



D11: Geotechnical Investigation

**PROPOSED SOLAR PARK: REMAINDER OF
THE FARM TWYFELVLAKTE 105-IQ AND
PORTION 5 OF THE FARM
VARKENSLAAGTE 119-IQ,
CARLETONVILLE, GAUTENG**

GHS1390-1

Geohazard Solutions

Consulting Engineering Geologists

VGI Geotech Services (Pty) Ltd. (trading as)

Registration number 2015/268464/07

**JUWI RENEWABLE ENERGIES (PTY) LTD
20TH FLOOR THE HALYARD
4 CHRISTIAAN BARNARD STREET
CAPE TOWN**

**P.O. Box 604
Fourways
2055
Gauteng**

ATTENTION: MR RAYMOND TAKUBA

**Telephone
Direct : (011) 469 0854**

Your reference

-

Our reference

GHS1390-1

Date

01 February 2023

**PROPOSED SOLAR PARK: REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ AND PORTION 5
OF THE FARM VARKENSLAAGTE 119-IQ, CARLETONVILLE, GAUTENG**

This report presents the results of Feasibility Stage dolomite stability investigation of the above referenced farm portions. The investigation included a review of existing data, a gravity survey, a borehole drilling programme, analysis and reporting.

Sixteen boreholes were drilled during the current investigation, which supplements various boreholes drilled in the past.

The groundwater level is deep (50m to >100m).

According to SANS 1936 Part 1 (2012) the Solar Park proposed is permitted, provided precautionary measures are implemented.

**PROPOSED SOLAR PARK: REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ AND PORTION 5
OF THE FARM VARKENSLAAGTE 119-IQ, CARLETONVILLE, GAUTENG**

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1. INTRODUCTION

This report presents the results of a feasibility stage dolomite stability investigation for a proposed Solar Park near Carletonville (hereafter referred to as 'the site'). This investigation included a review of existing data, a gravity survey, a borehole drilling programme, analysis and reporting.

2. TERMS OF REFERENCE AND SCOPE OF WORK

Geohazard Solutions is appointed by JUWI Renewable Energies (Pty) Ltd to investigate the suitability of two sites for development of a Solar Park from a geotechnical perspective. The terms of reference and scope of the work were set out in Proposal Number GHS1390P of 22 August 2022 and Geohazard was instructed to proceed with the report accordingly on 2 September 2022.

3. AVAILABLE INFORMATION

Information sources include:

3.1. Geological Information

- **Geological Map, 1: 250 000 Scale Series:** published by the Geological Survey of South Africa (Council for Geoscience):
- **The Geology of South Africa:** by MR Johnson, CR Anhaeusser, RJ Thomas, 2006.

3.2. Industry Standards and Publications

- South African National Standard **SANS 1936-1/2/3/4: 2012**, Edition 1 (ISBN 978-0-626-27840-3).
- Environmental Earth Sciences, Springer-Verlag: "**A Performance Based Approach to Dolomite Risk Management**" by D Buttrick, N Trollip, R Watermeyer, N Pieterse, A Gerber, Volume 64, Issue 4, p1127 to p1138, dated 2011.
- **Department of Public Work's Consultants Manual** entitled: "Department of Public Works: Appropriate development of infrastructure on dolomite: Manual for consultants: PW344", dated September 2010.
- Journal of the South African Institution of Civil Engineering: "**Proposed Method for Dolomite Land Hazard and Risk Assessment in South Africa**" by Buttrick, Van Schalkwyk, Kleywegt and Watermeyer, Volume 43, Number 2, dated 2001.
- Annals of the Geological Survey of South Africa: "Subsurface subsidences and sinkholes caused by lowering of the dolomitic water-table on the Far West Rand Gold Field of South Africa" by RJ Kleywegt and DR Pike, Volume 16, p77 to p105, dated 1982.

3.3. Geohydrological Data and Reports

Groundwater information is made available by the Department of Water Affairs through the National Groundwater Information System (NGIS) which offers read-only access to data. In addition, the report "Geohydrology Guideline Development: Implementation of Dolomite Guideline – Phase 1, Activities 19 & 28: Desktop development of a Dolomite Hydrogeological Compartment Map and explanation booklet (Report), dated November 2009, Project Number: 14/14/5/2, Authors: Martin Holland: Water Geosciences Consulting, Frans Wiegman: Golder Associates", was consulted.

4.2. Site Description

Portion 105 of the Farm Twyfelvlakte is 541 hectares in extent and currently vacant.



Figure 3: Portion 105 Site Layout



Figure 2: Portion 5 Site Layout

Portion 5 of Portion 119 of the Farm Varkenslaagte is 274 hectares in extent and also vacant.

5. PROCEDURES USED IN THIS STUDY

The procedure in the investigation and assessment of geotechnical conditions on the site follow:

5.1. Assimilation of Available Data

This investigation is initiated by gathering, assimilating and reviewing existing, available geological, geotechnical and geohydrological data pertaining to the site.

As dolomite hazard assessment is an empirical science that is constantly changing, these succinct background notes are provided to contextualise the procedures used in these investigations, in time and content. The objective is to provide an understanding of the process currently followed in classifying the site and the determination of appropriate risk management requirements, should it be required at some future date.

5.2. Gravity Data

The gravity method is the most widely used remote sensing technique applied on dolomite land. Variations in the earth's structure and composition give rise to variations in density. Indirectly the density variations are determined by measuring the gravity field which allows the determination of location, form and distribution of causative geological factors. A gravity survey of a dolomitic terrain can be used to help determine dolomite bedrock configuration (bedrock topography) and allows various deductions to be made about tectonic processes.

5.2.1 Gravity Survey

This survey was undertaken by GeoFocus Geophysical Services.

Fieldwork was carried out in 2022 when gravity stations were laid out at a 100m metre grid spacing, wherever space permitted.

The grid spacing is theoretically a function of the type of anomaly expected, the depth to the source of the anomaly, and the size of the investigated area. Measurements are taken with a gravimeter at each station of the grid surveyed for the area under investigation.

A Scintrex CG5 Autograv was used for gravity observations and station positions and elevations were recorded with a Javad GNS DGPS (Differential GPS) system.

5.2.2 Bouguer Gravity

The field observations were reduced to relative Bouguer values using an elevation correction factor of 0,1967 milliGals per metre and normal theoretical sea level variation of the earth's gravity field of 0,978 milliGals per kilometre. A relative Bouguer gravity anomaly contour map was produced.

5.2.3 Residual Gravity

Once depth to dolomite bedrock on the Bouguer gravity high anomalies are confirmed by drilling, the relative Bouguer field is adjusted by subtracting a regional field so that the map becomes a better representation of depth to dolomite bedrock.

Removal of the estimated regional field results in the creation of a residual data set, which is presented in this report. The geophysical report is also included in Appendix 1.

5.3. Rotary Percussion Boreholes

Sixteen boreholes were drilled during the current investigation. Specifications follow:

Drilling method:	Rotary Percussion
Drilling Contractor:	Rubicon
Drilling Machine:	Rock Giant 1000
Hammer diameter:	20.32cm
Drill bit size:	216mm
Drill bit type:	button
Compressor:	Doosan
Delivery:	27m ³ /min (950cfm) at 1800kPa

The borehole logs are presented in Appendix 2 and summarised in Table 1. The co-ordinates of the boreholes drilled during this investigation follow:

Borehole Number	Co-ordinates	Notes
009	27 Y-035624 X2917412	
142	27 Y-036026 X2918888	
022	27 Y-035762 X2918004	
225	27 Y-036838 X2919032	
229	27 Y-030000 X2922037	
264	27 Y-037187 X2918306	
338	27 Y-029732 X2921494	
364	27 Y-030134 X2923150	
379B	27 Y-029952 X2922748	chert collapse, terminate early
512	27 Y-035651 X2919310	
524	27 Y-035507 X2918626	
615	27 Y-034964 X2919564	rods damaged by chert
759B	27 Y-037783 X2918655	
822	27 Y-030153 X2921157	
843B	27 Y-030350 X2922137	
861B	27 Y-030622 X2923123	

5.4. Hazard Characterisation Procedure

National standards (SANS 1936, 2012) require use of internationally accepted terminology. The applicable terminology and its definition (with previous term used) are given below:

5.4.1. Terminology

1) Hazard

Source of potential harm. Hazard is the function of magnitude (of the events), area, and frequency.

2) Inherent Susceptibility (Inherent Risk)

A reflection of the geological susceptibility of a karst area to an event (sinkhole or subsidence). Inherent Susceptibility is expressed in terms of three broad categories, namely low, medium and high, typically, but not exclusively, denoting anticipated number of events per area over time.

3) Inherent Hazard Class (Inherent Risk Class)

A site is characterised in terms of **eight standard inherent hazard classes**, denoting the likelihood of an event (sinkhole or subsidence) occurring (susceptibility) as well as its likely size (diameter). The larger the Inherent Hazard Class (IHC) number, the greater the likelihood of the event occurring and the larger its potential size should it occur, for each respective inherent susceptibility category (low, medium, high).

4) Hazard Rating

The number of events per hectare that have occurred over a 20-year period due to human impact.

5) Tolerable Hazard Rating (Acceptable Development Risk)

The hazard rating is expressed as tolerable where the number of events experienced is less than and including 0.1 events per hectare per 20 years (preferably tending to 0 per hectare) that is exceeding the return period of 200 years and intolerable where the number of events experienced exceeds 0.1 events per hectare per 20 years (return period less than 200 years).

6) Return Period

Known as a recurrence interval and is an estimate of the interval of time between events of a certain size.

7) Subsidence (Doline)

Shallow, enclosed depression. In past South African literature subsidence, as defined above, is synonymous with doline. The term subsidence is substituted to prevent contradiction with international literature.

8) Sinkhole

A feature that occurs suddenly and manifests itself as a hole in the ground. In international literature the term sinkhole is often synonymous with doline.

9) Dolomite Land

Land underlain by dolomite or limestone rock directly or at a shallow depth, typically no more than:

- a) 60m in areas where no de-watering has taken place and the local authority has jurisdiction and is monitoring and has control over the groundwater levels over the areas under consideration; or
- b) 100m in areas where de-watering has taken place or where the local authority has no jurisdiction or control over groundwater levels.

10) Event

Occurrence [or change of a particular set of circumstances], in the context of this standard referring to a sinkhole or subsidence. An event can be one or more occurrences, and can have several causes. An event can consist of something not happening. An event can sometimes be referred to as an "incident" or "accident".

11) Potential Loss of Support

Refers to the removal of support below the foundation due to a nominal sinkhole or subsidence event. In proposing suitable foundation types in D3 areas, consideration should be given to the **potential loss of support** which could be anticipated for the designated Inherent Hazard Class based on the nascent¹ sinkhole size.

The philosophy to be applied to the design of the foundations is that in the event of catastrophic loss of support, there is sufficient time for occupants to safely escape

¹ Adj. beginning to develop

after the occurrence of the sinkhole, and the level of expected damage associated with soil movements unrelated to sinkhole formation in near surface horizons is kept within reasonable limits.

5.4.2. Assessment Procedure

The hazard characterisation procedure (previously referred to as “risk” characterisation procedure in South African literature) is in accordance with the peer reviewed paper “A performance based approach to dolomite risk management”:

The available information, geophysical data, borehole data and geohydrological information gathered during the investigation has been pooled and reviewed permitting the formulation of a perspective concerning the characterisation of the stability of the site.

The predominant mobilising agencies considered in this investigation are major groundwater level fluctuations (>6m), ingress of water, ground vibrations and gravity. Use is made of a generalised list of evaluation factors to evaluate the hazard.

These factors are as follows:

- Receptacle development;
- Mobilising agencies, particularly ingress of water from leaking services;
- Potential sinkhole development space;
- Nature of the blanketing layer;
- Mobilisation potential of the blanketing layer;
- Bedrock morphology.

Receptacles or disseminated receptacles refer to any voids or cavities in the dolomite bedrock or in the overburden capable of receiving mobilised materials. *Receptacles are assumed to be present as no reliable geophysical tool exists to determine the location of these features. Consequently, the information gathered from boreholes, including penetration times, air loss, hammer action, etc, combined with geophysical and geological information are used to formulate an impression of the degree of voids.*

The potential sinkhole development space, where used, refers to the expected maximum size sinkhole that conservatively may be anticipated to be generated if sustained ingress of water were to occur. This factor is related to the depth of the receptacles or disseminated receptacles. The gravity survey, combined with borehole information strongly guides the appraisal of this factor.

The nature of the material covering the receptacles, be they above or in the bedrock, determines the susceptibility of the subsurface material to erosion by ingress of water. The presence of materials such as shales or intrusives, which can act as aquitards, serve to reduce the mobilisation potential and enhance the stability.

In the case of dramatic groundwater level fluctuations, the susceptibility of the soil material to mobilisation (i.e. consolidation settlement - subsidence formation, or ravelling and arch failure - sinkhole formation, due to pore pressure changes in soils), is strongly influenced by the position of the original groundwater level in the subsurface profile. In assessing the susceptibility of a subsurface profile to sinkholes and subsidences due to groundwater level drawdown, attention is given to the nature and extent of the material below the groundwater level.

