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A REPORT ON GEOTECHNICAL CONDITIONS ON STAND 11883 IN VRYBURG: A REPORT FOR THE PROPOSED CONSTRUCTION OF A NEW SHOPPING MALL

1 INTRODUCTION

1.1 Appointment

Soilkraft cc was appointed by Mr D Freislich on behalf of the Eris Property Group (Pty) Ltd to undertake a geotechnical investigation for the proposed establishment of a new shopping complex in Vryburg, North West Province. The shopping complex is to be known as the Mall of the North West.

2 AVAILABLE INFORMATION

The following sources of information were consulted:

- 1 : 250 000 scale geological map: 2624 Vryburg, published in 1993
- 1 : 250 000 scale geological map: 2724 Christiana, published in 1994
- 1 : 50 000 scale topographical map: 2624DC Vryburg, published in 2005
- *Report on a bedrock identification investigation for Vryburg Extension 25, North West Province,* compiled by WSM Leshika (report number WH11117) and issued on 21 June 2012
- A letter of communication to WSM Leshika from GeoStable SA regarding Vryburg Extension 25, dated 20 June 2012
- A letter of comment from the Council for Geoscience regarding Vryburg Extension 25 (document F4008.2), dated 21 June 2012

3 SITE DESCRIPTION

3.1 Site Location

The portion of land investigated is located on the south western outskirts of Vryburg and consists of stand 11883, a portion of stand 506. The land is located tangentially to the N14 National Route as it

exits the town of Vryburg in the direction of Kuruman and is also accessible from the same road. The property has an area of approximately 5,1ha was investigated, while the proposed shopping centre is likely to be approximately 26 000m^2 in size.

The study area is bordered to the north by vacant land, partially forming the golf course. The eastern boundary is also formed by the golf course, with a non-perennial stream passing in between. The southern boundary is formed by an existing residential estate, while the N14 forms the western boundary.

Figure 1 : Locality Plan illustrates the location of the study area.

3.2 Land Utilisation

At the time of the investigation the site was found to be vacant and devoid of any services or utilities. It was apparent that the northern half of the site had at some point been exploited for the procurement of construction gravel (i.e. a borrow pit).

Site conditions are illustrated in Photo 1. Photo 2 illustrates the area which has been exploited for material procurement.

3.3 Climate

The site is located in an area with an approximate Weinert N-value of 8,2 and a Thornthwaite Moisture Index between -20 and -40. As such, the site is located in an area which is considered to be semi-arid. In the given climate, mechanical weathering of rock material is likely to dominate chemical weathering, due to the arid nature of the area.

3.4 Existing Facilities

As mentioned in section 3.2, no facilities or services are available on the site. It is likely that the road reserve of the N14 route may host bulk services which serve the development/estate immediately south of the study area.

4 METHOD OF INVESTIGATION

4.1 Trial Holes

On 31 October 2012 a total of nine trial holes were excavated with the aid of a CAT 424D backhoe. The trial holes were excavated across the study area in a representative fashion and were inspected, sampled and profiled by a professional engineering geologist according to the standard profiling

parameters as per SAICE[Reference 8.1]. These parameters are summarised in the attached Table 1 : Soil Descriptive Terms, and the soil profiles contained in Addendum A to this report.

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

4.2 Soil Tests

Very limited soil samples were collected from the study area due to prevailing shallow bedrock and very limited soil profiles. Nevertheless, samples were retrieved and delivered to Geostrada, a SANAS accredited laboratory in Pretoria. Material tests included the following:

- Foundation indicator tests were done to determine general geotechnical properties such as grading (i.e. sieve screen analysis and hydrometer testing) and Atterberg Limits from which potential expansiveness could be deduced.
- Soil corrossivity tests (i.e. pH and conductivity) were done to verify whether in situ soils are corrosive towards buried steel objects.
- CBR tests were performed to establish whether in situ materials have the potential to be used in layer work construction.

The results of the soil testing can be found in Addendum B to this report, but are summarised in Table 2 : Material Testing Summary.

4.3 Rock Sample Tests

Rock sample tests were performed in an effort to accurately classify the materials encountered in the borehole profiles on site. This was done amidst a shortage of substantiated similar data in the immediate vicinity. In order to accurately describe and identify the rock materials and the state they were in, rock samples were submitted to XRD Analytical and Consulting cc. The following was requested:

- X-ray Diffraction (XRD) analyses of three samples collected from site or from borehole spoils.
- Petrographic description of two samples retrieved from site. The petrographic description was done using a thin section cut from the sample and analysed using a petrographic microscope under normal and cross-polarised light.

The results of the rock sample tests are included in Addendum C and will be discussed in more detail later.

4.4 Percussion Drilling

The sub-surface profile of the site was investigated by means of rotary percussion drilling. Boreholes were drilled by JK Developments using a Thor 5000 drill rig. The rig uses a 165mm hammer head and between 15 bar and 18 bar air pressure, in accordance with current specifications. The boreholes were inspected and profiled by a professional engineering geologist. Log sheets and driller’s journals are included in Addendum D.

Figure 2 : Site Layout illustrates the placement of all trial holes and boreholes used in the investigation.

5 DISCUSSION

5.1 Geology

The regional geology map depicts a relatively simple geology in the vicinity of the study area, amidst a more complicated regional geology. According to the regional information, the study area is situated on the Dwyka Group of the Karoo Supergroup. The Dwyka Group largely consists of diamictite and shale. In addition, the Vryburg Formation of the Griqualand West Sequence wedges in from north west of the site. Also in the vicinity is the Boomplaas Member of the Schmidtsdrif Formation, Campbell Group (Griqualand West Sequence). The Boomplaas Member is a dolomitic lithology that contains dolomite with oolitic and/or stromatolitic structures. Interlayered shale also occurs.

