.425	**32**	**25**	**12**	Activity	**7.0**	**0.0**	**7.0**
0.250	**27**	**20**	**9**				
0.150	**21**	**15**	**6**	% Soil Mortar	**49**	**44**	**23**
0.075	**15**	**10**	**4**				
0.060	**10**	**6**	**2**	Grading Modulus	**2.04**	**2.21**	**2.61**
0.050	**9**	**5**	**2**	Moisture Content (%)	**N / T**	**N / T**	**N / T**
0.035	**7**	**3**	**1**	Relative Density (SG)*	**2.65**	**2.65**	**2.65**
0.020	**6**	**2**	**1**				
0.006	**4**	**1**	**1**	Unified (ASTM D2487)	**SC**	**SP-SM**	**SW**
0.002	**3**	**1**	**1**	AASHTO (M145-91)	**A - 2 - 7**	**A - 1 - a**	**A - 2 - 4**

Remarks: *: Assumed
N / T: Not Tested

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Project Name: Gamakor
Job Number: CLG-04
Date: 2020-05-27
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Sheet Ref: R-STL-011-Rev02

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	TP 29	TP 31	TP 33	Sample	TP 29	TP 31	TP 33
Depth (mm)	0 - 300	700 - 1400	300 - 700	Depth (mm)	0 - 300	700 - 1400	300 - 700
Lab No	CLG-04-20	CLG-04-21	CLG-04-22	Lab No	CLG-04-20	CLG-04-21	CLG-04-22
53.0	**100**	**100**	**100**	Liquid Limit (%)	**21**	-	-
37.5	**98**	**96**	**100**	Plastic Limit (%)	**15**	-	-
26.5	**90**	**96**	**100**	Plasticity Index (%)	**6**	**NP**	**NP**
19.0	**89**	**95**	**100**	Linear Shrinkage (%)	**3.0**	**0.0**	**0.0**
13.2	**83**	**93**	**100**	PI of whole sample	**2**	-	-
9.5	**79**	**92**	**94**				
6.7	**74**	**91**	**89**	% Gravel	**48**	**24**	**37**
4.75	**67**	**90**	**81**	% Sand	**41**	**68**	**57**
2.00	**52**	**76**	**63**	% Silt	**10**	**7**	**5**
1.00	**46**	**52**	**46**	% Clay	**1**	**1**	**1**
0.425	**41**	**34**	**32**	Activity	**6.0**	**0.0**	**0.0**
0.250	**33**	**23**	**22**				
0.150	**26**	**16**	**15**	% Soil Mortar	**52**	**76**	**63**
0.075	**19**	**10**	**9**				
0.060	**11**	**8**	**6**	Grading Modulus	**1.88**	**1.80**	**1.96**
0.050	**9**	**7**	**5**	Moisture Content (%)	**N / T**	**N / T**	**N / T**
0.035	**6**	**5**	**3**	Relative Density (SG)*	**2.65**	**2.65**	**2.65**
0.020	**4**	**4**	**2**				
0.006	**2**	**2**	**2**	Unified (ASTM D2487)	**SC-SM**	**SW-SM**	**SW-SM**
0.002	**1**	**1**	**1**	AASHTO (M145-91)	**A - 1 - b**	**A - 1 - b**	**A - 1 - b**

Remarks: *: Assumed
N / T: Not Tested

Specialised Testing Laboratory (Pty) Ltd
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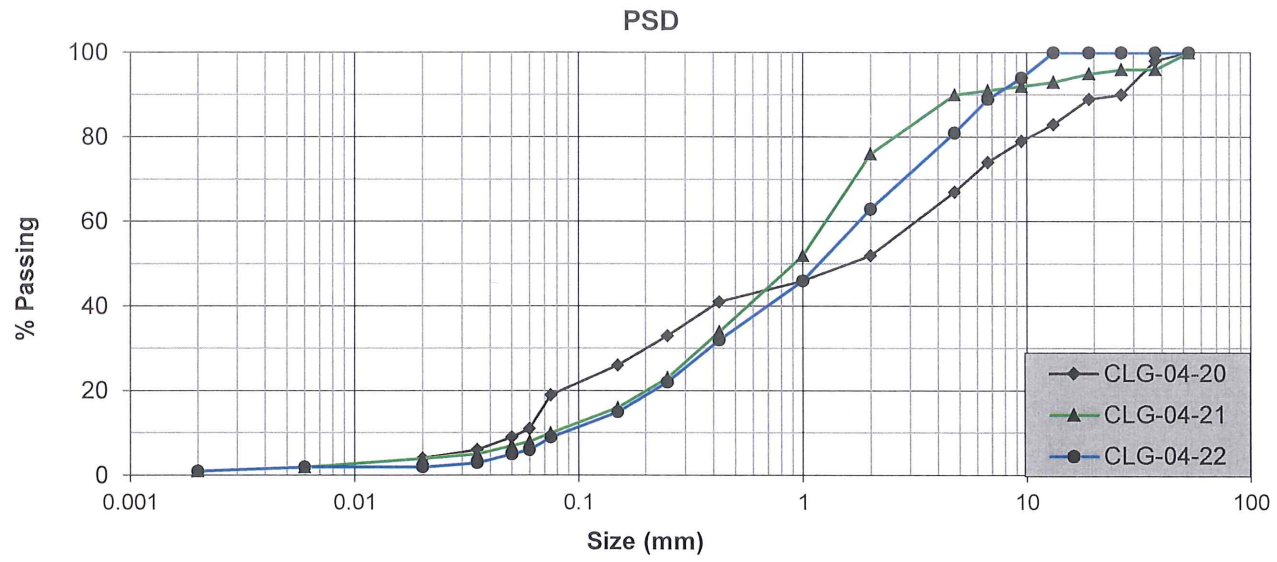
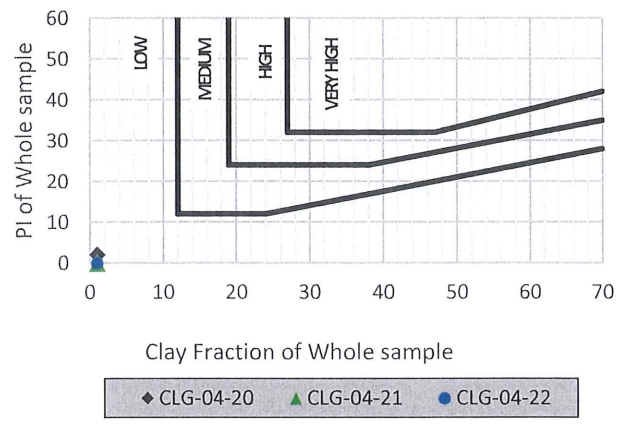
Job Number: CLG-04
Date: 2020-05-27
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