For example, in the case of compressible dolomite residuum, as the groundwater recedes, pore pressures in the residual dolomite soils, typically characterized by high void ratios, gradually dissipate and the effective stress on the soil increases causing consolidation of the compressible material.

A surface depression may occur gradually due to the load of the near-surface materials on the deeper lower density materials that settle into a denser state.

The general maximum magnitude of natural groundwater fluctuation in the Gauteng dolomites is in the order of 5m (Hobbs, 2004; Holland, 2007). Hence artificial groundwater level drawdown is generally defined as drawdown exceeding 6m.

Experience shows that groundwater level drawdown (beyond seasonal variations) has the greatest negative impact on dolomite stability in areas of shallow groundwater levels (30 m or shallower) i.e., deeper (> 30 m) groundwater levels, pose less of a negative impact on stability, in the event of groundwater level drawdown or dewatering. However, where groundwater drawdown occurs in areas of deeper groundwater, the size of instability is typically anticipated to be large to very large.

In view of the factors discussed above the following characteristics have been extracted from the gathered information during the assessment process:

- borehole position relative to the gravity data.
- collar elevation.
- depth to dolomite bedrock.
- depth to potential receptacles.
- depth to the present and original groundwater level.
- nature and thickness of blanketing layer i.e., material type, penetration times, etc.
- position of the bedrock with respect to the present and original groundwater level.
- thickness and nature of the soil materials above and below the present and original groundwater level.

Inherent susceptibility is a reflection of the geological susceptibility of a karst area to an event (sinkhole or subsidence formation) and is expressed in three broad categories, namely low, medium and high. The following reference to incidences, gives a perspective of the magnitude of problems encountered in each of the of hazard zones in research areas.

It is important to note that these figures are largely derived from developments not effectively and appropriately designed or maintained.

Inherent Susceptibility	Anticipated events per hectare over time (magnitude of problem)*
LOW	0 up to and including 0.1 events per hectare anticipated but occurrence of events cannot be excluded. Return Period is greater than 200 years.
MEDIUM	Greater than 0.1 and less than and equal to 1.0 events per hectare. Return period is between 200 and 20 years.
HIGH	Greater than 1.0 events anticipated per hectare. Return period is less than 20 years.
* that have occurred per hectare in a 20 year period in the "type" areas (statistics based on poor service design and maintenance)	

The study area is characterised in terms of eight standard Inherent Hazard Classes. These classes denote the chance of a sinkhole or subsidence occurring as well as its likely size (diameter).

The terminology used in terms of likely size of an event (sinkhole or subsidence) is defined as follows:

Maximum diameter of surface manifestation (in metres)	Terminology
< 2	Small-size
2-5	Medium-size
5-15	Large-size
> 15	Very large-size

The larger the Inherent Hazard Class number, the greater the chance of a sinkhole or subsidence occurring and the larger its potential size should it occur for each of the inherent susceptibility categories. The meaning/definition of each Inherent Hazard Class is as follows:

Inherent Hazard Class	Characterisation of Area
Class 1 Areas	Areas characterised as reflecting a low inherent susceptibility of all sizes of events occurring.
Class 2 Areas	Areas characterised as reflecting a medium inherent susceptibility of small-size events occurring.
Class 3 Areas	Areas characterised as reflecting a medium inherent susceptibility of medium-size events occurring.
Class 4 Areas	Areas characterised as reflecting a medium inherent susceptibility of large-size events occurring.
Class 5 Areas	Areas characterised as reflecting a high inherent susceptibility of small-size events occurring.
Class 6 Areas	Areas characterised as reflecting a high inherent susceptibility of medium-size events occurring.
Class 7 Areas	Areas characterised as reflecting a high inherent susceptibility of large-size events occurring.
Class 8 Areas	Areas characterised as reflecting a high inherent susceptibility of very large-size events occurring.

In this report Inherent Susceptibility is defined in terms of ingress of water and groundwater level drawdown reflected by two Inherent Hazard Class designations separated by a double forward slash, i.e.-Inherent Hazard Class (ingress of water) // Inherent Hazard Class (groundwater level drawdown)

5.4.3. Dolomite Area Designation

Dolomite Area Designations must be identified on sites located on or near dolomite land (land where dolomite is located at or near [less than 100m] ground surface). The definitions of the Dolomite Area Designations as defined in SANS 1936 Part 1 (2012) are as follows:

D Designation	Description
D1	No precautionary measures are required.
D2	General precautionary measures, in accordance with the requirements of SANS 1936-3, that are intended to prevent the concentrated ingress of water into the ground, are required.
D3	Precautionary measures in addition to those pertaining to the prevention of concentrated ingress of water into the ground, in accordance with the relevant requirements of SANS 1936-3, are required.

D Designation	Description
D4	Development may only be considered provided the following requirements are met: • Involvement of Competence Level 4 geo-practitioner in all the categories of the geotechnical engineering work, i.e. site characterization, analysis and design, supervision and review, supervision of execution and management (primary geo-practitioner). • Review and acceptance of all the categories of the geotechnical engineering work by a Competence Level 4 peer. This peer reviewer may not be a business associate of the primary geo-practitioner(s) and may not have a vested interest in the project. • All the categories of the geotechnical engineering work to be reviewed and accepted by the Authority who may request a further review by an Authority designated Competence Level 4 peer, if required. • The responsible Local Authority must indicate its commitment to maintain dolomite risk management principles in accordance with SANS 1936-4.

5.4.4. Permissible Land Use

Permissible Land Use in terms of SANS 1936-1 (2012)

According to SANS 1936 Part 1, Table 2 (2012), the development types suitable for the eight standard Inherent Hazard Classes are summarised as follows:

Inherent Hazard Class	Land Usage Type	Land Usage Permitted with Dolomite Area Designation and footprint investigation requirement in terms of Deemed-To-Satisfy
1	Commercial and miscellaneous non-residential usage	C1 (D3 + FPI), C2 (D3 + FPI), C3 (D2 + FPI), C4 (D2 + FPI), C5 (D2 + DLI), C6 (D2 + DLI), C7 (D2), C8 (D2)
	High rise dwelling units	RH1 (D4), RH2 (D2 + FPI), RH3 (D2 + FPI)
	Low rise dwelling units	RL1 (D2 + FPI), RL2 (D2 + FPI)
	Dwelling houses	RN1 (D2), RN2 (D2), RN3 (D2)
2	Commercial and miscellaneous non-residential usage	C1 (D3 + FPI), C2 (D3 + FPI), C3 (D3 + FPI), C4(D3 + FPI), C5 (D3 + DLI), C6 (D3 + DLI), C7 (D3+ FPI), C8 (D3)
	High rise dwelling units	RH1-RH2 (D4), RH3 (D3 + FPI)
	Low rise dwelling units	RL1 (D2 + FPI), RL2 (D2 + FPI)
	Dwelling houses	RN1 (D3), RN2 (D3), RN3 (D3)
3	Commercial and miscellaneous non-residential usage	C1 (D3 + FPI), C2 (D3 + FPI), C3 (D3 + FPI), C4 (D4), C5 (D3 + DLI), C6 (D3 + DLI), C7 (D3 + FPI), C8 (D3)
	High rise dwelling units	RH1-RH2 (D4), RH3 (D3 + FPI)
	Low rise dwelling units	RL1 (D4), RL2 (D3 + FPI)
	Dwelling houses	RN1 (D4), RN2 (D3), RN3 (D3)
4	Commercial and miscellaneous non-residential usage	C1 (D3 + FPI), C2 (D3 + FPI), C3 (D3 + FPI),), C4 (D4), C5 (D3 + DLI), C6 (D3 + DLI), C7 (D3 + FPI), C8 (D3)
	High rise dwelling units	RH1-RH2 (D4), RH3 (D3 + FPI)
	Low rise dwelling units	RL1 (D4), RL2 (D3 + FPI)
	Dwelling houses	RN1 (D4), RN2 (D3), RN3 (D3)
5	Commercial and miscellaneous non-residential usage	C1 (D3 + FPI), C2 (D3 + FPI), C3 (D3 + FPI),), C4 (D4), C5 (D3 + DLI), C6 (D3 + DLI), C7 (D3 + FPI), C8 (D3)
	High rise dwelling units	RH1-RH2 (D4), RH3 (D3 + FPI)
	Low rise dwelling units	RL1-2 (D4), RL2 (D3 + FPI)
	Dwelling houses	RN1-RN2 (D4), RN3 (D3 + FPI)
6	Commercial and miscellaneous non-residential usage	C1 (D4), C2 (D3 + FPI), C3 (D3 + FPI),C4-C5 (D4), C6 (D3 + DLI) , C7 (D3 + FPI), C8 (D3)

Inherent Hazard Class	Land Usage Type	Land Usage Permitted with Dolomite Area Designation and footprint investigation requirement in terms of Deemed-To-Satisfy
	High rise dwelling units	RH1-RH3 (D4)
	Low rise dwelling units	RL1-RL2 (D4)
	Dwelling houses	RN1-RN3 (D4)
7	Commercial and miscellaneous non-residential usage	C1-C5 (D4), C6 (D3 + DLI), C7 (D4), C8 (D3)
	High rise dwelling units	RH1-RH3 (D4)
	Low rise dwelling units	RL1-RL2 (D4)
	Dwelling houses	RN1-RN3 (D4)
8	Commercial and miscellaneous non-residential usage	C1-C8 (D4)
	High rise dwelling units	RH1-RH3 (D4)
	Low rise dwelling units	RL1-RL2 (D4)
	Dwelling houses	RN1-RN3 (D4)

Land Use Class Definitions	
Commercial and miscellaneous non-residential usage	
C1	Places of detention, police stations, and institutional homes for the handicapped or aged
C2	Hospitals, hostels, hotels
C3	Commercial developments ≤ 3 storeys, including railway stations, shops, wholesale stores, offices, places of worship, theatrical, indoor sports or public assembly venues, other institutional land uses, such as universities, schools, colleges, libraries, exhibition halls and museums, light (dry) industrial developments, dry manufacturing, commercial uses such as warehousing, packaging, electrical sub-stations, filling stations
C4	Commercial developments > 3 storeys, including railway stations, shops, wholesale stores, offices, places of worship, theatrical, indoor sports or public assembly venues, other institutional land uses, such as universities, schools, colleges, libraries, exhibition halls and museums, light (dry) industrial developments, dry manufacturing, commercial uses such as warehousing, packaging, electrical sub-stations
C5	Fuel depots, processing plants or any other areas for the storage of liquids, waste sites
C6	Outdoor storage facilities, stock yards, container depots
C7	Parking garages
C8	Parking areas
High rise dwelling units	
RH1	> 10 storeys
RH2	> 3 storeys, no higher than 10 storeys with a population of $\leq 1\,500$ people per hectare
RH3	> 3 storeys with a residential coverage ratio of ≤ 0.4 , no higher than 10 storeys, and a population of ≤ 800 people per hectare
Low rise dwelling units	
RL1	≤ 3 storeys with 80 to 120 units per hectare and a population not exceeding 600 people per hectare
RL2	≤ 3 storeys with up to 80 units per hectare and a population not exceeding 400 people per hectare
Dwelling houses	
RN1	Up to 60 dwelling houses per hectare with stands larger than 150 m^2 , and a population of ≤ 300 people per hectare
RN2	Up to 25 dwelling houses per hectare with stands no smaller than 300 m^2 , and a population of ≤ 200 people per hectare
RN3	Up to 10 dwelling houses per hectare with $1\,000$ to $4\,000\text{ m}^2$ stands, and a population of ≤ 60 people per hectare

According to SANS 1936 (2012) Part 1, Table 3, the infrastructure and social services suitable for the eight standard Inherent Hazard Classes are summarised as follows:

Infrastructure and social facilities		Inherent hazard class determined in accordance with the requirements of SANS 1936-2							
Designation	Description	1	2	3	4	5	6	7	8
		Dolomite area designation							
IN1	Trunk roads (national and regional roads which facilitate intercity travel) and primary distributor roads (major arterial roads forming the primary network for an urban area as a whole), railway lines, power lines, runways, bulk pipelines, including water, sewer, fuel and gas lines, pump stations	D2	D3					D4	
IN2	Reservoirs and public swimming pools, water care works, attenuation and retention ponds for stormwater management and artificial lakes	D2	D3				D4		
IN3	Cemeteries	D3				D4			
IN4	Dams, slimes dams	D3	D4						
IN5	Solid waste disposal facilities	D3						D4	