5.2 Site Specific Geology

The site specific geology and geological materials encountered in the vertical profile is very significant in this instance as the area may potentially be underlain by dolomitic strata and would therefore require related investigation. This will be discussed in detail at a later stage. For the purposes of the surface investigation it can at this point be assumed that tillite bedrock was encountered at shallow depth and as outcrop on surface.

The northern portion of the study area has at some point been exploited for gravel procurement and from surface observations a quartzitic sandstone material (Vryburg Formation) was targeted. Upon closer inspection it was found that the borrow area had very well defined boundaries and terminated tangentially to hornfels/tillite outcrop. While little is known about the material that was removed from the borrow area, the base of the depression showed extensive water ripple marks in the rock structure, as illustrated in Photo 3. The abrupt termination of the material procurement area and the materials encountered would suggest that a fault traverses the study area at this boundary; however the nature of the fault could not be determined from the surface inspection. Borehole information obtained later was applied to solve this question and will be discussed in Section 5.8.

The attached Figure 3 : Regional Geology Map allows an overview of the geology of the area.

5.3 Groundwater

- *Perched Water*: No perched groundwater or seepage was encountered in any of the trial holes inspected. It must be anticipated that very shallow bedrock and even outcrop prevailed; however

the study area is located in a semi-arid climate; hence conditions of perched water are unlikely to occur.

- *Permanent Groundwater*: Vegter[Reference 8.3] indicates the probability of drilling successfully for water in the area to be between 40% and 60% and, should water be encountered, chances are between 20% and 30% that the yield of such a borehole will exceed 2l/s. Such groundwater that is present in the area is usually encountered in compact dominantly arenaceous strata between depths of 10m and 20m. Considering the materials encountered on site, it is considered more likely that groundwater will occur in Dwyka Group materials (i.e. diamictites and tillites).

5.4 Soil Profiles

The trial holes excavated on site were of limited depth due to the presence of shallow bedrock or surface outcrop of bedrock. In addition, the depression on the northern half of the site continued into the bedrock with soil materials only being encountered along the periphery of the depression. Nevertheless, the following materials were encountered:

- *Colluvium 1*: The first colluvial material that was identified occurred in trial holes one, two and three. The material was described as pale brown silty sand with an intact structure and very loose consistency. The horizon spanned from surface to depths between 300 and 900mm, with the latter being an exception. The material had a non-plastic nature and hydrometer analysis revealed active clay content of only 3%, suggesting that the material is not expansive. A grading modulus of 1,88 was calculated and a PRA classification of A-2-6 was awarded.
- *Colluvium 2*: A second distinctive colluvial horizon was encountered in trial holes four through seven, and nine. The soil had grey brown colour, a very loose consistency, an intact structure and was described as silty sand. The horizon had a very limited thickness, measured between 100mm and 200mm. This material was sampled in a mixture with underlying bedrock gravel, but nevertheless, results indicate a plasticity index of 5% and an active clay content of only 2%. The material is therefore not expansive. A grading modulus of 1,88 was calculated and the material was classified as A-1-b according to the PRA system.

5.5 Conditions of Excavation

As is to be expected, conditions of excavation on site are dictated by the shallow bedrock and bedrock outcrop. The following applies:

- *Colluvium:* Colluvial soils proved to be of limited thickness, but are very easily excavatible by backhoe. The materials composition and consistency resulted in very little resistance to excavation.
- *Tillite Bedrock:* Tillite bedrock near or on the surface proved to induce instant refusal of excavation by backhoe. While the bedrock was mostly described as soft to very hard rock, it is

generally not excavatible by backhoe.

- *Quartzitic Sandstone Bedrock:* The quartzitic sandstone bedrock encountered at the base of the borrow area was also described as medium hard rock and was excavatible to a very limited extent (between 100mm and 300mm) before refusal of excavation was encountered. Overall then, the material should not be considered excavatible with the aid of a backhoe.
- *Depth of Excavation*: A minimum depth of excavation by backhoe was established at 100mm at the borrow pit floor; however the remaining trial holes reached depths between 300mm and 1200mm with the latter being an exception.
- *Sidewall Stabilities*: The excavations inspected proved stable during the investigation, largely due to the very limited depth thereof.

5.6 Founding Conditions

5.6.1 Conditions of Unrestrained Heave

Material testing revealed that in situ materials are not likely to heave, simply due to low plasticity indices and weighted plasticity indices. Moreover, the soil profiles are extremely limited.

5.6.2 Conditions of Settlement

As with the preceding section, conditions of consolidation are not expected on site, simply due to the limited thickness of the soil profile. While loose and very loose colluvial soils do occur, these are largely located above conventional founding depths. Nevertheless, a limited (i.e. 10mm) amount of settlement will be accommodated when supporting typical loads associated with single storey structures (i.e. approximately 50kPa).

5.6.3 Bedrock

The entire site is characterised either by the presence of shallow bedrock or bedrock outcrop. This must clearly be taken into account when considering foundation solutions.

5.6.4 Borrow Area

The borrow area that prevails on site presents a problem. The borrow area leaves a substantial area with irregular topography that would have to be rehabilitated prior to construction.