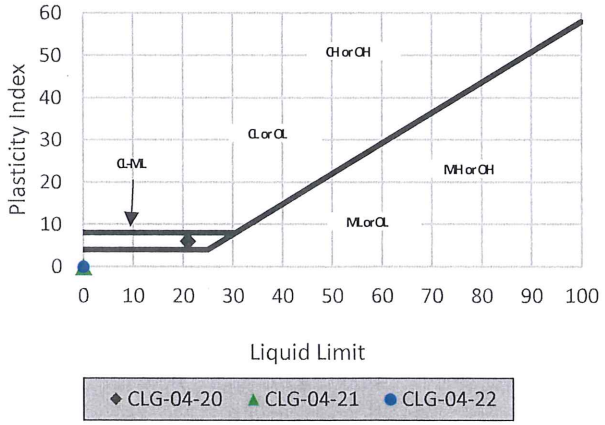
Sheet Ref: R-STL-011-Rev02



Potential Expansiveness



Casagrande Plasticity Chart



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Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Sheet Ref: R-STL-011-Rev02

Grading & Hydrometer Analysis
(Particle Size (mm) & % Passing)

Sample	TP 34	TP 35	
Depth (mm)	300 - 1500	400 - 1500	
Lab No	CLG-04-23	CLG-04-24	
53.0	**100**	**79**	
37.5	**100**	**71**	
26.5	**100**	**69**	
19.0	**100**	**67**	
13.2	**98**	**63**	
9.5	**93**	**60**	
6.7	**81**	**57**	
4.75	**70**	**55**	
2.00	**43**	**45**	
1.00	**28**	**37**	
0.425	**18**	**31**	
0.250	**13**	**24**	
0.150	**8**	**19**	
0.075	**5**	**12**	
0.060	**3**	**8**	
0.050	**3**	**7**	
0.035	**2**	**4**	
0.020	**1**	**3**	
0.006	**1**	**2**	
0.002	**1**	**1**	

Atterberg Limits & Classification

Sample	TP 34	TP 35	
Depth (mm)	300 - 1500	400 - 1500	
Lab No	CLG-04-23	CLG-04-24	
Liquid Limit (%)	-	**26**	
Plastic Limit (%)	-	**19**	
Plasticity Index (%)	**NP**	**7**	
Linear Shrinkage (%)	**0.0**	**3.5**	
PI of whole sample	-	**2**	
% Gravel	**57**	**55**	
% Sand	**40**	**37**	
% Silt	**2**	**7**	
% Clay	**1**	**1**	
Activity	**0.0**	**7.0**	
% Soil Mortar	**43**	**45**	
Grading Modulus	**2.34**	**2.12**	
Moisture Content (%)	**N / T**	**N / T**	
Relative Density (SG)*	**2.65**	**2.65**	
Unified (ASTM D2487)	**SW-SM**	**SP-SC**	
AASHTO (M145-91)	**A - 1 - a**	**A - 2 - 4**	

Remarks: *: Assumed
N / T: Not Tested

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Job Number:	CLG-04
Date:	2020-05-27
Method:	SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