6. GEOLOGY

6.1. Regional Geological Setting

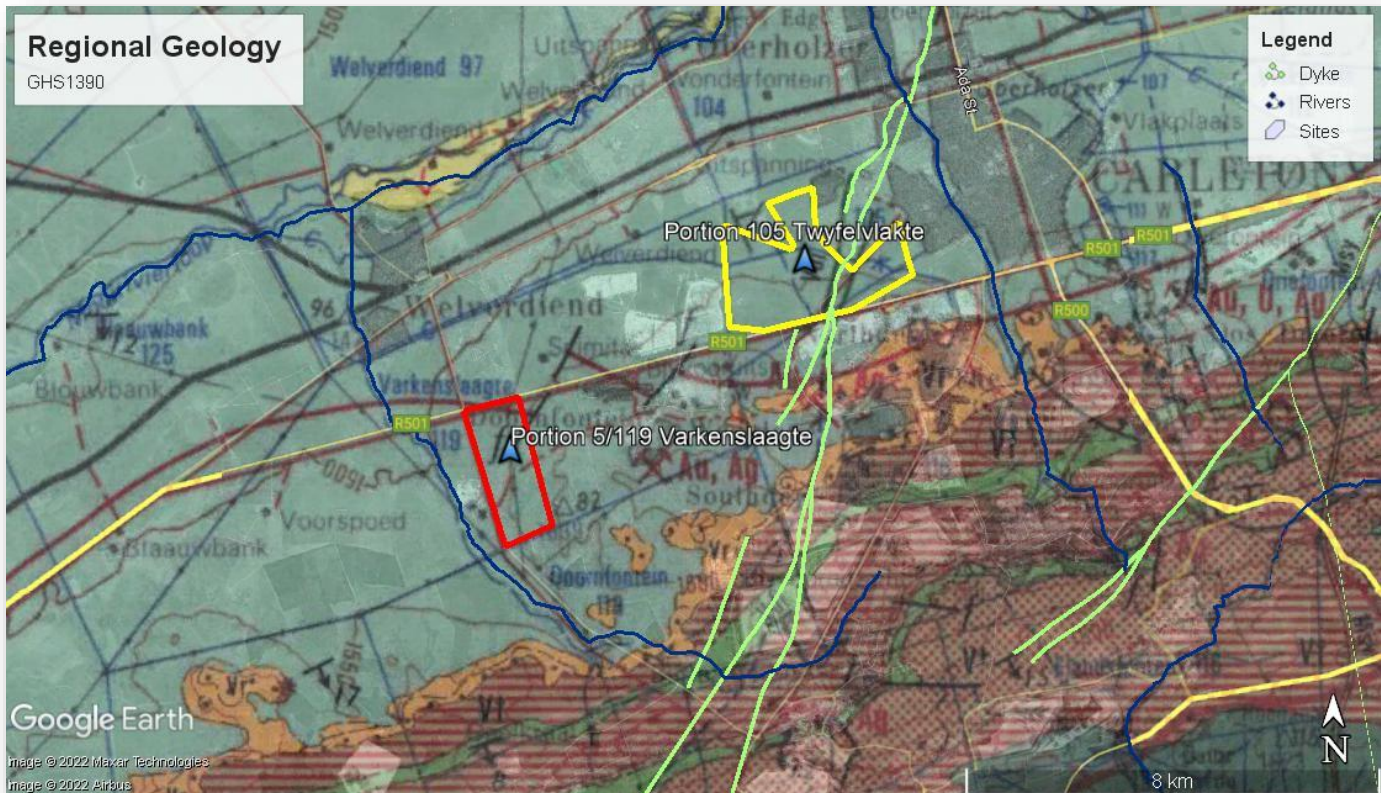


Figure 4: 1:250 000 Geological Map (Sheet 2626)

The sites are located on the southern limb of the Hartebeestfontein Anticline.

Overlying the southern limb and forming the lower part of an elongated east-west orientated basin that is drained by the Wonderfontein Spruit, is the southward dipping Black Reef Formation, which does not outcrop on the site. Overlying the Black Reef Formation is the Malmani Subgroup dolomite and chert of the Chuniespoort Group, Transvaal Supergroup.

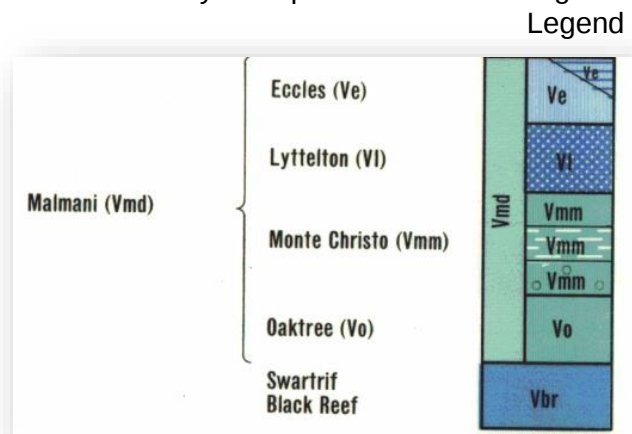
Several syenite and diabase dykes trend slightly east of north and form impervious barriers in the dolomite aquifer, compartmentalising the dolomite in Wonderfontein Valley. During pre-Karoo times the dolomite weathered to great depth along fault planes and fracture zones, resulting in deep subsurface bedrock valleys. These palaeo-valleys, in addition to various depressions in the Malmani Subgroup south of the Wonderfontein Spruit were infilled with Karoo strata. Various cycles of erosion in post-Karoo times cut uniformly across both the dolomite and Karoo strata with only remnant Karoo strata remaining as isolated outliers that progressively settled into sockets produced by the continuous weathering of dolomite.

The lithological units (and their weathered derivatives), anticipated according to regional geological mapping information are as follows:

Lithostratigraphic Unit	Lithology
Chuniespoort Group, Transvaal Supergroup	Dolomite, chert and associated soil derivatives.

Typically mantling these rocks are horizons of naturally transported soils including alluvial material deposited by the Wonderfontein Spruit. Occasionally thick sequences of transported soils, particularly aeolian sand, silt and clay occur, suggesting the presence of more recent palaeo-features such as palaeo-sinkholes.

Unconsolidated materials deemed to be various recent deposits (most likely 24 Ma [Miocene Epoch] and younger) are anticipated to mantle the hard rock geology (and residual product thereof). The material varies in thickness, sedimentological- and geotechnical properties:



Post-Gondwana Deposits	
Fill material	Variable composition
Pedocretes (cemented soils)	e.g., calcrete (cemented or replaced by carbonates), ferricrete (cemented or replaced by iron oxides), silcrete (cemented or replaced by silica), manganocretes (cemented or replaced by manganese oxides) OR Calcified- (less than 50% cement or replacement material), ferruginised-, silicified -OR manganised soil
Colluvium: Talus (Course Colluvium) or Hillwash	Soils of clayey and silty composition or gravels
Sandy Soils of Mixed Origin	Silty and clayey sands, sandy silts, sandy clays (Red brown, orange brown, or yellow in colour)

6.2. Localised Sub-surface Conditions (Varkenslaagte)

Seven boreholes were drilled on the site to determine broad feasibility of the site. The boreholes indicate deeper dolomite bedrock conditions on the western edge (>60m), while in the central and eastern portion and dolomite bedrock depth varies from 3m to 30m depth. One borehole intercepted a thick horizon of coarse dominant chert which resulted in collapse onto the drill rod, leading to the borehole being terminated prematurely to intercepting dolomite bedrock.

No low density or cavernous conditions were intercepted.

No groundwater strikes were recorded and the boreholes were dry upon the backfilling programme.

Summaries of horizons intercepted during the drilling programme are provided as follows:

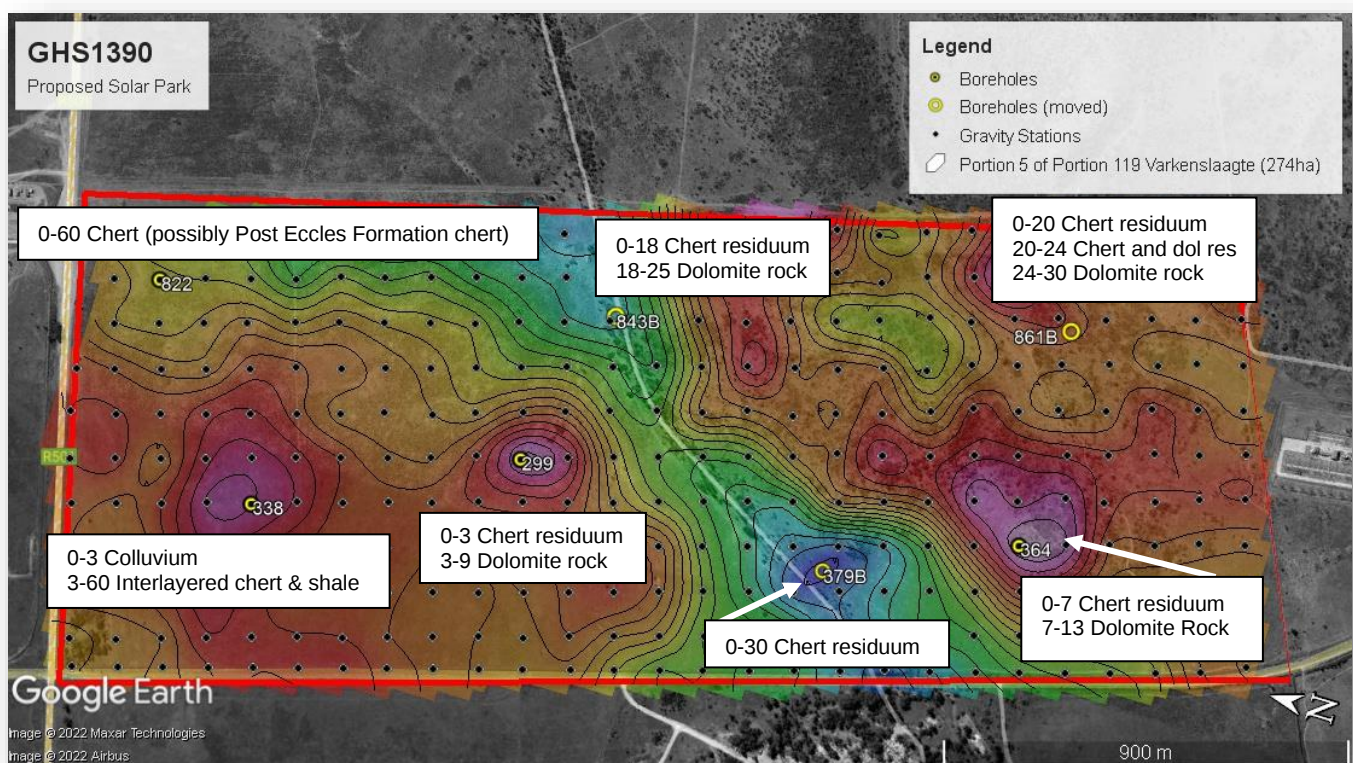


Figure 5: Summaries of Subsurface Conditions: Varkenslaagte Site

6.3. Localised Sub-surface Conditions (Twyfelveklakte)

Thirty-three boreholes were drilled on the site (with fifteen of these at the reservoir site) and nine during the current study. The boreholes indicate:

- Shallow dolomite conditions at the reservoir.
- Deeper dolomite bedrock conditions over most of the site, with depth ranges of 29m to > 60m.
- On the southwestern most portion dolomite bedrock is intercepted at intermediate depth of 14-15m depth.
- Dolomite rock is mantled by chert and dolomite residuum and colluvial material of variable thickness.
- Extensive areas indicate Karoo age deposits, varying from 14m to 58m or more.
- Low density conditions were intercepted in Borehole 1086 from 12m to 18 m depth. In all other boreholes no cavities or cavernous conditions were recorded.
- No groundwater strikes were recorded and the boreholes were dry upon backfill.