5.6.5 General

Considering all of the above, the area investigated is of **S**/**R** classification[Reference 8.4]. The classification does not make provision for the depression on site, but this will be considered when

recommendations are given.

5.7 Soil Corrossivity

With the limited soil materials on site, only a single sample was extracted for soil chemistry analysis. A sample of colluvial soil was extracted from trial hole one and results revealed a soil paste pH of 8,42 and a conductivity reading of 0,0289S/m. While the pH is indicative of non-acidic conditions, the conductivity indicates a slightly to moderately corrosive material. With this in mind, some precautionary measures may be required if services are installed in the colluvium (or the material is used as backfill).

5.8 Material Utilisation

In order to assess the potential of in situ materials to be utilised in the construction of layer works, three CBR samples were extracted for laboratory tests. The tree samples can be summarised as follows:

- Sample 1: This sample was taken from trial hole one and comprised a mixture of colluvium and tillite gravel encountered at the base of the trial hole. The sample proved to be of G6 COLTO quality and achieved CBR values of 29%, 38% and 53% at Mod AASHTO densities of 93%, 95% and 98%.
- Sample 2: This sample consisted of quartzitic sandstone sample at the base of the borrow area (trial hole eight). Considerable effort was required to loosen sufficient material to collect a CBR sample and the material broke into plate-like (i.e. elongated) gravel. Nevertheless, the sample achieved a G6 COLTO classification. CBR values of 26%, 37% and 54% were achieved at Mod AASHTO densities of 93%, 95% and 98%.
- Sample 3: The final sample was taken from trial hole nine and consisted once more of a mixture between tillite and colluvial material. Results revealed that CBR values of 47%, 51% and 65% were achieved at Mod AASHTO densities of 93%, 95% and 98%. As a result, the material was classified as G5 (COLTO).

With the above in mind, it is clear that in situ materials have significant potential for use in the construction of layer works.

5.9 Dolomite Related Considerations

5.9.1 Preliminary Drilling

In order to confirm or disprove the presence of dolomitic bedrock on the site, a single percussion borehole was initially drilled on site to a depth of 100m. The borehole was drilled on 19 June 2012

and subsequently inspected.

On inspection of the borehole spoils, an interesting profile was encountered (refer to Addendum D for borehole log sheets). The borehole revealed a surface cover of colluvium underlain by tillite bedrock to a depth of seven metres. From this depth distinctive pale white quartzite was encountered to a depth of approximately 42m. Between 42m and 46m dolomitic bedrock was encountered; however immediately below this, tillite was once more encountered and continued to a depth of 100m. The lithology seemed puzzling.

The borehole was discussed with Mr Greg Heath who was part of the dolomite division of the Council for Geoscience (but has since taken employment elsewhere). In particular it was discussed whether the presence of a small interval of dolomite at depth – and overlain by relatively competent rock – would justify a full dolomite stability investigation. In the end it was decided that limited additional drilling would be undertaken to determine whether the site had similar properties to the area investigated for the proposed establishment of Vryburg Extension 25, just south of the study area.

5.9.2 Existing Sources

A copy of the rock identification report for Vryburg Extension 25 was obtained from WSM Leshika (refer to section 2). The document was studied in order to determine the conditions encountered on the area investigated nearby for the proposed establishment of Vryburg Extension 25. The document was supplemented by a letter of comment from the Council for Geoscience. After reviewing the report and associated communications, the following was concluded:

- Boreholes for the township establishment investigation were logged by Ms Beverley Keyter of GeoStable SA. Some correspondence was provided regarding the erroneous identification of bedrock during borehole inspection, where a significant amount of materials were “conservatively” described as dolomite but was in fact diamictite.
- The misidentification of diamictite as dolomite was ascribed to the fact that the diamictite displayed a positive reaction to the acid test (i.e. the chips reacted to acid, a field test for dolomite).
- Ultimately additional boreholes were drilled and inspected across the study area to verify the misidentification. Supplementary borehole data suggested, based on visual observation, that the positive reaction of the diamictite to the acid test was the result of some dolomite fragments within the material mass.
- Ultimately the site was accepted as being free of karst-related issues and was not subject to further dolomite stability review. The findings were supported by the Council for Geoscience in document F4008.2, dated 21 June 2012.

After reviewing the documents a number of points were considered for further consideration:

- No chemical or other tests were performed on any of the materials obtained from boreholes.
- The description of the diamictite complies with that encountered during Soilkraft's borehole investigation, with the exception of a four metre interval of relatively clear dolomite encountered from 42m depth.
- The description of the diamictite/tillite was peculiar in the sense that the material resembled amygdaloidal lava, rather than a diamictite deposit with drop stone inclusions.

5.9.3 Supplementary Percussion Drilling

In order to substantiate the findings of the initial borehole, an additional three boreholes were drilled across the site, but were limited to depths of 60m. The additional boreholes complied roughly with the initial borehole drilled on site, except that no dolomite was intercepted. With the exception of borehole four, the borehole all showed a sequence of tillite overlying quartzite. The quartzite was again underlain by tillite.

5.9.4 Lithological Model

The aim of this section is not to derive a detailed lithology of the area, as this would have limited relevancy to the investigation at hand. The aim, however, is to substantiate the occurrence of dolomite encountered in borehole one and in order to do this, a general concept of the lithology must be compiled.

The profiles recorded in boreholes within the study area were similar to profiles recorded in the report compiled by WSM, but the lithology was limited only to describing diamictite overlying quartzite. The report stated that the diamictite (Dwyka Group) was most likely underlain by quartzite of the Vryburg Formation and while this seems sensible, no further mention is made of the fact that the quartzite is again underlain by diamictite, according to the report. This is a conundrum as the Vryburg Formation can not overlie and underlie the Dwyka Group unless tectonic displacement events took place.