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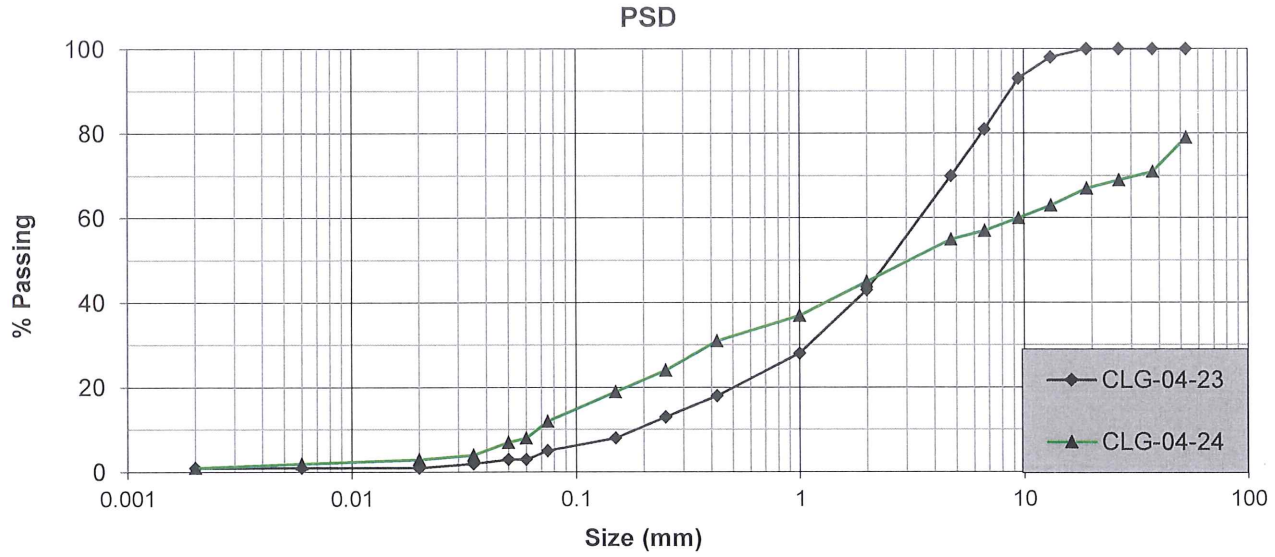
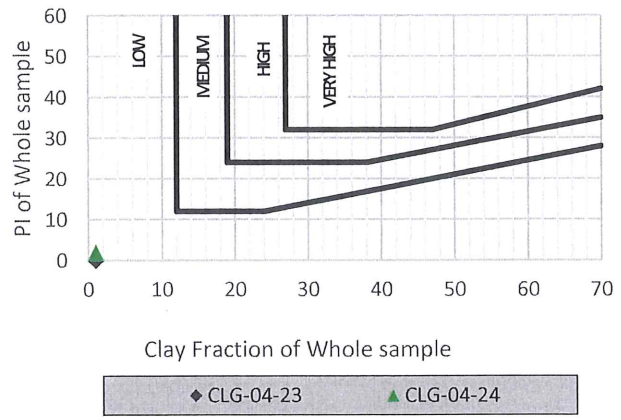
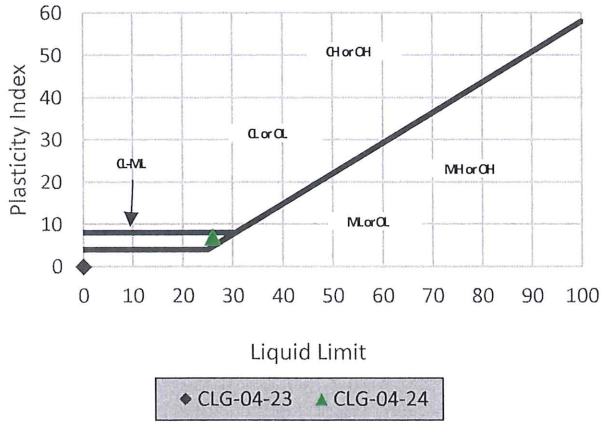
Sheet Ref: R-STL-011-Rev02



Potential Expansiveness



Casagrande Plasticity Chart



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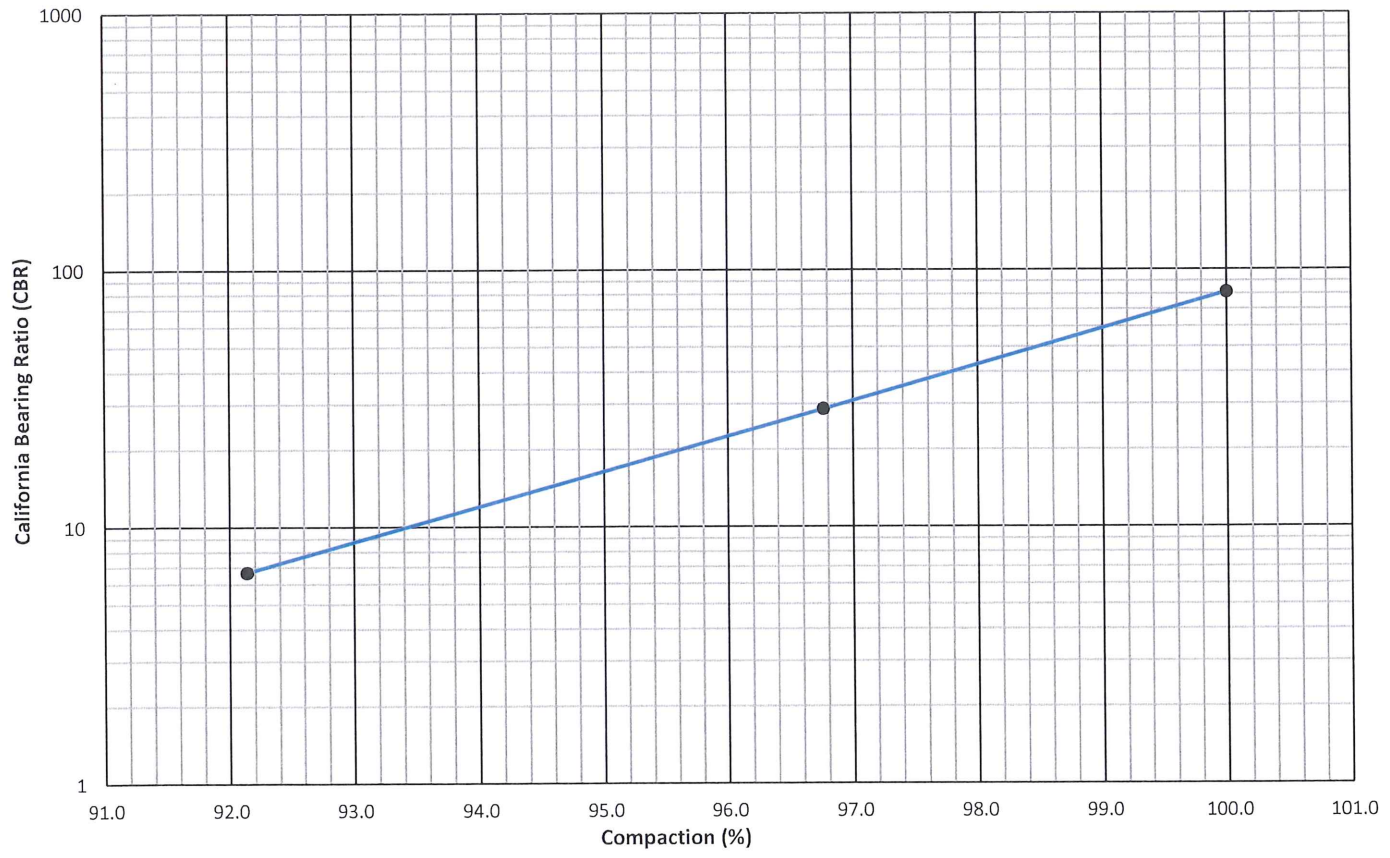
Client Name:	Cedar Land Geotechnical Consult (Pty) Ltd	**Job Number:**	CLG-04
Project Name:	Gamakor	**Lab Number:**	CLG-04-16
Sample:	TP 17	**Method:**	SANS 3001 GR40
Depth: (mm)	0 - 1100	**Date:**	27-May-20