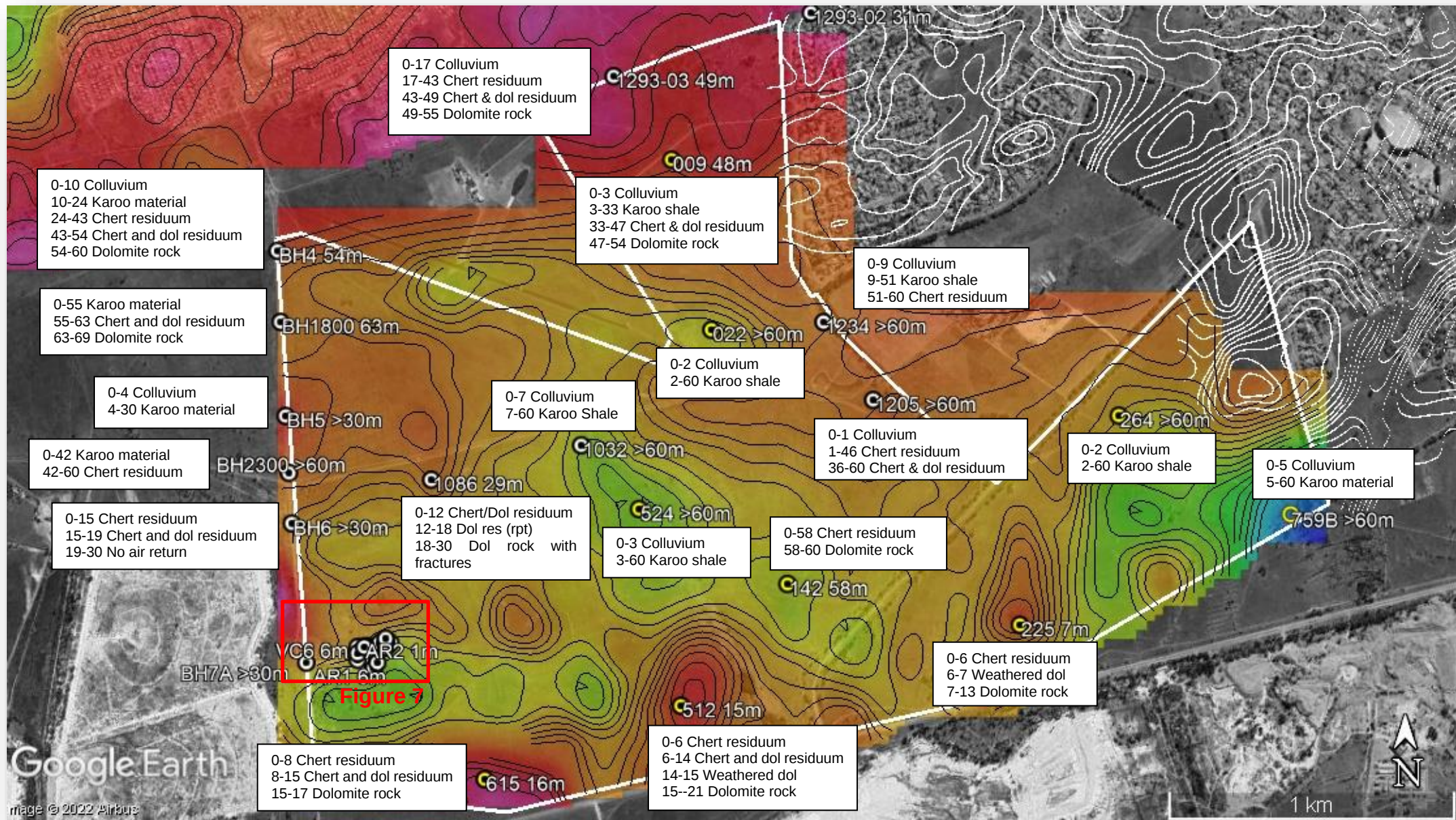


Figure 6: Summaries of Sub-surface Conditions: Twyfelvlaakte Site

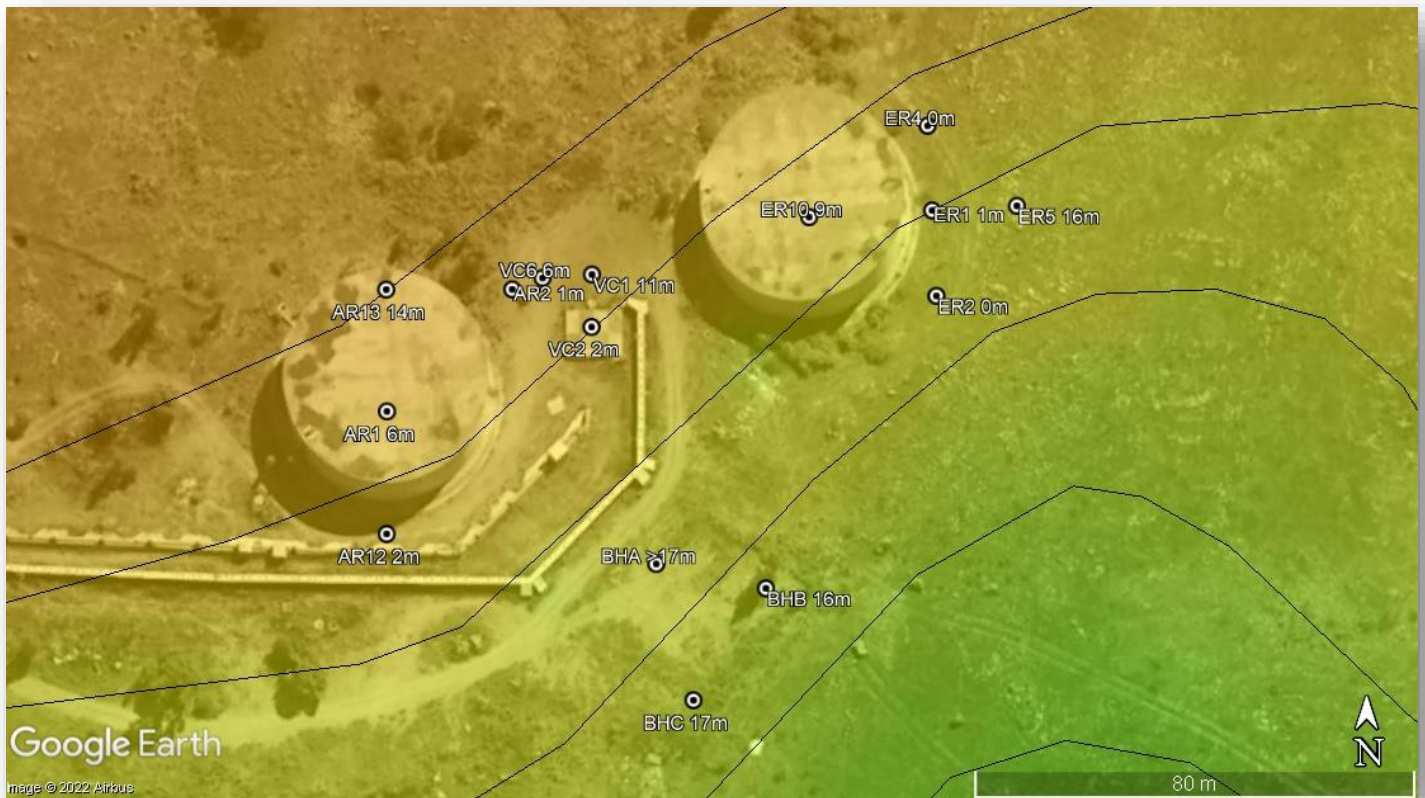


Figure 7: Depth to Dolomite Rock and Gravity Survey Contours at Reservoir Site

7. GEOHYDROLOGY

7.1. Regional and Site-specific Geohydrology

7.1.1. Quaternary Catchment Area

According to the country wide Quaternary Catchment data the site is located in Catchment **C23E**.

7.1.2. Groundwater Management Area (WMA)

According to the country wide Water Management Areas data the site is located in **WMA 8: Upper Vaal**.

7.1.3. Dolomite Groundwater Management Area

According to the Water Geosciences Consulting Dolomite Hydrogeological Compartment Map² (2009) the site is located in the **Turffontein Dolomite GMA**.

7.1.4. Groundwater Compartmentalisation and Original groundwater Level

The Varkenslaagte site is located in the Boskop-Turffontein Dolomite Groundwater Compartment. The groundwater level, as recorded in the SCTC archives, is as follows:

² The map represents the subdivision of the dolomitic surface outcrop of the Ghaap Plateau and the Gauteng/North West dolomites. The major delineation is represented by the dolomitic Groundwater Management Areas (GMA). The names of these GMA's typically correspond closely to the common known dolomitic compartments as established in the late 1980's by the DWA. However, the delineation does not necessarily represent a dolomite compartment or unit.

Dolomite Groundwater Compartment	Original Water Level in m AMSL	Current Groundwater Level
Boskop-Turffontein	1424-1425	At OWL

According to the Water Geosciences Consulting Dolomite Hydrogeological Compartment Map there are no known compartmentalising dykes near the site. However, it is known that the eastern boundary of the Compartment is the Oberholzer Dyke.

The Twyfelvlakte site traverses the Boskop-Turffontein, the Oberholzer-Sub and the Oberholzer Dolomite Groundwater Compartments.

In the Oberholzer Dolomite Groundwater Compartment, the groundwater level, as recorded in the SCTC archives, is as follows:

Dolomite Groundwater Compartment	Original Water Level (m AMSL)	Current Groundwater Level (2005) (m AMSL)
Oberholzer	1469	1420-1460 (Oberholzer) 1220 (southern Carletonville)

The original, pre-mining groundwater level had a flat gradient. This is a consequence of the highly transmissive nature of the karstified dolomite. Groundwater flow is in a westerly direction, interrupted to varying degrees at the major compartment forming dykes, e.g. Bank, Oberholzer Dykes. Before dewatering commenced the aquifer overflowed at the lowest topographic point along these dykes in a series of springs or 'eyes', such as the Venterspost and Oberholzer Eyes.

During the 1960's and 70's interest focussed on mining related issues of control and disposal of inflow water. A policy of dewatering was implemented for the Venterspost and Oberholzer Compartments (1964), Bank Compartment (1969) and Gembokfontein West Compartment (late 1980's). Dewatering is defined as pumping exceeding natural recharge and a compartment is considered to be dewatered when pumping/inflow has reduced to a steady-state equilibrium with recharge. For example, dewatering of the Oberholzer Compartment began in September 1955 and was accomplished in April 1973 (Hodgson et al, 2001).

During this period, pumping rates reached 170 Mℓ/day, while the steady state pumping after dewatering is 50 Mℓ/day. The dewatering programme led to the formation of large zones of depression in the groundwater level above the main mine inflow areas. Drawdown is greatest at the pumping station (mine shaft) becoming less pronounced towards the Wonderfontein Spruit.

The pumped water is discharged via pipeline(s) back into the Wonderfontein Spruit downstream of the Oberholzer Dyke. SCTC boreholes drilled in the late 1960's within the town were typically dry.

The Oberholzer Sub-Compartment is also dewatered:

Dolomite Groundwater Compartment	Original Water Level in m AMSL	Current Groundwater Level
Oberholzer Sub	1455	100-200 m below OWL

7.2. Groundwater Depths (Site Specific and Current)

No groundwater was intercepted all the boreholes were recorded as dry subsequent to drilling.

Borehole 524 recorded groundwater at 21m depth (no strike) indicating a possible perched groundwater level in Karoo material.

Borehole No	Depth	Groundwater Rest Level
009	54	NIL
524	60	21m
022	60	NIL
142	60	NIL
512	21	NIL
615	17	NIL
338	60	NIL
822	60	NIL
759B	60	NIL
225	13	NIL
264	60	NIL
843	25	NIL
299	9	NIL
861B	30	NIL
364	13	NIL
379B	31	NIL



Figure 8: Dolomite Groundwater Compartments

8. DOLOMITE STABILITY CHARACTERISATION

8.1. Twyfelvlakte Site

The site has been assessed in accordance with the **"Proposed Method for Dolomite Land Hazard and Risk Assessment in South Africa"** by Buttrick, Van Schalkwyk, Kleywegt and Watermeyer, Volume 43, Number 2, dated 2001. The hazard assessment procedure is presented in Sections 5 of this report. Summarised information concerning the hazard characterisation of the site is provided in Table 1. The dolomite hazard zonation is presented in Drawing 1.

The site is characterised in terms of three broad Inherent Hazard Class areas, described as follows:

Inherent Hazard Class	Description
1(4)//1	Area largely reflecting a low susceptibility of <u>all-size</u> (with sub-areas reflecting a medium susceptibility of up to large-size-) sinkhole and subsidence formation with respect to ingress of water and a low susceptibility of <u>all-size</u> sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.
4//1	Area largely reflecting a medium susceptibility of <u>large-size</u> sinkhole and subsidence formation with respect to ingress of water and a low susceptibility of <u>all-size</u> sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.
3/5(7)//1	Area largely reflecting a medium to high susceptibility of <u>small to medium-size</u> (with sub-areas reflecting a high susceptibility of up to large-size-) sinkhole and subsidence formation with respect to ingress of water and a low susceptibility of <u>all-size</u> sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.