While the identification of quartzitic material is fairly simple, some reservations prevailed regarding the identification of the so-called diamictite or tillite in boreholes and on surface. The fact that the origin of the bedrock was previously changed and never substantiated was a concern which was further exacerbated when the author found the properties of the "tillite" in the study area to be peculiar in that it resembled amygdaloidal lava. In order to address uncertainties, three samples were collected for analyses as follows:

- Sample 1 was taken from bedrock in trial hole three from "tillite" bedrock
- Sample 2 was sampled from surface outcrop, also from "tillite" bedrock
- Sample 3 was taken from drill spoils of borehole two (between depths of 53m and 57m)

Samples 1 and 2 were submitted for XRD analyses and thin section (petrography) description, while sample 3 was only used for XRD analysis. The results of the analyses indicate that the samples are in fact hornfels or epidote hornfels, with XRD results being relatively similar for all three samples. The petrographic study indicated that alteration was noted in the thin sections and that the materials had undergone greenschist facies metamorphism, likely the result of contact metamorphism.

With the results in mind a number of hypotheses were formulated as to how the rock materials developed its structure and why it displayed an initial reaction to the acid test. As far as can be discerned, it is likely that the hornfels is the result of diamictite or tillite metamorphism. A massive source of heat (or pressure) would have been required on a regional scale to result in contact metamorphism of the material to the depths to which it was encountered. Such a source is present in the area in the form of the Ventersdorp lavas; however these lavas predate the Dwyka significantly. The same applies to the lavas of the Vryburg Formation. The only potential source that could induce contact metamorphism in the area and would be of suitable age would be dolerite of the Karoo Supergroup. While no dolerite was encountered in the boreholes on this site, the area investigated by WSM noted dolerite in many boreholes. As such, a potential source of heat would be present in the area; however whether this source would have been suitably large to metamorphose such a large area remains unknown.

Another factor that needs consideration is the sequence in which the rock materials were encountered. Boreholes revealed diamictite/tillite (metamorphosed to hornfels) underlain by quartzite – seemingly from the Vryburg Formation. The quartzite; however, was again underlain by metamorphosed diamictite/tillite. No other source of tillite – other than the Dwyka Group – is recorded on the regional geological map in this vicinity. Consulting the literature, both Eriksson *et al.*[Reference 8.5] and Kent[Reference 8.6] indicate that the Vryburg Formation is unconformably underlain by the Ventersdorp Supergroup. Kent also mentions that the Vryburg Formation may contain subordinate lava.

To get a clearer idea of the rock profile, Figure 4 illustrates a cross section, based on borehole data. From the figure it is clear that the metamorphosed diamictite/tillite is divided into an upper and lower section, with quartzite present in between. Notably the quartzite was deposited in a fairly consisted thickness and (from borehole observations) had a fairly uniform composition or grain size. Given the accepted fact that the tillite is a glacial deposit deposited into a marine basin, it is possible (but unsubstantiated) that the quartzite could have been an erosion channel cut into the soft deposits at the time of deposition (similar to small channels at a delta running into an ocean). Once the channel had been eroded and the sand (which is now quartzite) deposited, glacial deposits continued, resulting in more diamictite/tillite overlying the quartzite. This model would also explain why a single (seemingly) boulder of dolomite could be intercepted in the profile. The dolomite could well have been a large drop stone deposited at the top of the initial till deposits. It is unlikely that the dolomite boulder was deposited with the quartzite, as the constant grain size of the quartzite suggests that the

depositional energy was fairly constant and not large enough to transport boulders. More importantly, this hypothesis could explain why the quartzite may not necessarily be from the Vryburg Formation and ultimately, why it is not underlain by the Ventersdorp lavas, but more (metamorphosed) diamictites.

5.9.5 Implications to Dolomite Stability

Taking into account the findings of boreholes drilled on site in conjunction with the existing report compiled by WSM Leshika, it is concluded in this section that the occurrence of dolomite in borehole one was an isolated incident similar to that described in the said report. As a result, the study area is not considered to be dolomitic land and therefore the pursuit of further investigation of this matter is not necessary.

6 CONCLUSIONS

The following are the main conclusions that can be made from the discussion above and must be considered prior to making recommendations:

- *Geology*: The study area appears to be located on tillite bedrock associated with the Dwyka Group of the Karoo Supergroup. Subsequent rock analyses showed that the material has been subjected to metamorphism which has altered the bedrock to hornfels.
- *Soil Profile*: The soil profiles encountered on site were very limited due to shallow bedrock and bedrock outcrop. Only very shallow colluvial soils were encountered.
- *Hydrology*: Perched water was not encountered during the investigation and is not expected to prevail.
- *Conditions of Excavation*: Conditions of excavation are dictated by bedrock. Excavation by backhoe was severely restricted by shallow bedrock and bedrock outcrop. With one exception, trial holes never reached a depth of 1000mm before encountering refusal on bedrock.
- *Soil Corrossivity*: The colluvial soil proved to be slightly to moderately corrosive with regard to the material's conductivity.
- *Material Utilisation*: In situ materials proved to be of G5 to G6 COLTO quality.
- *Founding Conditions*: A site classification of **S**/**R** was awarded to the site; however founding conditions will be affected by the prevailing depression left (i.e. borrow pit area).
- *Dolomite Related Issues*: The site is not considered to be subject to further dolomite-related studies.