CALIFORNIA BEARING RATIO

Mod. AASHTO Values		Compaction Data: CBR			Swell	CBR at (mm)			CBR Values	
MDD	OMC	Dry Dens.	MC	Comp.						
(kg/m³)	(%)	(kg/m³)	(%)	(%)	(%)	2.5	5.0	7.5	Compaction (%)	CBR
									100	**82**
2084	6.6	2073	6.8	100.0	0.0	82	102	94	98	**43**
									97	**31**
2084	6.6	2006	6.8	96.8	0.0	29	38	41	95	**17**
									93	**9**
2084	6.6	1910	6.8	92.1	0.0	7	7	7	90	**3**



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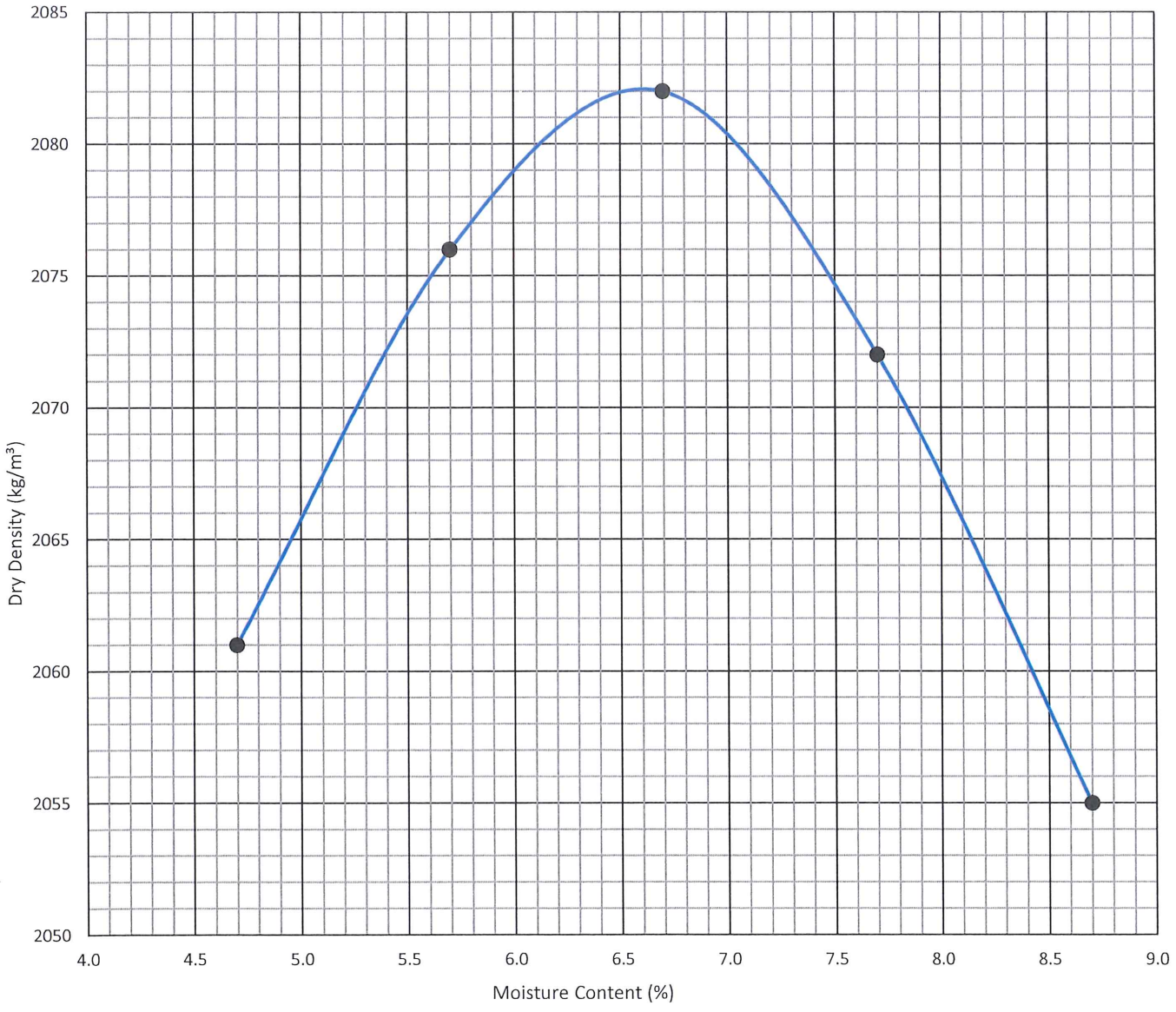
Client Name:	Cedar Land Geotechnical Consult (Pty) Ltd	**Job Number:**	CLG-04
Project Name:	Gamakor	**Lab Number:**	CLG-04-16
Sample:	TP 17	**Method:**	SANS 3001 GR30
Depth: (mm)	0 - 1100	**Date:**	27-May-20