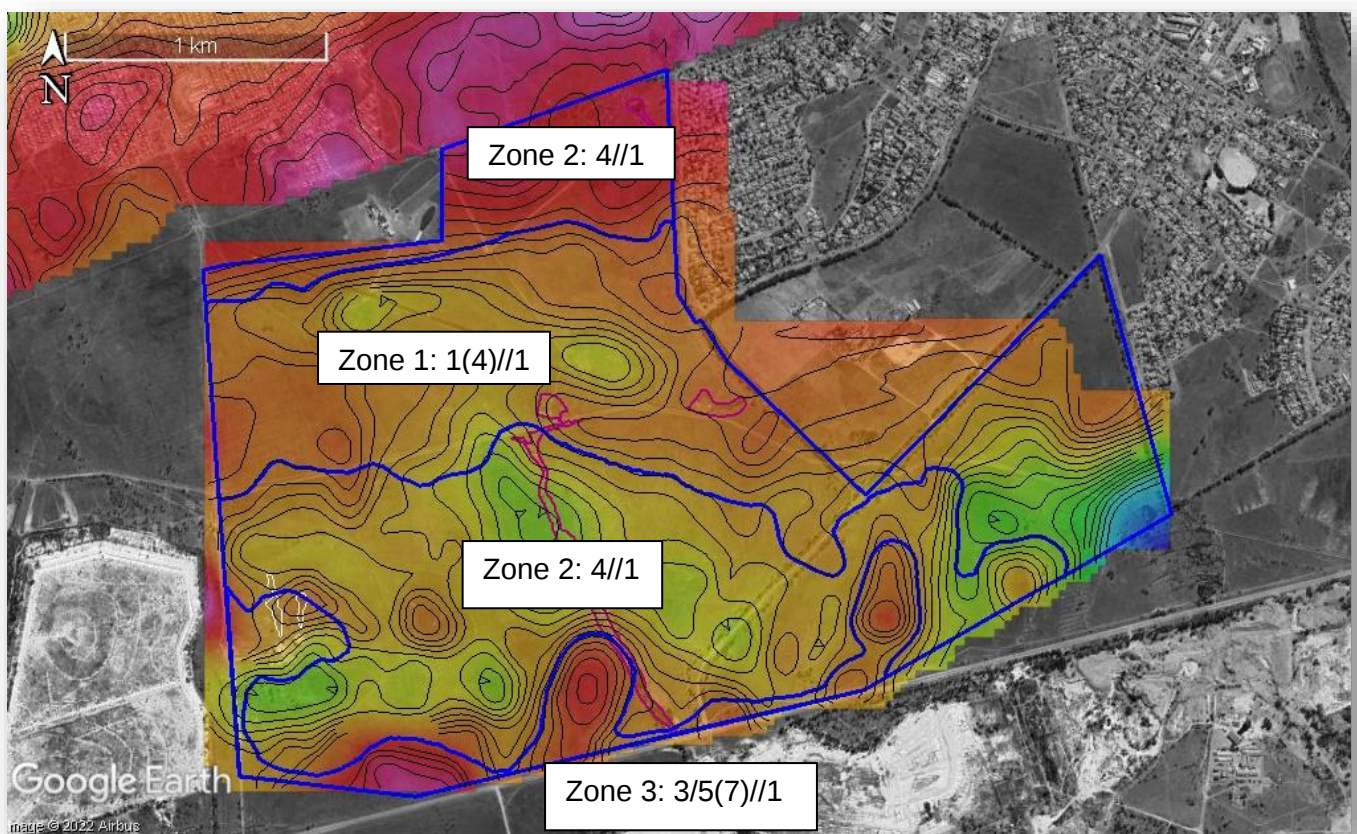


Figure 9: Dolomite Hazard Zonation (Twyfelvlakte)

8.1.1. Dolomite Hazard Zone 1 (Inherent Hazard Class 1(4)//1)

a) Hazard Characterisation

i. Blanketing Layer

The blanketing layer is of **great to very great thickness**.

The blanketing layer mainly consists of transported material, and fines dominant Karoo age shale to great depth. The blanketing layer is anticipated to be characterised by **poor internal drainage characteristics**. Prolonged ingress of water is unlikely to lead to erosion and sinkhole or subsidence formation.

ii. Potential Development Space

In general, the depth to dolomite bedrock, as well as the groundwater level (which acts as a base level for erosion) and the potential receptacles determine the Potential Development Space (PDS). The PDS is characterised as, typically, **large**.

iii. Hazard Classification (with Ingress of Water as a Triggering Mechanism)

Boreholes intercept thick (60m or more) Karoo age deposits. Weathered dolomite occurs at depths in excess of 60m. As the zone boundaries are broad and provisional, it is possible that sub-areas may exist where the Karoo cover pinches out. No sample or air loss indicative of cavernous conditions were intercepted.

iv. Hazard Classification (with Groundwater Drawdown as a Triggering Mechanism)

This zone straddles all three groundwater compartments. The groundwater level is anticipated at very great depth (50-100m). Artificial drawdown is likely to occur within hard rock.

Experience shows that groundwater level drawdown (beyond seasonal variations) has the greatest negative impact on dolomite stability in areas of shallow groundwater levels (30 m or shallower) i.e., deeper (> 30 m) groundwater levels, pose less of a negative impact on stability, in the event of artificial groundwater level drawdown. In assessing the susceptibility of a subsurface profile to sinkhole and subsidence formation due to groundwater level drawdown, attention is given to the nature and extent of the material below the groundwater level. For example, in the case of compressible dolomite residuum, as the groundwater recedes, pore pressures in the residual dolomite soils, typically characterized by high void ratios, gradually dissipate and the effective stress on the soil increases causing consolidation of the compressible material. A surface depression may occur gradually due to the load of the near-surface materials on the deeper lower density materials that settle into a denser state.

v. Impact of Lowering of the Groundwater Level/Base Level of Erosion on the Action of Ingress

In the event that the groundwater level is drawn down significantly (6 m or more), the hazard classification remains unchanged.

vi. Composite Hazard Classification

The composite hazard classification is **Inherent Hazard Class 1(4)/1**, defined as an area largely reflecting a **low** susceptibility of all-size (with sub-areas reflecting a medium susceptibility of up to large-size-) sinkhole and subsidence formation with respect to ingress of water and a **low** susceptibility of all-size sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown. In the event that the groundwater level is drawn down significantly (6 m or more), the hazard classification remains unchanged as it relates to the base level of erosion.

8.1.2. Dolomite Hazard Zone 2 (Inherent Hazard Class 4/1)

a) Hazard Characterisation

i. Blanketing Layer

The blanketing layer is of **great to very great thickness**.

The blanketing layer mainly consists of chert residuum to great depth. The blanketing layer is anticipated to be characterised by **good internal drainage characteristics**. Prolonged ingress of water is may lead to erosion and sinkhole or subsidence formation.

ii. Potential Development Space

In general, the depth to dolomite bedrock, as well as the groundwater level (which acts as a base level for erosion) and the potential receptacles determine the Potential Development Space (PDS). The PDS is characterised as, typically, **large**.

iii. Hazard Classification (with Ingress of Water as a Triggering Mechanism)

Boreholes intercept thick horizons of chert residuum. Weathered dolomite occurs at depths ranging from 29m to 58m depth. No sample or air loss indicative of cavernous conditions were intercepted.

iv. Hazard Classification (with Groundwater Drawdown as a Triggering Mechanism)

This zone straddles all three groundwater compartments. The groundwater level is anticipated at very great depth (50-100m). Artificial drawdown is likely to occur within hard rock.

v. Impact of Lowering of the Groundwater Level/Base Level of Erosion on the Action of Ingress

In the event that the groundwater level is drawn down significantly (6 m or more), the hazard classification remains unchanged.

vi. Composite Hazard Classification

The composite hazard classification is **Inherent Hazard Class 4//1**, defined as an area largely reflecting a **medium** susceptibility of large-size sinkhole and subsidence formation with respect to ingress of water and a **low** susceptibility of all-size sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.

In the event that the groundwater level is drawn down significantly (6 m or more), the hazard classification remains unchanged as it relates to the base level of erosion.

8.1.3. Dolomite Hazard Zone 3 (Inherent Hazard Class 3/5(7)//1)

a) Hazard Characterisation

i. Blanketing Layer

The blanketing layer is typically **thin**.

The blanketing layer consists of chert and dolomite residuum. The blanketing layer is anticipated to be characterised by **good to very good internal drainage characteristics**. Prolonged ingress of water is may readily lead to erosion and sinkhole or subsidence formation.

ii. Potential Development Space

In general, the depth to dolomite bedrock, as well as the groundwater level (which

acts as a base level for erosion) and the potential receptacles determine the Potential Development Space (PDS). The PDS is characterised as, typically, small to **medium**.

iii. Hazard Classification (with Ingress of Water as a Triggering Mechanism)

Boreholes intercept shallow dolomite bedrock. The following is typically known of shallow dolomite areas (based on experience):

- Existence of a highly variable dolomite bedrock topography with deep weathering along linear features such as fractures;
- Occurrence of insoluble weathering product of dolomite rock. This material is highly compressible and mobilisable;
- Particularly problematic environment mainly due to the fact that the overburden is thin and smaller quantities of water are required to mobilize the overburden resulting in sinkholes or subsidences;
- Dolomite may outcrop at surface, sometimes as actual rock masses, but often as isolated pinnacles and large floaters (detached from main bedrock);
- Buildings may be founded on loose boulders, mistaken to be stable rock;
- The undulating micro-topography of a shallow dolomite environment may typically not be discerned in gravity data.

Furthermore, boreholes can only sample a small area and therefore the frequency and dimensions of slots cannot be accurately defined with limited numbers of boreholes as exists in the zone.

iv. Hazard Classification (with Groundwater Drawdown as a Triggering Mechanism)

This zone straddles all three groundwater compartments. The groundwater level is anticipated at very great depth (50-100m). Artificial drawdown is likely to occur within hard rock.

v. Impact of Lowering of the Groundwater Level/Base Level of Erosion on the Action of Ingress

In the event that the groundwater level is drawn down significantly (6 m or more), the hazard classification remains unchanged.

vi. Composite Hazard Classification

The composite hazard classification is **Inherent Hazard Class 3/5(7)//1**, defined as an area largely reflecting a **medium to high** susceptibility of small to medium-size (with sub-areas reflecting a high susceptibility of up to large-size-) sinkhole and subsidence formation with respect to ingress of water and a **low** susceptibility of all-size sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.

In the event that the groundwater level is drawn down significantly (6 m or more), the hazard classification remains unchanged as it relates to the base level of erosion.

8.2. Varkenslaagte Site

The site is characterised in terms of three broad Inherent Hazard Class areas, described as follows:

Inherent Hazard Class	Description
1/4//1	Area largely reflecting a low to medium susceptibility of <u>all-size</u> sinkhole and subsidence formation with respect to ingress of water and a low susceptibility of <u>all-size</u> sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.
3/4///1	Area largely reflecting a medium susceptibility of <u>medium to large-size</u> sinkhole and subsidence formation with respect to ingress of water and a low susceptibility of <u>all-size</u> sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.
3/5(7)//1	Area largely reflecting a medium to high susceptibility of <u>small to medium-size</u> (with sub-areas reflecting a high susceptibility of up to large-size-) sinkhole and subsidence formation with respect to ingress of water and a low susceptibility of <u>all-size</u> sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.

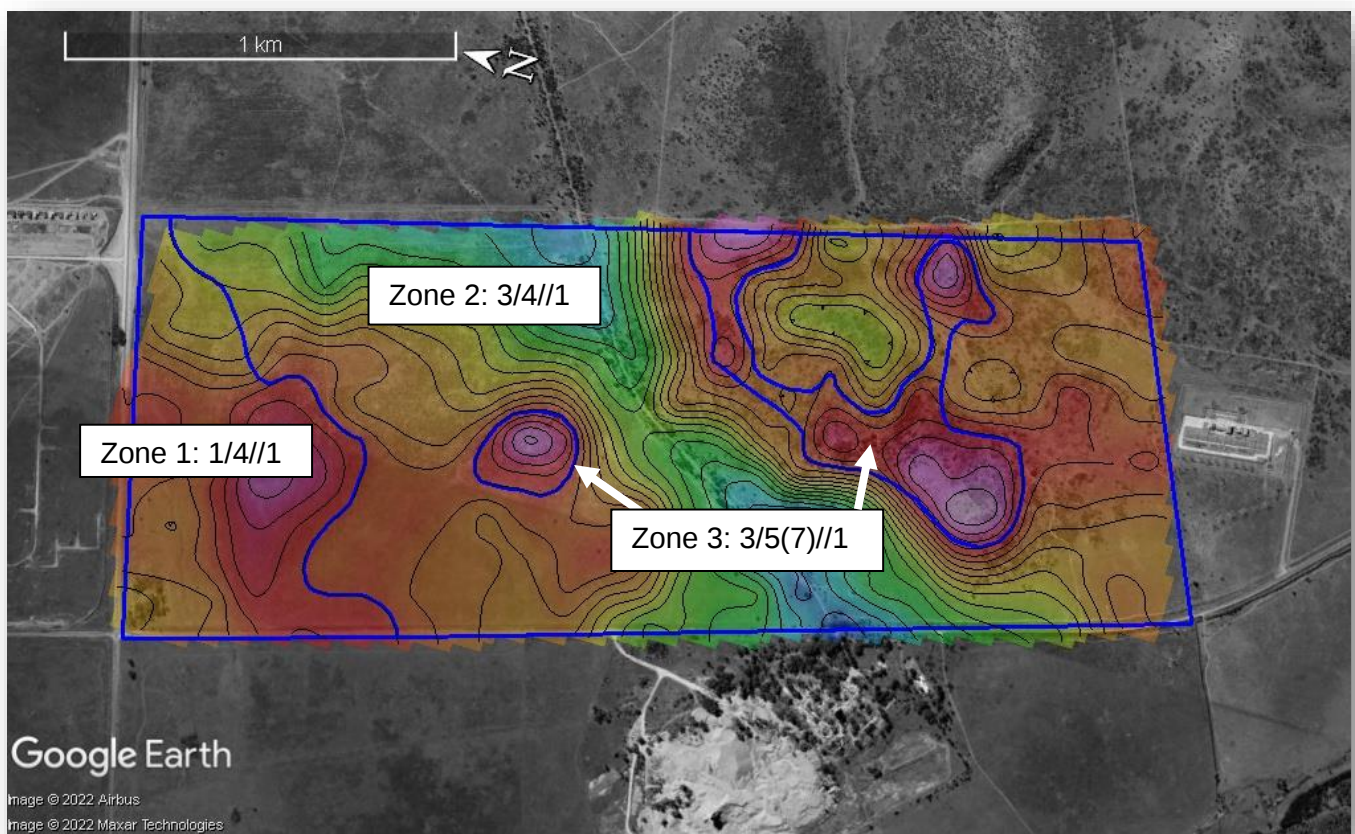


Figure 10: Dolomite Hazard Zonation (Varkenslaagte)

8.2.1. Dolomite Hazard Zone 1 (Inherent Hazard Class 1/4//1)

a) Hazard Characterisation

i. Blanketing Layer

The blanketing layer is of **great to very great thickness**.