7 RECOMMENDATIONS

7.1 Structural Design

Considering the practical implications of the borrow pit depression to construction costs, two alternatives are recommended:

7.1.1 Borrow Pit Incorporation

The first option proposed is to incorporate the depression resulting from the borrow area into the design. The existing depression can be expanded and used as a lower level to the structure (e.g. parking basement). The materials removed from the profile during such an operation could potentially be processed (i.e. crushed), stockpiled and used during platform or layer work construction. This option seems viable as the materials were proved to be of a fairly good quality, but quality assurance testing must be undertaken.

If this option is selected, founding can be done directly on bedrock. The single storey structure may be founded by means of lightly reinforced strip footings hosted on suitable bedrock (as pointed out by a competent person). A full movement joint must be installed between the sections constructed at ground level and the section constructed on the expanded base of the borrow area.

7.1.2 Borrow Pit Rehabilitation

The second option is to rehabilitate the borrow area in order to restore ground level to align with surface level of the remainder of the site. Rehabilitation of the borrow area must be undertaken by backfilling the depression with inert material of at least G7 COLTO quality, compacted in layers to 93% Mod AASHTO density. In essence, the area must be rehabilitated using a soil replacement raft. Once the depression has been rehabilitated, plate load tests must be performed to verify the bearing capacity of the backfill material.

In this instance, construction on the undisturbed portion of the site may be undertaken as previously described (i.e. reinforced strip footings). The section located on the rehabilitated borrow pit area may be constructed using reinforced strip footings hosted on the soil replacement raft. The foundation must be designed by a suitably qualified structural engineer. As before, a full movement joint must be installed between the two sections of the structure.

7.1.3 General Measures

Site drainage must be planned carefully to ensure effective dispersion of storm water. In addition, it is recommended that buried metal objects (e.g. services, utilities, anchoring poles, etc.) be protectively

coated to protect them from mildly corrosive soils.

Provision must also be made for blasting to enable services installation. This will be discussed in more details in section 7.2.

7.2 Conditions of Excavation

In general conditions of difficult to very difficult excavation prevail on site. The following is recommended:

- *Colluvium:* All colluvial soils may be considered excavatible by backhoe. The materials are easily excavatible.
- *Bedrock*: Provision must be made for blasting, splitting and/or the use of pneumatic equipment to excavate bedrock materials.
- *General*: Excavation by backhoe was proven to a minimum depth of 100mm and seldom achieved a depth of 1000mm. Conditions of very difficult excavation prevail on site.

7.3 Material Utilisation

It is recommended that in situ materials be considered for the construction of layer works and construction platforms. Samples tested during the investigation proved to be of G5 to G6 COLTO quality and it is recommended that an overall quality of G6 be accepted.

In situ rock materials may potentially be crushed and stockpiled for use as construction aggregate. Such materials must be adequately tested before utilisation.

8 SOURCES OF REFERENCE

8.1 South African Institute of Engineering Geologists *: Guidelines for Urban Engineering Geological Investigations*, pages 2 to 8, published in 1997.

8.2 Geotechnical Division of SAICE : *Guidelines for Soil and Rock Logging*, published in 1990.

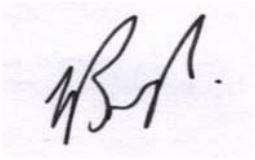
8.3 Vegter JR : *An Explanation of a Set of National Ground Water Maps*, published by the Water Research Commission in 1995.

8.4 IStructE : Code of Practice – foundations and Superstructures for Single Storey Residential Buildings of Masonry Construction, page 2.3.

8.5 Eriksson P.G., Altermann W. and Hartzer F.J. *The Transvaal Supergroup and its Precursors* **in**

The Geology of South Africa, published jointly by the Geological Society of South Africa and The Council for Geoscience in 2006

8.6 Kent L.E. (1980). *Stratigraphy of South Africa Handbook 8*, published by the Department of Mineral and Energy Affairs, page 212



IJ Breytenbach (Pr. Sci. Nat.)

FJ Breytenbach (Pr. Eng.)

6 February 2013

For Soilkraft cc

NOTES

0 1000 2000

NO.	DATE	REVISION	
0	04/10/21	ISSUED FOR CONSTRUCTION	SDH

AMENDMENTS

CLIENT

Approved Date

LOCAL AUTHORITY

NALEDI LOCAL MUNICIPALITY
P.O Box 35
Vryburg
8600
North West

Tel: +27 (0)53 928-2200
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Approved Date

CONSULTANT DETAIL

BSM CONSULTING ENGINEERS
142 Western Service Road
Woodmead
Johannesburg, 2191

TEL :+27 (0)72 438 2465
TEL :+27 (0)83 250 9898

Approved Date

PROJECT NAME

VRYBURG MALL DEVELOPMENT ON ERF 11883 (A PORTION OF ERF 506)

DRAWING TITLE

BULK EARTHWORKS – LOWER PARKING CONTOURS PLOT

	NAME	
Client		
Designer	S MAPHOTHOMA	
Drawn	S MAPHOTHOMA	
Checked	NC MEYER	
Approved	NC MEYER	
Engineer	NC MEYER	
Scale 1:750 (A1)		ORIGINAL PAPER SIZE: A1