MDD & OMC DETERMINATION (Mod. AASHTO)

Maximum Dry Density: **2084** kg/m³ Optimum Moisture Content: **6.6** %

Moisture Content (%):	4.7	5.7	6.7	7.7	8.7			
Dry Density (kg/m³)	2061	2076	2082	2072	2055			



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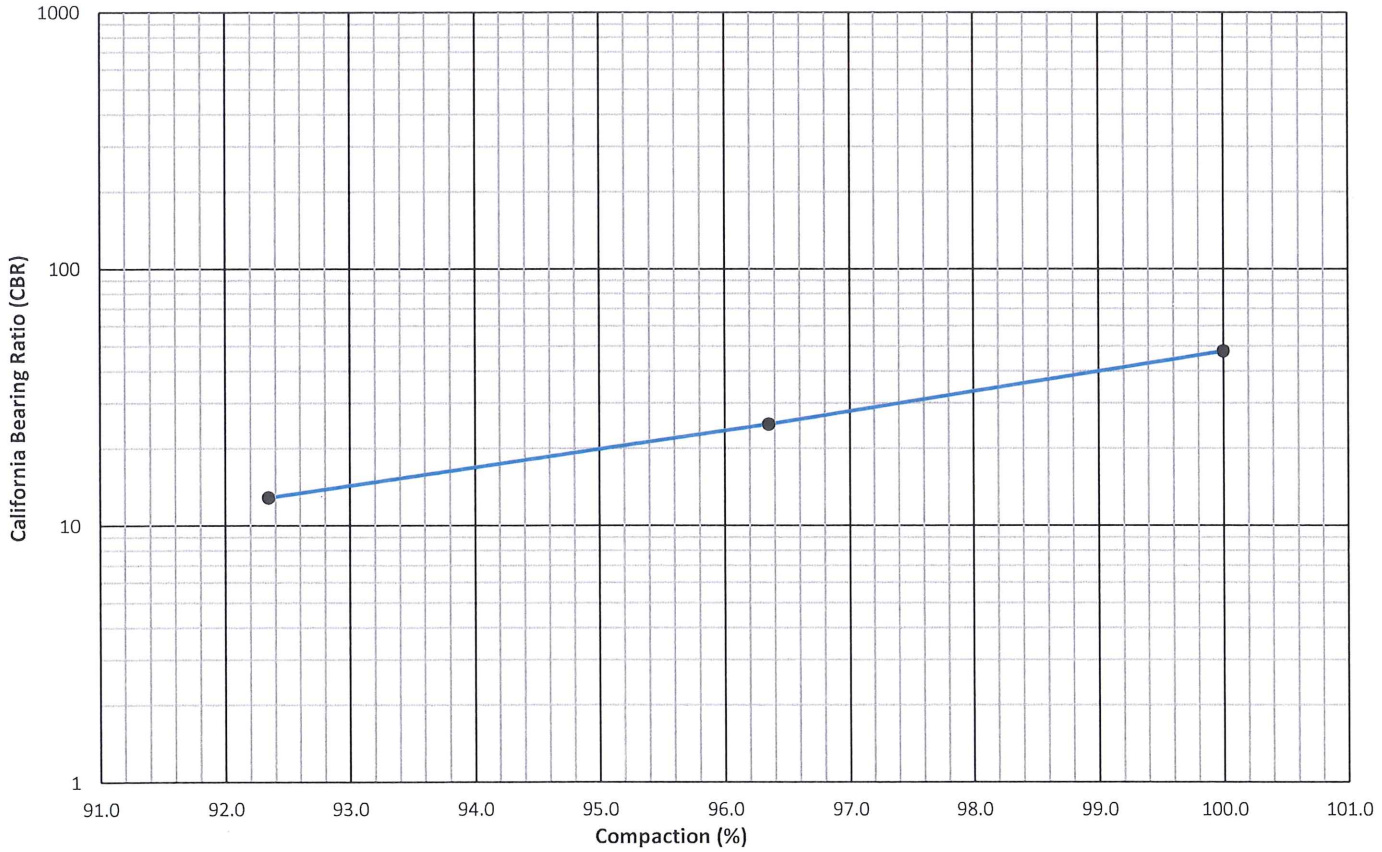
Client Name:	Cedar Land Geotechnical Consult (Pty) Ltd	**Job Number:**	CLG-04
Project Name:	Gamakor	**Lab Number:**	CLG-04-17
Sample:	TP 23	**Method:**	SANS 3001 GR40
Depth: (mm)	300 - 1600	**Date:**	27-May-20

CALIFORNIA BEARING RATIO

Mod. AASHTO Values		Compaction Data: CBR			Swell	CBR at (mm)			CBR Values	
MDD	OMC	Dry Dens.	MC	Comp.						
(kg/m³)	(%)	(kg/m³)	(%)	(%)	(%)	2.5	5.0	7.5	Compaction (%)	CBR
									100	**48**
1997	10.2	1947	10.3	100.0	0.6	48	64	71	98	**33**
									97	**28**
1997	10.2	1876	10.3	96.4	1.0	25	31	32	95	**20**
									93	**14**
1997	10.2	1798	10.3	92.3	1.3	13	15	15	90	**9**