The blanketing layer mainly consists of chert, possibly Post Eccles Formation. The blanketing layer is anticipated to be characterised by **poor to moderate internal drainage characteristics**. Prolonged ingress of water is may to lead to erosion and sinkhole or subsidence formation.

ii. **Potential Development Space**

In general, the depth to dolomite bedrock, as well as the groundwater level (which acts as a base level for erosion) and the potential receptacles determine the Potential Development Space (PDS). The PDS is characterised as, typically, **large**.

iii. **Hazard Classification (with Ingress of Water as a Triggering Mechanism)**

Boreholes intercept thick horizons of chert and shale interlayered. Weathered dolomite occurs at depths in excess of 60m. No sample or air loss indicative of cavernous conditions were intercepted.

iv. **Hazard Classification (with Groundwater Drawdown as a Triggering Mechanism)**

This zone is located in the Boskop-Turffontein Compartment. The groundwater level is anticipated at very great depth (>100m). Artificial drawdown is likely to occur within hard rock.

v. **Impact of Lowering of the Groundwater Level/Base Level of Erosion on the Action of Ingress**

In the event that the groundwater level is drawn down significantly (6 m or more), the hazard classification remains unchanged.

vi. **Composite Hazard Classification**

The composite hazard classification is **Inherent Hazard Class 1/4//1**, defined as an area largely reflecting a **low to medium** susceptibility of all-size sinkhole and subsidence formation with respect to ingress of water and a **low** susceptibility of all-size sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown. In the event that the groundwater level is drawn down significantly (6 m or more), the hazard classification remains unchanged as it relates to the base level of erosion.

8.2.2 Dolomite Hazard Zone 2 (Inherent Hazard Class 3/4//1)

a) **Hazard Characterisation**

i. **Blanketing Layer**

The blanketing layer is of **great to very great thickness**.

The blanketing layer mainly consists of chert residuum to intermediate and great depth. The blanketing layer is anticipated to be characterised by **good internal drainage characteristics**. Prolonged ingress of water may lead to erosion and sinkhole or subsidence formation.

ii. **Potential Development Space**

In general, the depth to dolomite bedrock, as well as the groundwater level (which acts as a base level for erosion) and the potential receptacles determine the Potential Development Space (PDS). The PDS is characterised as, typically, **medium to large**.

iii. **Hazard Classification (with Ingress of Water as a Triggering Mechanism)**

Boreholes intercept chert residuum. Weathered dolomite occurs at depths ranging from 18m to >30m depth. No sample or air loss indicative of cavernous conditions

were intercepted.

iv. Hazard Classification (with Groundwater Drawdown as a Triggering Mechanism)

The groundwater level is anticipated at very great depth (>100m). Artificial drawdown is likely to occur within hard rock.

v. Impact of Lowering of the Groundwater Level/Base Level of Erosion on the Action of Ingress

In the event that the groundwater level is drawn down significantly (6 m or more), the hazard classification remains unchanged.

vi. Composite Hazard Classification

The composite hazard classification is **Inherent Hazard Class 3/4//1**, defined as an area largely reflecting a **medium** susceptibility of medium to large-size sinkhole and subsidence formation with respect to ingress of water and a **low** susceptibility of all-size sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.

In the event that the groundwater level is drawn down significantly (6 m or more), the hazard classification remains unchanged as it relates to the base level of erosion.

8.2.3 Dolomite Hazard Zone 3 (Inherent Hazard Class 3/5(7)//1)

a) Hazard Characterisation

i. Blanketing Layer

The blanketing layer is typically **thin**.

The blanketing layer consists of chert and dolomite residuum. The blanketing layer is anticipated to be characterised by **good to very good internal drainage characteristics**. Prolonged ingress of water is may readily lead to erosion and sinkhole or subsidence formation.

ii. Potential Development Space

In general, the depth to dolomite bedrock, as well as the groundwater level (which acts as a base level for erosion) and the potential receptacles determine the Potential Development Space (PDS). The PDS is characterised as, typically, **small to medium**.

iii. Hazard Classification (with Ingress of Water as a Triggering Mechanism)

Boreholes and gravity contour data indicate a shallow dolomite bedrock environment.

iv. Hazard Classification (with Groundwater Drawdown as a Triggering Mechanism)

The groundwater level is anticipated at very great depth (>100m). Artificial drawdown is likely to occur within hard rock.

v. Impact of Lowering of the Groundwater Level/Base Level of Erosion on the Action of Ingress

In the event that the groundwater level is drawn down significantly (6 m or more), the hazard classification remains unchanged.

vi. Composite Hazard Classification

The composite hazard classification is **Inherent Hazard Class 3/5(7)//1**, defined as an area largely reflecting a **medium to high** susceptibility of small to medium-size (with sub-areas reflecting a high susceptibility of up to large-size-) sinkhole and subsidence formation with respect to ingress of water and a **low** susceptibility of all-size sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.

In the event that the groundwater level is drawn down significantly (6 m or more), the hazard classification remains unchanged as it relates to the base level of erosion.

9. CONCLUSIONS

9.1. Dolomite Hazard Assessment

The Varkenslaagte site is characterised in terms of three broad Inherent Hazard Class areas, described as follows:

Inherent Hazard Class	Description
1/4//1	Area largely reflecting a low to medium susceptibility of <u>all-size</u> sinkhole and subsidence formation with respect to ingress of water and a low susceptibility of <u>all-size</u> sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.
3/4///1	Area largely reflecting a medium susceptibility of <u>medium to large-size</u> sinkhole and subsidence formation with respect to ingress of water and a low susceptibility of <u>all-size</u> sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.
3/5(7)//1	Area largely reflecting a medium to high susceptibility of <u>small to medium-size</u> (with sub-areas reflecting a high susceptibility of up to large-size-) sinkhole and subsidence formation with respect to ingress of water and a low susceptibility of <u>all-size</u> sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.

The Twyfelvlakte site is characterised in terms of three broad Inherent Hazard Class areas, described as follows:

Inherent Hazard Class	Description
1(4)//1	Area largely reflecting a low susceptibility of <u>all-size</u> (with sub-areas reflecting a medium susceptibility of up to large-size-) sinkhole and subsidence formation with respect to ingress of water and a low susceptibility of <u>all-size</u> sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.
4//1	Area largely reflecting a medium susceptibility of <u>large-size</u> sinkhole and subsidence formation with respect to ingress of water and a low susceptibility of <u>all-size</u> sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.

Inherent Hazard Class	Description
3/5(7)//1	Area largely reflecting a medium to high susceptibility of <u>small to medium-size</u> (with sub-areas reflecting a high susceptibility of up to large-size-) sinkhole and subsidence formation with respect to ingress of water and a low susceptibility of <u>all-size</u> sinkhole and subsidence formation with respect to anthropogenically induced groundwater level drawdown.

9.2. Dolomite Area Designation

Varkenslaagte and Twyfelvlakte are designated as D3.

10. RECOMMENDATIONS

10.1. Permissible Land Use SANS 1936 Part 1 (2012)

A Solar Park is deemed permissible on both the Varkenslaagte and Twyfelvlakte sites.

Structures³ may require design-level dolomite stability investigations. Once the positions of structures (for example buildings) have been decided upon a competent person (as defined in SANS 1936) should study the plans, together with this report and advise on the need for design-level dolomite stability investigations.

SANS 1936 requires a design-level investigation as follows-

- a) *where required in terms of table 2 of SANS 1936-1:2011;*
- b) *where additional investigation is required for particular types of development, if not included in the feasibility-level investigation;*
- c) *where the feasibility-level investigation identifies the need for additional information or confirmation of the findings of that investigation, particularly with regard to the inherent hazard class of the site or parts thereof;*
- d) *where further geotechnical information is required for the design of foundations, structures or infrastructure; or*
- e) *where deemed necessary by the competent person.*

The following requirements are laid down for design level investigations:

- 4.3.2.1** *Design-level investigations required for particular types of development shall comply with the requirements of Annex A of SANS 1936 Part 2.*
- 4.3.2.2** *The requirements for and methods used during all other design-level investigations shall be determined by the competent person to ensure that the investigation fulfils its intended purpose.*
- 4.3.2.3** *Footprint investigations shall be carried out to confirm, refine or amend inherent hazard class below the footprint of the structure and the associated dolomite area designations.*
- 4.3.2.4** *During the design-level investigation, the competent person shall compare the geotechnical conditions encountered with those expected on the basis of the feasibility-level investigation. Where discrepancies or variations exist, sufficient additional work shall be undertaken to determine the extent and effect of such discrepancies and the inherent hazard class of the site or part thereof shall be amended accordingly.*

³ SANS 1936-4 defines **structure** as: organized combination of connected parts designed to provide some measure of rigidity, or construction works that have such an arrangement

10.2. Precautionary Measures

Both Varkenslaagte and Twyfelvlakte sites are subject to dolomite precautionary measures and designated as D3:

- The minimum standards contained in **SANS 1936, Part 3 (2012): Design and construction of buildings, structures and infrastructure** must be complied with as a point of departure, as this standard now forms part of the National Building Regulations.
- **No ponding of water should be permitted on the site.** An essential component of risk management is ensuring that stormwater is efficiently and effectively removed from the proximity of structures and infrastructure and safely distributed or deposited into either municipal stormwater systems or natural river courses.
- According to SANS 1936, Part 4 (2012) every Local Authority in whose jurisdiction a proposed development is located must establish, document, implement and maintain a Dolomite Risk Management System. In order to implement such a system, a regional dolomite stability assessment must be undertaken. This assessment should underpin all the planning decisions of the Municipality. **Merafong is obligated to continue to do so.**

11. GENERAL

11.1. Verification Process

The findings in this report are based upon our interpretation of the data recovered during these investigations. While every effort has been made, within the limits of the project budget, time and present-day insight, to determine overall ground conditions on this site, poorer sub-areas may have been missed. For this reason, it is recommended that a competent specialist is always invited to inspect open works on this site in order to further confirm the findings described in this report.

11.2. Third Party Reviews

If this report is reviewed by third parties, it should be noted that dolomite hazard assessment and management is an empirical science and consequently such parties may formulate opinions concerning the findings, conclusions and recommendations of this investigation at variance with those contained in this report. This fact should be borne in mind when costs are incurred on this project prior to receipt of the comments of these parties. Geohazard Solutions, its members and personnel cannot be held responsible for these divergent views or consequential damages.

Borehole Number with collar elevation in m AMSL	Transported material (m-m)	Pre or Post Malmani Subgroup material (m-m)	Chert Residuum		Dolomite Residuum (m-m)	Soft and weathered dolomite rock (Malmani Subgroup) (m-m)	Dolomite Bedrock (Malmani Subgroup) m and m AMSL	On site groundwater rest level in m and m AMSL*	Hazard Characterisation			
			Fines subordinate (m-m)	Fines predominant (m-m)					Ingress Water		Groundwater Drawdown	
									Subsidence Formation	Sinkhole Formation	Subsidence Formation	Sinkhole Formation
009 1525	0-3	3-33 K S	-	-	33-47 W CHERT	47-48	48-54 1477	Dry OWL 1425	LOW	LOW	LOW	LOW
022 1534	0-2	2-60 K S	-	-	-	-	>60 <1474	Dry OWL 1425	LOW	LOW	LOW	LOW
142 1549	-	-	-	0-58	-	-	58-60 1491	Dry OWL 1455	MEDIUM	MEDIUM	LOW	LOW
225 1555	-	-	-	0-6	-	6-7	7-13 1548	Dry OWL 1469	MEDIUM-HIGH?	MEDIUM-HIGH?	LOW	LOW
264 1538	0-2	2-60 K S	-	-	-	-	> 60 < 1478	Dry OWL 1469	LOW	LOW	LOW	LOW
299 1545	-	-	-	0-3	-	-	3-9 1542	Dry OWL 1425	MEDIUM-HIGH?	MEDIUM-HIGH?	LOW	LOW
338 1531	0-3	3-60 K S	-	-	-	-	> 60 < 1471	Dry OWL 1425	LOW	LOW	LOW	LOW
364 1551	-	-	-	0-7	-	-	7-13 1547	Dry OWL 1425	MEDIUM-HIGH?	MEDIUM-HIGH?	LOW	LOW
379B 1540	-	-	3-27 27-30 NSR	0-3	-	-	30-31 NSR 1510	Dry OWL 1425	MEDIUM	MEDIUM	LOW	LOW
512 1556	-	-	-	0-6	6-14 W CHERT	14-15	15-21 1541	Dry OWL 1425	MEDIUM	MEDIUM	LOW	LOW
524 1542	0-3	3-60 K S	-	-	-	-	> 60 < 1482	21 (perched) OWL 1425	LOW	LOW	LOW	LOW
615 1569	-	-	-	0-8	8-15 W CHERT	15-16	16-17 1553	Dry OWL 1425	MEDIUM	MEDIUM	LOW	LOW
759B 1542	0-5	5-60 K S	-	-	-	-	> 60 < 1482	Dry OWL 1469	LOW	LOW	LOW	LOW
822 1540	-	-	3-60 PEFC?	0-3	-	-	> 60 < 1480	Dry OWL 1425	MEDIUM	MEDIUM	LOW	LOW
843B 1543	-	-	3-18	0-3	-	18-19	19-25 1524	Dry OWL 1425	MEDIUM	MEDIUM	LOW	LOW
861B 1571	-	-	-	0-20	20-24 W CHERT	-	24-30 1547	Dry OWL 1425	MEDIUM	MEDIUM	LOW	LOW