Contract Number :P0078

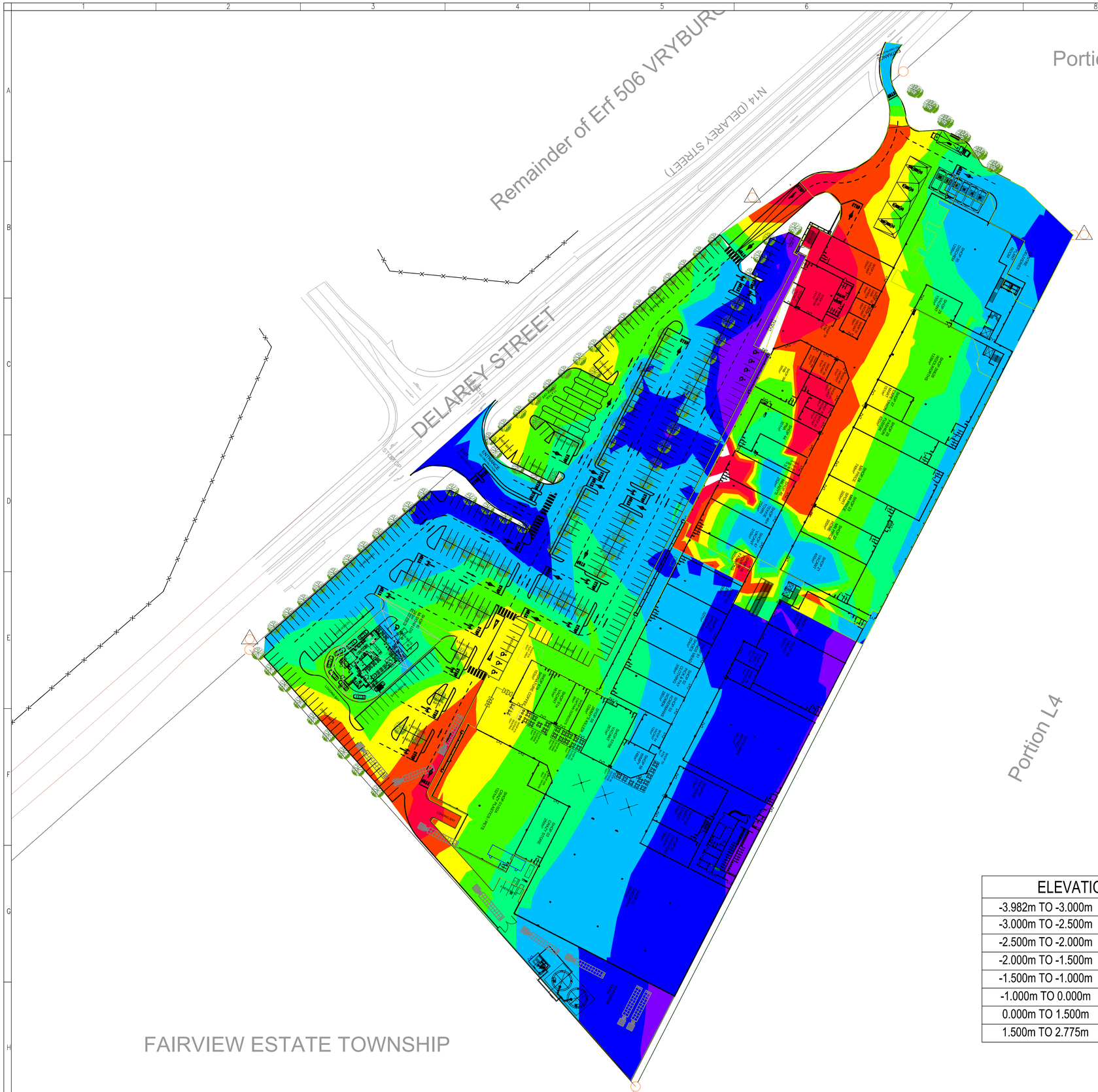
Project Number :P0078

Drawing Number : P0078-150-003

PROJECT STATUS

● CONCEPT DRAWING ○ TENDER DRAWING ○ CONSTRUCTION DRAWING ○ AS BUILT DRAWING

SHEET	REVISION
1/1	0



ELEVATIONS LEGEND

-3.982m TO -3.000m	
-3.000m TO -2.500m	
-2.500m TO -2.000m	
-2.000m TO -1.500m	
-1.500m TO -1.000m	
-1.000m TO 0.000m	
0.000m TO 1.500m	
1.500m TO 2.775m	

NOTES

0 1000 2000

NO.	DATE	REVISION	
0	05/04/22	ISSUED FOR INFORMATION	SDH

AMENDMENTS

CLIENT

Approved Date

LOCAL AUTHORITY

NALEDI LOCAL MUNICIPALITY
P.O Box 35
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North West

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TEL :+27 (0)72 438 2465
TEL :+27 (0)83 250 9898

Approved Date

PROJECT NAME

VRYBURG MALL DEVELOPMENT ON ERF 11883 (A PORTION OF ERF 506)

DRAWING TITLE

BULK EARTHWORKS – ELEVATIONS PLOT

	NAME
Client	
Designer	S MAPHOTHOMA
Drawn	S MAPHOTHOMA
Checked	NC MEYER
Approved	NC MEYER
Engineer	NC MEYER

Scale 1:750 (A1) ORIGINAL PAPER SIZE: A1

Contract Number :P0078

Project Number :P0078

Drawing Number : P0078-150-002

PROJECT STATUS

● CONCEPT DRAWING ○ TENDER DRAWING ○ CONSTRUCTION DRAWING ○ AS BUILT DRAWING

SHEET	REVISION
1/1	0

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website: www.geoscience.org.za