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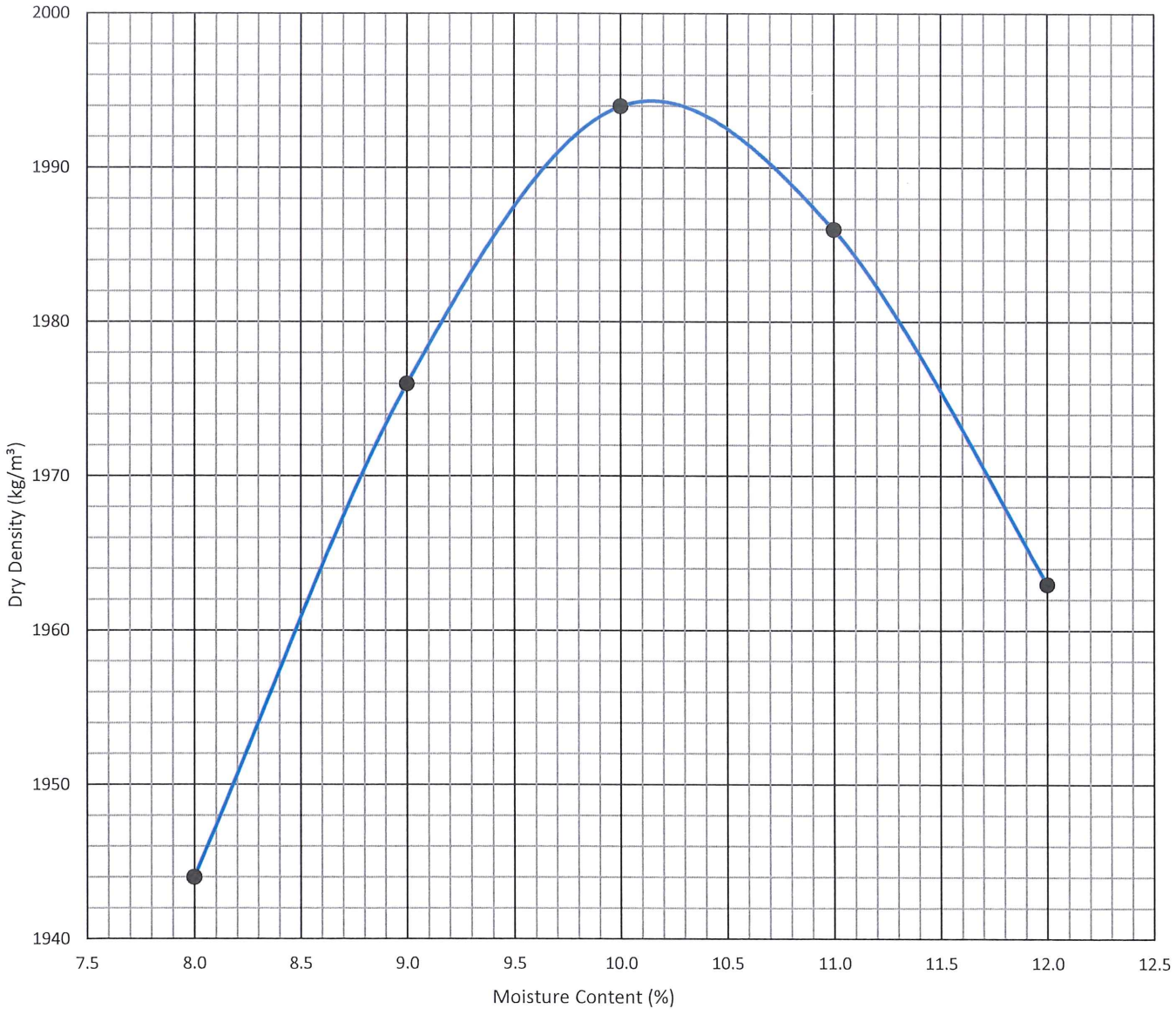
Quality | Excellence | On Time

Client Name:	Cedar Land Geotechnical Consult (Pty) Ltd	**Job Number:**	CLG-04
Project Name:	Gamakor	**Lab Number:**	CLG-04-17
Sample:	TP23	**Method:**	SANS 3001 GR30
Depth: (mm)	300 - 1600	**Date:**	27-May-20

MDD & OMC DETERMINATION (Mod. AASHTO)

Maximum Dry Density: **1997** kg/m³ Optimum Moisture Content: **10.2** %

Moisture Content (%):	8.0	9.0	10.0	11.0	12.0			
Dry Density (kg/m³)	1944	1976	1994	1986	1963			