Table 1: Summarised Borehole Information and Inherent Hazard Characterisation

R residual WD weathered RPT rapid penetration times W with I Intrusive NSR NO SAMPLE RETURN
S Shale PED pedogenic horizon K Karoo age PEFC Post Eccles Formation Chert

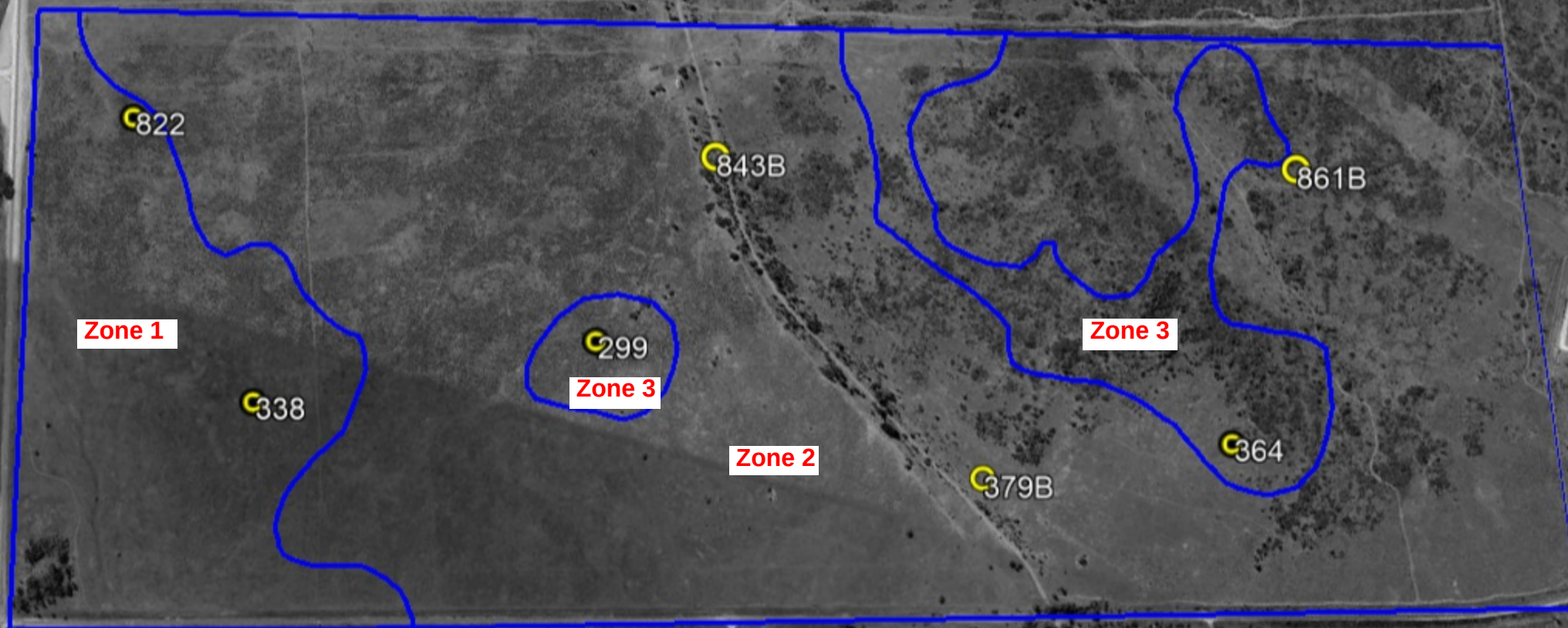


900 m



Legend

-  Boreholes
-  Boreholes (Relocated due to access constraints)



Google Earth

Image © 2022 Airbus
Image © 2022 Maxar Technologies

GHS1390

Proposed Solar Park: Drawing 2: Dolomite Hazard Zonation and Borehole Positions

APPENDICES

APPENDIX 1

To: Nicole Trollip
Company: Geohazard Solutions
Email: nyg.trollip@gmail.com
Date: 8 December 2022

From: Oleg Brovko
Company: Geofocus
Reg: 2016 / 324488 / 07
Email: oleg@geofocus.co.za



Twyfelvlakte Area 1 - Report on the Gravity Survey

General

This report presents the results of a gravity survey, conducted in support of a dolomitic stability study, at Twyfelvlakte (Figure 1). The site is located on the outskirts of Carletonville, adjacent to the R501. The survey was done on behalf of Geohazard Solutions. A total of 566 gravity stations were acquired on a 100m grid in October 2022. In total 580ha was covered.

Methodology

Gravity was observed with a Scintrex CG5 gravimeter in conjunction with a GNSS (RTK) GPS. The latter are used to acquire high precision location information.

Standard gravity processing procedures were applied, firstly reducing the data to relative Bouguer values by applying Earth Tide (ETC), elevation and Bouguer corrections. As a final step, the regional gravity field, derived through linear regression or fitting a 1st order plane to the data, was removed from the Bouguer gravity to produce a residual gravity map.

Results

The residual gravity values fall within a fairly broad peak-to-peak envelope of ~2.3 mGals (Figure 1). Broadly, the area is typified by highs along the S and N connected by a fairly wide, N-S orientated, high in the central E. The northern high appears more regular compared to the S, where the highs appear more intense and localised. The gravity highs encompass a broad low within which rectilinear lows striking roughly E-W and N-S are delineated. A comparatively more intense gravity low is resolved in the far SE of the survey, it is however only partially resolved.

Results for eight boreholes are presented on Figure 1 on the following page.

Correlation between dolomite bedrock intersections and the residual gravity are plain. Only boreholes drilled over the southern and northern gravity highs intersected bedrock, that being between 7m - 16m and 48m respectively; hence bedrock dips from S to N. Bedrock is in excess of 60m i.e. the depth at which drilling was terminated. The maximum residual gravity values are just below 0 mGal suggesting that dolomite approaches surface, likely just S of the survey area.

Overall, the gravity is a fair reflection of changes in bedrock depth.

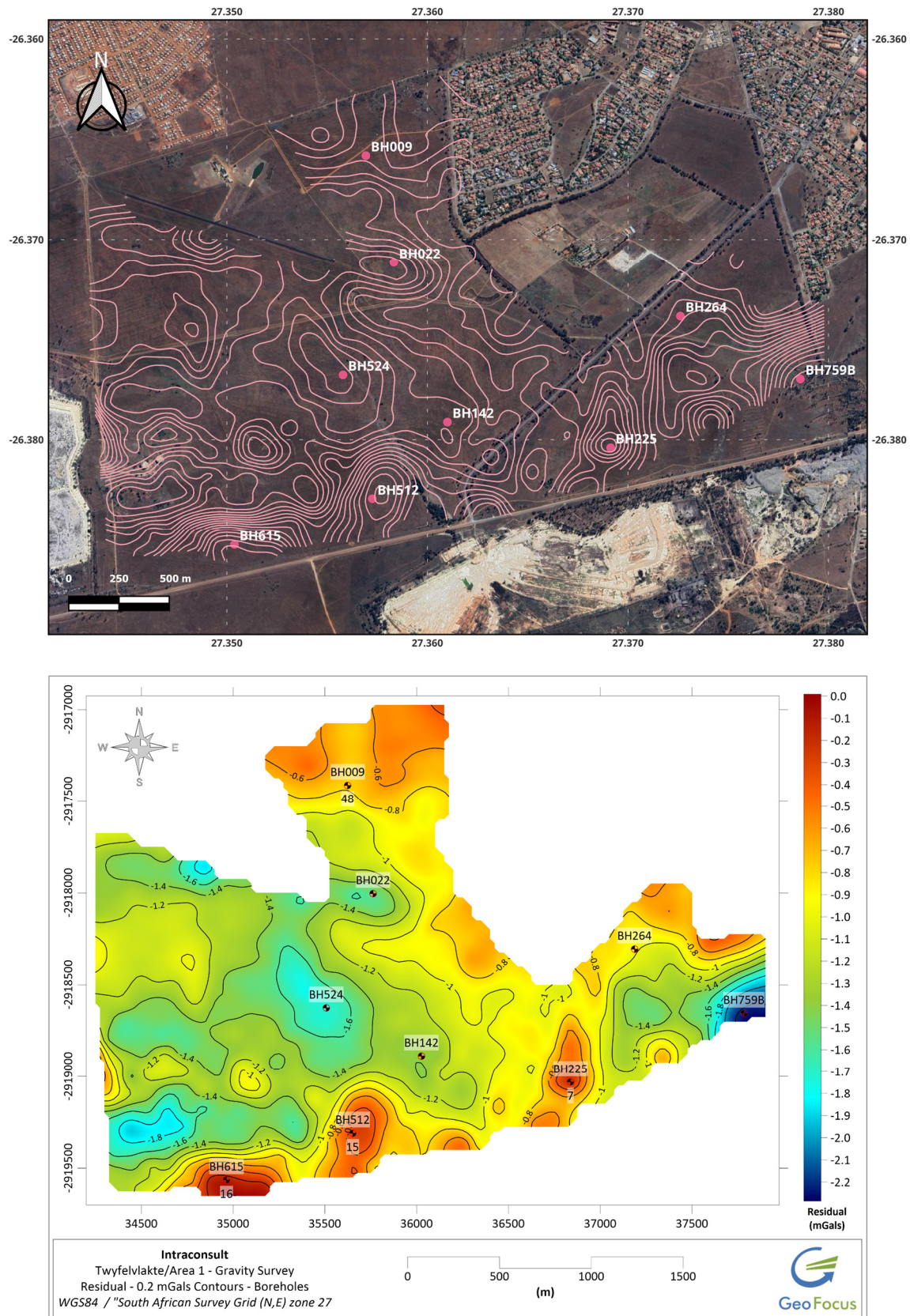


Figure 1. (Top) Google Earth image showing location of the boreholes and corrected residual 0.1 mGals contours; map is projected in Lat-Long/WGS84; (Bottom) corrected residual gravity with 0.2 mGals contours, borehole locations and depths to dolomite bedrock; map is projected in LO27/WGS84.

To: Nicole Trollip
Company: Geohazard Solutions
Email: nyg.trollip@gmail.com
Date: 8 December 2022

From: Oleg Brovko
Company: Geofocus
Reg: 2016 / 324488 / 07
Email: oleg@geofocus.co.za



Varkenlaagte Area2 - Report on the Gravity Survey

General

This report presents the results of a gravity survey, conducted in support of a dolomitic stability study, at Varkenlaagte (Figure 1). The site is located on the outskirts of Carletonville, adjacent to the R501. The survey was done on behalf of Geohazard Solutions. A total of 294 gravity stations were acquired on a 100m grid in October 2022. In total 267 Ha was covered.

Methodology

Gravity was observed with a Scintrex CG5 gravimeter in conjunction with a GNSS (RTK) GPS. The latter are used to acquire high precision location information.

Standard gravity processing procedures were applied, firstly reducing the data to relative Bouguer values by applying Earth Tide (ETC), elevation and Bouguer corrections. As a final step, the regional gravity field, derived through linear regression or fitting a 1st order plane to the data, was removed from the Bouguer gravity to produce a residual gravity map.

Results

The residual gravity values fall within a fairly broad peak-to-peak envelope of ~1.8 mGals (Figure 1). The area is characterised by a broad, irregular gravity highs with NE trending gravity low running through the centre of the block. The gravity highs in the northern part appear be more regular with the gravity highs in the southern part characterised by undulating pattern of highs and subtle lows. The NE trending gravity low appears to be more intense on the western edge of the survey block, characterised by the steeper gradients then the eastern segment.

Results for seven boreholes are presented on Figure 1 on the following page.

Correlation between dolomite bedrock intersections and the residual gravity are moderate. There is a good correlation between dolomite bedrock depth and residual gravity with the central and southern gravity highs, with the shallowest bedrock intersection logged in BH299 at 3 m. NE trending gravity low logged bedrock intersection of 19 m in borehole BH843B, located on the eastern site. Borehole BH379B located over more intense segment of the gravity low did not intersect bedrock. Although partially covered in the east and west, the NE trending low could represent a channel or a trough in dolomite. Boreholes BH338 and BH822, located in the northern part of the block also did not intersect bedrock.