Council for Geoscience

Our Reference: F4159.1
Stand 11883 Vryburg
New Shopping Mall
Your Reference: 2013/J008/EPG
Enquiries: T Oosthuizen
Tel: 012 841 1160
Fax: 086 615 6682
Email: toosthuizen@geoscience.org.za
No. of Pages: 3

19 February 2013

Naledi Local Municipality
P O Box 35
Vryburg
8600

ATTENTION: Manager: Strategic Planning and Support Services
Mr. Leon Pretorius

By fax: *053 927 3482*

Dear Sir,

STAND 11883 VRYBURG: PROPOSED NEW SHOPPING MALL

The firm, Soilkraft CC (SK) submitted their report: "A report on geotechnical conditions on Stand 11883 in Vryburg: A report for the proposed construction of a new Shopping Mall", dated February 2013 on behalf of their client, Eris Property Group (Pty) Ltd, to this office for comment on 8 February 2013. This office acts as an agent to state authorities in reviewing dolomite stability investigations on their behalf.

The site is located on the south western outskirts of Vryburg and consists of Stand 11883, a Portion of Stand 506. The property covers a surface area of approximately 5,1 hectares, which the proposed shopping centre is likely to be approximately 26 000 m^2 in size. The site is currently vacant. The proposed shopping complex is to be known as the Mall of the North West.

The regional geology map depicts relatively simple geology in the vicinity of the site, amongst more complicated regional geology. The site is situated on the Dwyka Group of the Karoo Supergroup. The Dwyka Group largely consist of diamictite and shale. The Vryburg Formation of the Griqualand West Sequence wedges in from north to west of the site. The Boomplaas member

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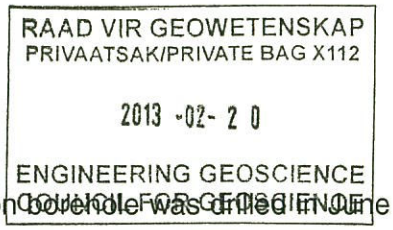
Council for Geoscience

of the Schmidtsdrif Formation, Campbell Group is also present in the vicinity of the site, which contains mainly dolomite with oolitic and/or stromatolitic structures.

SK did not indicate in which groundwater compartment the site is situated. No groundwater was encountered in any of the trail holes excavated or boreholes drilled on the site.

SK indicates that the site was investigated by means of the following:

- A total of 9 trail holes were excavated;
- Soil samples were collected to conduct some material tests, including Foundation Indicator Tests, Soil corrossivity tests and CBR tests.
- Four rotary percussion boreholes were drilled across the site.
- Rock sample tests were performed to accurately classify the materials encountered in the borehole profiles on the site.



Background:

* In Section 5.9 of the report SK indicates that a single percussion borehole was drilled in June 2012 in order to confirm or disprove the presence of dolomitic bedrock on the site. This borehole (BH1) revealed a surface cover of colluvium underlain by tillite bedrock to a depth of 7 m. From this depth white quartzite was encountered to a depth of approximately 42 m. Between 42 m and 46 m dolomitic bedrock was encountered; however immediately below this, tillite was again encountered and continued to a depth of 100 m.
* The results of the borehole were discussed with staff at the CGS and it was recommended that the information from the adjacent site, Vryburg Extension 25 should also be studied.
* SK obtained a copy of the report that was conducted for Vryburg Extension 25 (Report conducted by WSM Leshika). Additional drilling was also conducted in this area after some materials in the initial boreholes were misinterpreted as dolomite. This site was latterly classified as non-dolomitic (CGS letter dated 21 June 2012).
* SK indicates that in order to substantiate the findings of the initial borehole (on Stand 11883), an additional 3 boreholes were drilled across the site, but were limited to depths of 60 m.

Having reviewed the SK report, we submit that:

a) SK indicates that the profiles recorded in the boreholes within the study area were similar to the profiles in the report compiled by WSM Leshika, but the lithology was limited only to describing diamictite overlying quartzite. The three additional boreholes drilled by SK did not encounter any dolomitic materials. SK described the lithology as follows:
   - Three samples were submitted for XRD analysis by SK and two samples for petrography.
   - The results of the analysis indicated that the samples are in face hornfels or epidote hornfels, with the XRD results being relatively similar for all three samples.
   - The petrographic study indicated that alteration was noted in the thin sections and that the materials had undergone greenschist facies metamorphism, likely the results of contact metamorphism.

- According to SK, it is likely that the hornfels is the results of diamictite or tillite metamorphism.
- SK indicates that the dolomite encountered in BH 1 could well have been a large drop stone deposited at the top of the initial till deposits. It is unlikely that the dolomite boulder was deposited with the quartzite, as the constant grain size of the quartzite suggest that the depositional energy was fairly constant and not large enough to transport boulders.

This Office is in broad agreement with the explanation of the lithology of the site, as described in Section 5.9 of the report and briefly summarized above.

b) Based on the information in (a), we confirm that the site is regarded as non-dolomitic.

c) SK's report in general is supported and the recommendations made in the report should be followed.

This letter reflects the Council for Geoscience's view and approach to development on dolomite at this time, as reflected by the above date. These comments may not be viewed as open-ended. If a property changes ownership or land-use changes are made, the comment may in part or wholly no longer apply. This Office should be informed of such changes and the Competent Person responsible for the dolomite stability investigation should be given the opportunity to indicate the influence such changes could have on the overall stability.

If you have any further queries, please do not hesitate to contact this office.