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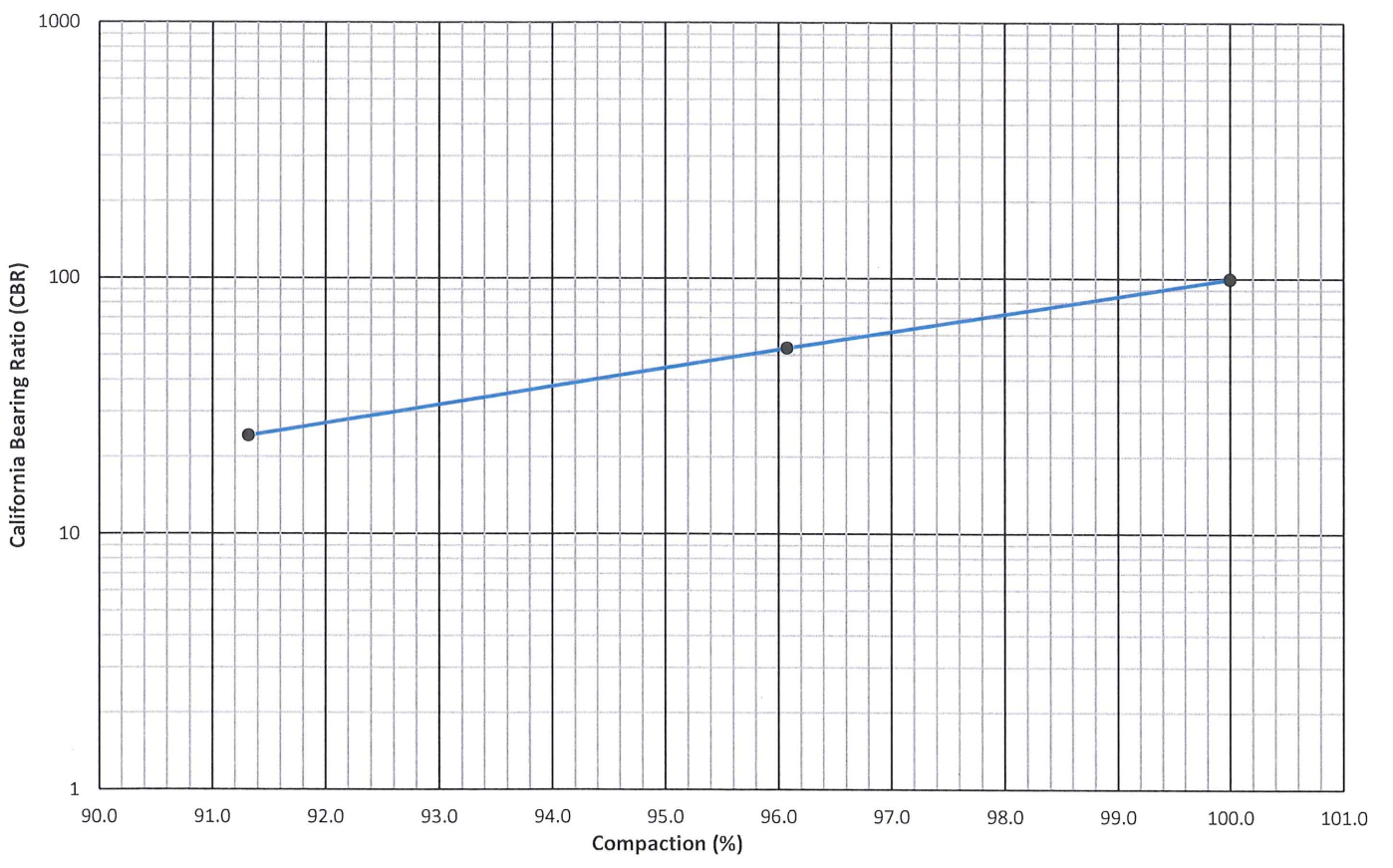
Unit 1, 13 Bloubokkie Street, Koedoespoort 0186
Roelof | 072 674 6343 | roelof@stlab.co.za
Gerrie | 082 309 4448 | gerrie@stlab.co.za
www.stlab.co.za

Quality | Excellence | On Time

Client Name:	Cedar Land Geotechnical Consult (Pty) Ltd	**Job Number:**	CLG-04
Project Name:	Gamakor	**Lab Number:**	CLG-04-19
Sample:	TP 27	**Method:**	SANS 3001 GR40
Depth: (mm)	300 - 600	**Date:**	27-May-20

CALIFORNIA BEARING RATIO

Mod. AASHTO Values		Compaction Data: CBR			Swell	CBR at (mm)			CBR Values	
MDD	OMC	Dry Dens.	MC	Comp.						
(kg/m³)	(%)	(kg/m³)	(%)	(%)	(%)	2.5	5.0	7.5	Compaction (%)	CBR
									100	**100**
2146	6.8	2166	6.9	100.0	0.0	100	131	147	98	**73**
									97	**62**
2146	6.8	2081	6.9	96.1	0.0	53	67	70	95	**45**
									93	**32**
2146	6.8	1978	6.9	91.3	0.0	24	29	29	90	**20**



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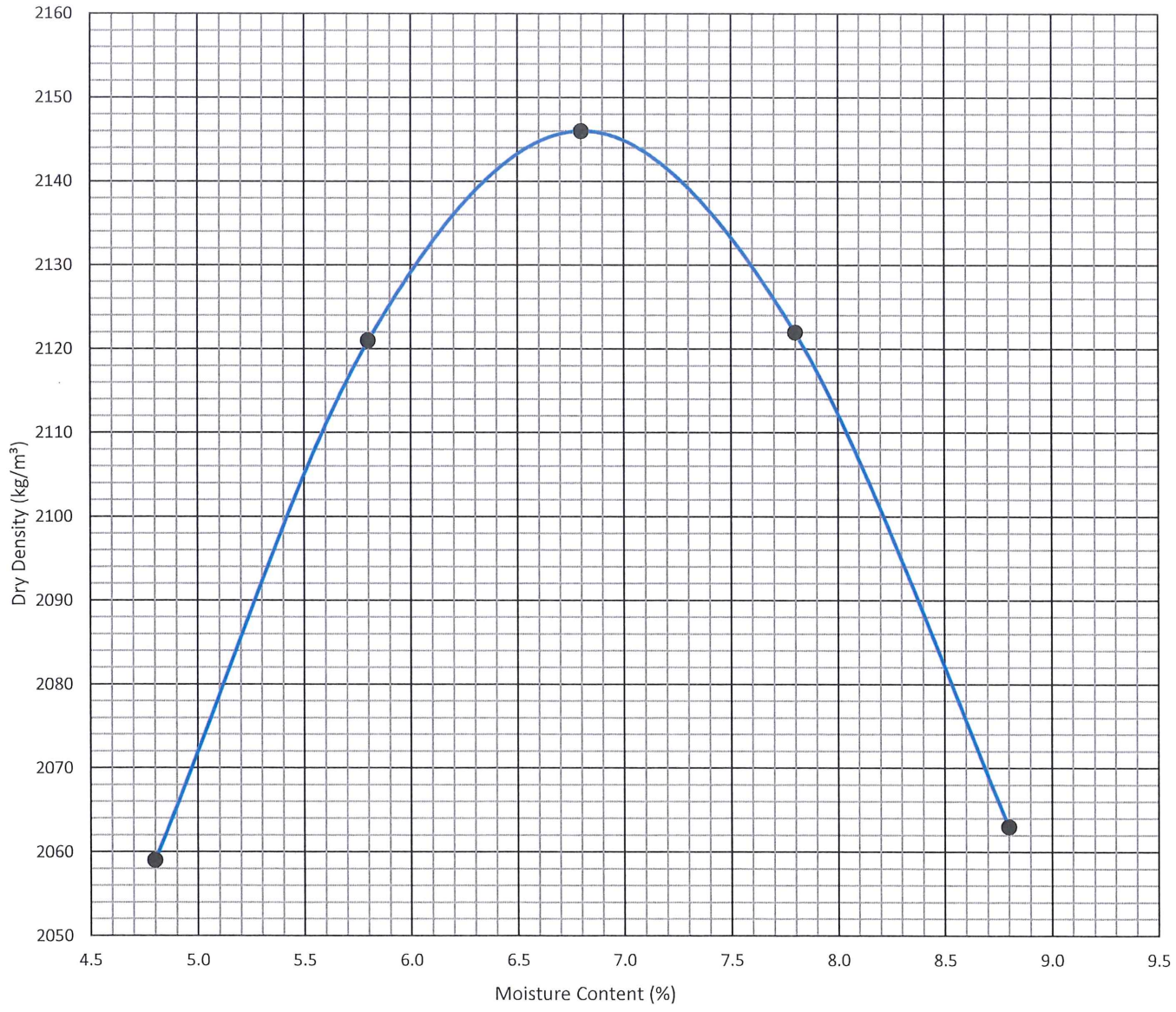
Quality | Excellence | On Time

Client Name:	Cedar Land Geotechnical Consult (Pty) Ltd	**Job Number:**	CLG-04
Project Name:	Gamakor	**Lab Number:**	CLG-04-19
Sample:	TP 27	**Method:**	SANS 3001 GR30
Depth: (mm)	300 - 600	**Date:**	27-May-20

MDD & OMC DETERMINATION (Mod. AASHTO)

Maximum Dry Density: **2146** kg/m³ Optimum Moisture Content: **6.8** %

Moisture Content (%):	4.8	5.8	6.8	7.8	8.8			
Dry Density (kg/m³)	2059	2121	2146	2122	2063			



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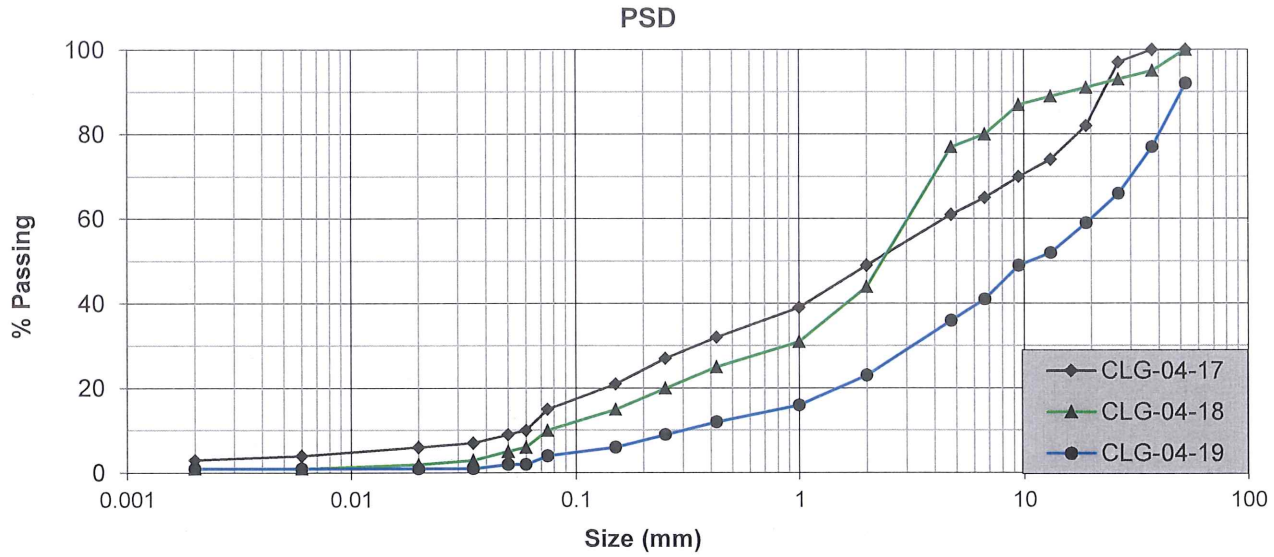
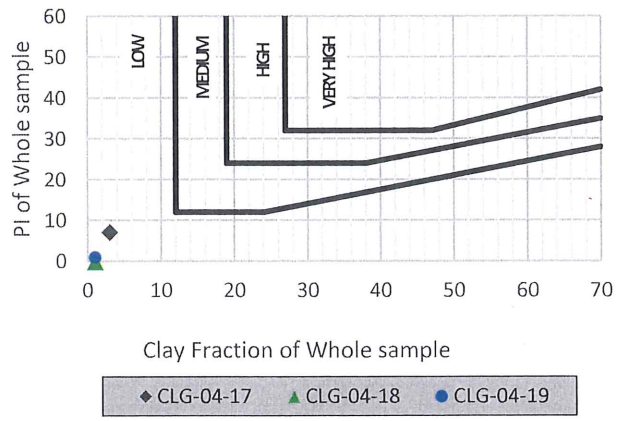
Client Name: Cedar Land Geotechnical Consult (Pty) Ltd
Project Name: Gamakor
Job Number: CLG-04
Date: 2020-05-27
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Sheet Ref: R-STL-011-Rev02



Potential Expansiveness



Casagrande Plasticity Chart