Yours faithfully,

A C OOSTHUIZEN
Engineering Geologist

for Dr S FOYA
Engineering Geoscience Acting Unit Manager

CC: **SOILKRAFT CC**
P O Box 73478
Lynnwood Ridge
0040

Attention: **Mr. I Breytenbach**

By email: *soilkraft02@iburst.co.za*

environmental2@hilland.co.za

From: cathy@hilland.co.za
Sent: Sunday, 24 April 2022 12:10 PM
To: Inge Delport
Subject: FW: D371/MAT11189: DUSTY MOON INVESTMENTS 344 (PTY) LTD/ TWIN CITY TRADING TWO (PTY) LTD
Attachments: 20220322_cgs DATA_HUHUDI STAND 5146 VRYBURG.jpg

Follow Up Flag: Follow up
Flag Status: Flagged

This is the response from the Council for Geosciences confirming that the Dusty Moon site has been tested in terms of dolomite while the competing site has no data on record which confirms that they have not yet complied with the requirements in terms of Dolomite risk.

From: Karabo Mphuthi <kmphuthi@geoscience.org.za>
Sent: Thursday, 24 March 2022 13:39
To: Busisiwe Mthimkhulu <busisiwe@sesi.co.za>
Cc: Johan Senekal <senekal@sesi.co.za>; Solange Seixal <solange@sesi.co.za>; Jessica Saner <Jessica@sesi.co.za>
Subject: RE: D371/MAT11189: DUSTY MOON INVESTMENTS 344 (PTY) LTD/ TWIN CITY TRADING TWO (PTY) LTD

Good day

Please see the attached map.

The site is possibly underlain by dolomite, however the CGS does not have a report covering the site available in our database .

We can't seem to locate stand 11883 Vryburg as it is not on the stand layout we have, but as you can see from the attached map, we do not have much data in the area

Regards

Karabo Mphuthi
Public Information Officer
Tel: +27 (0)12 841 1025 Email: info@geoscience.org.za
data@geoscience.org.za
Website: http://www.geoscience.org.za
280 Pretoria Street, Silverton, Pretoria, 0184

POPIA Act 4 of 2013 as well as our processing notice that can be accessed from our website www.geoscience.org.za

From: Busisiwe Mthimkhulu <busisiwe@sesi.co.za>
Sent: Friday, 18 March 2022 11:42
To: Info <info@geoscience.org.za>
Cc: Jessica Saner <Jessica@sesi.co.za>; Solange Seixal <solange@sesi.co.za>; Johan Senekal <senekal@sesi.co.za>
Subject: D371/MAT11189: DUSTY MOON INVESTMENTS 344 (PTY) LTD/ TWIN CITY TRADING TWO (PTY) LTD

Dear Sir,

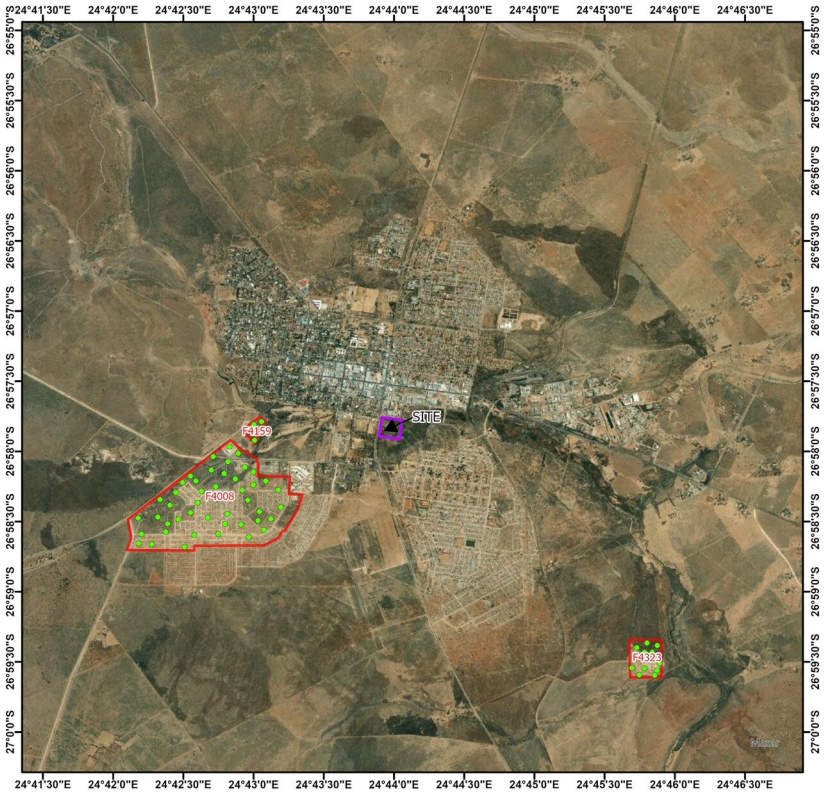
Kindly find attached hereto the following documents for your attention;

1. Cover letter dated 18 March 2022; and
2. Form A – Request for access to record of a public body.

Kindly acknowledge receipt hereof.

We thank you for your assistance in advance.

Yours faithfully



ENGEODE DATA REQUEST

Legend

- Dolomite Borehole Positions
- Dolomite Report Boundaries

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info@geoscience.org.za
Council for Geoscience

HUHUDI STAND 5146

N

0 490 980 1 500 2 000 m

Date Compiled: 2022/03/22	Compiled by: LG Heath
Datum: WGS 1984	Scale (on A4) 1:50 000