Overall, the gravity is a moderate reflection of changes in bedrock depth.

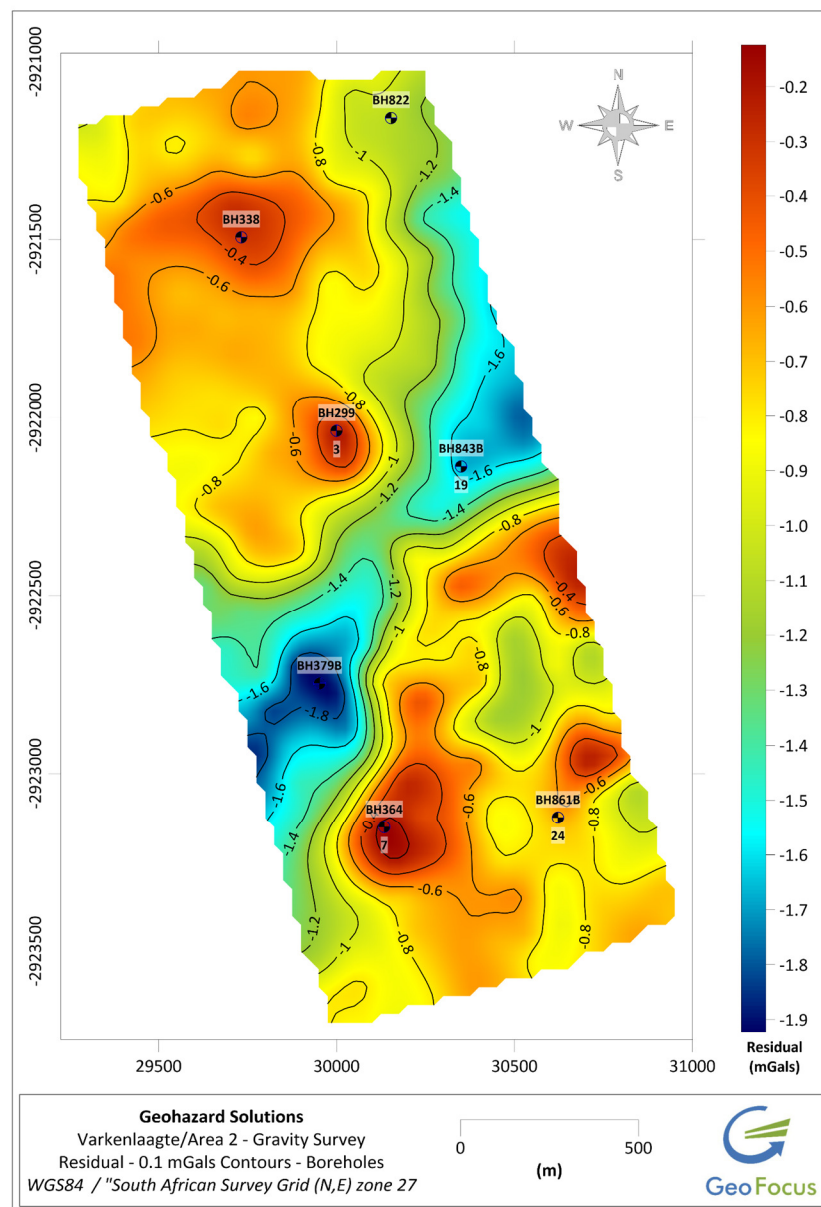
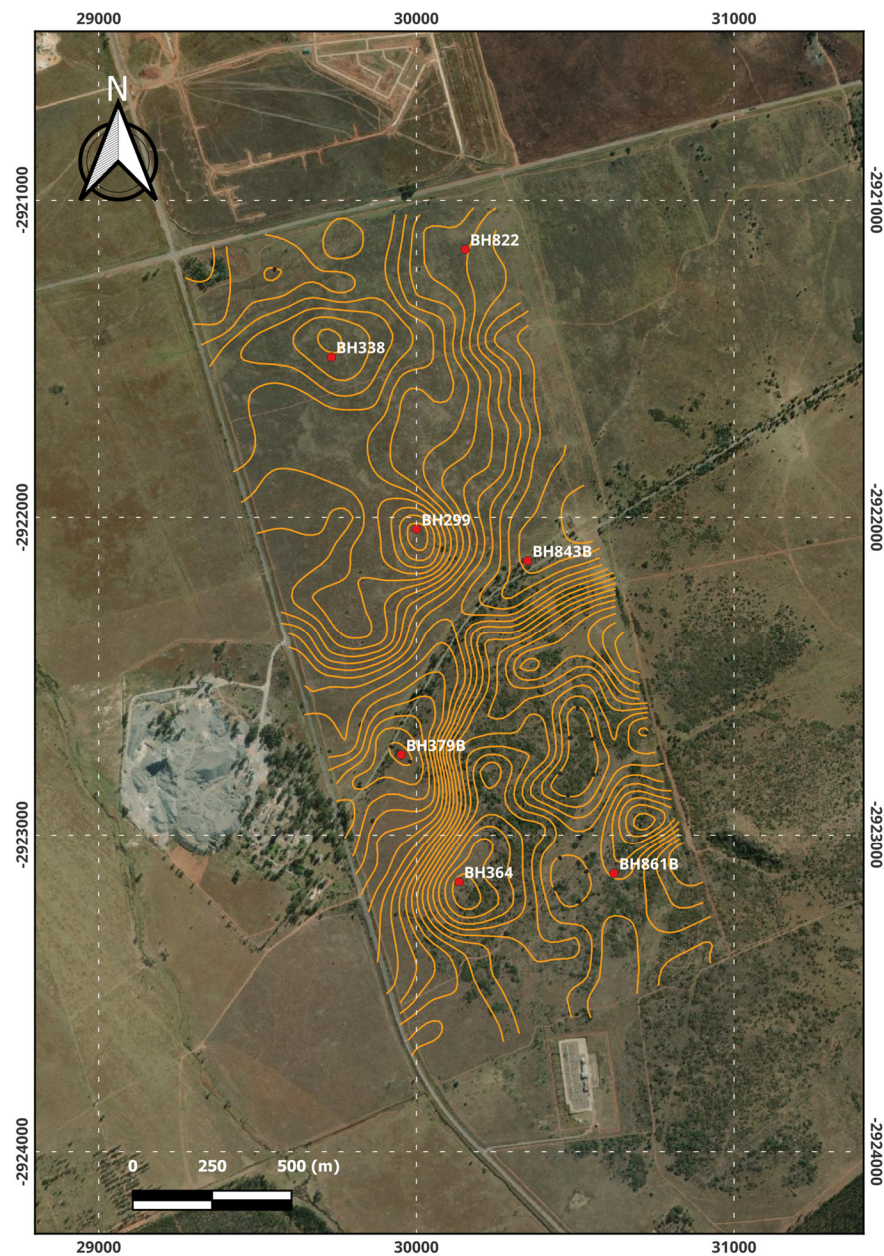
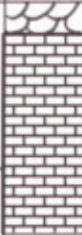


Figure 1. (Left) Google Earth image showing location of the boreholes and corrected residual 0.1 mGals contours; (Rigth) corrected residual gravity with 0.2 mGals contours, borehole locations and depths to dolomite bedrock; both maps are projected in LO27/WGS84.

APPENDICES

APPENDIX 2

PERCUSSION DRILLING REPORT			BOREHOLE NO : ER1 SHEET : 1 OF 1	
LOCALITY : RESERVOIR CARLETONVILLE : TRIG BEACON 242				
CO-ORDINATES : X = see residual Y =gravity map.		COLLAR ELEV : Beacon 1 578m amsl WATER LEVEL : Dry		
CONTRACTOR : Bennett Drilling				
DATE COMPLETED : 14/8/2000				
The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.				
PENETRATION (MIN,SEC/METRE)			KEY REFERENCE	Casing Air Loss Static water level
			DESCRIPTION	
0.14				
2.35				
3.17				
3.34				
3.15	5			
3.06				
2.59				
	10			
	15			
	20			
	25			
	30			
	35			
	40			
PROFILED BY GH/DB ON 16/8/2000 2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE 750cfm delivering 250psi to a 155mm diameter button bit 3. WATER ENCOUNTERED NIL 4. AIR LOSSES NIL 5. AIR CURRENTS NIL			Reservoir : East of Trig. Beacon 242, Carlevontille Intraconsult Consulting Engineers & Geologists Tel : (011) 465-8706	
			REF NO. IR417	FIG NO.

LOCALITY : RESERVOIR CARLETONVILLE : TRIG BEACON 242

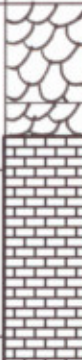
CO-ORDINATES : X = see residual
Y = gravity map.COLLAR ELEV : Beacon 1 578m amsl
WATER LEVEL : Dry

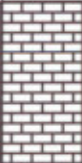
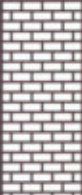
CONTRACTOR : Bennett Drilling

DATE COMPLETED : 14/8/2000

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)				KEY REFERENCE	Casing Air Loss Static water level	
				DESCRIPTION		
2.17				0.0 – 6.0m : Angular, blue grey, unweathered DOLOMITE with angular light to dark grey, medium weathered CHERT, DOLOMITE BEDROCK.		
3.21						
3.42						
3.27						
3.16		5				
4.02						
		10				
		15				
		20				
		25				
		30				
		35				
		40				
PROFILED BY GH/DB ON 16/8/2000 2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE 750cfm delivering 250psi to a 155mm diameter button bit 3. WATER ENCOUNTERED NIL 4. AIR LOSSES NIL 5. AIR CURRENTS NIL				Reservoir : East of Trig. Beacon 242, Carletonville Intraconsult Consulting Engineers & Geologists Tel : (011) 465-8706		REF NO. IR417 FIG NO.

PERCUSSION DRILLING REPORT				BOREHOLE NO : ER3	
				SHEET : 1 OF 1	
LOCALITY : RESERVOIR CARLETONVILLE : TRIG BEACON 242					
CO-ORDINATES		: X = see residual		COLLAR ELEV : Beacon 1 578m amsl	
		Y =gravity map.		WATER LEVEL : Dry	
CONTRACTOR : Bennett Drilling					
DATE COMPLETED : 14/8/2000					
The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.					
PENETRATION (MIN,SEC/METRE)				KEY REFERENCE	Casing Air Loss Static water level
				DESCRIPTION	
0.15				0.0 – 3.0m : Angular, white to light grey, highly weathered chert with reddish brown, SILTY SAND. CHERT RESIDUUM.	
0.21					
0.20					
0.15					
1.39		5		3.0 – 4.0m : Dark, reddish brown SILTY SAND with abundant angular, white to light grey, chert. CHERT RESIDUUM.	
2.03				4.0 – 11.0m : Angular, blue grey, unweathered DOLOMITE with angular light to dark grey, medium weathered CHERT. DOLOMITE BEDROCK.	
3.10					
3.26					
3.33					
3.11		10			
3.20					
		15			
		20			
		25			
		30			
		35			
		40			
PROFILED BY GH/DB ON 16/8/2000				Reservoir : East of Trig. Beacon 242, Carletonville	
2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE 750cfm delivering 250psi to a 155mm diameter button bit					
3. WATER ENCOUNTERED NIL					
4. AIR LOSSES NIL					
5. AIR CURRENTS NIL					
				Intraconsult	
				Consulting Engineers & Geologists	
				Tel : (011) 465-8706	
				REF NO. IR417	
				FIG NO.	

PERCUSSION DRILLING REPORT			BOREHOLE NO : ER4 SHEET : 1 OF 1		
LOCALITY : RESERVOIR CARLETONVILLE : TRIG BEACON 242					
CO-ORDINATES : X = see residual Y =gravity map.		COLLAR ELEV : Beacon 1 578m amsl WATER LEVEL : Dry			
CONTRACTOR : Bennett Drilling					
DATE COMPLETED : 14/8/2000					
The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.					
PENETRATION (MIN,SEC/METRE)				KEY REFERENCE	Casing Air Loss Static water level
				DESCRIPTION	
2.51	5			0.0 – 5.0m : Angular, blue grey, unweathered DOLOMITE with angular light to dark grey, medium weathered CHERT. DOLOMITE BEDROCK.	
3.06					
3.09					
3.00					
2.59					
1.06					
1.10					
-					
-					
-					
2.09					
2.30					
3.16	10			5.0 – 7.0m : Dark, reddish brown SILTY SAND with abundant angular, white to light grey CHERT. CHERT RESIDUUM.	
3.21					
3.07					
3.15					
	15			7.0 – 10.0m : No sample return. Fissure? Limited extent : Full sample recovery below.	
	20			10.0 – 16.0m : Angular, blue grey, unweathered DOLOMITE with angular, light to dark grey, medium weathered CHERT. DOLOMITE BEDROCK.	
	25			Full sample return.	
	30				
	35				
	40				
PROFILED BY GH/DB ON 16/8/2000 2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE 750cfm delivering 250psi to a 155mm diameter button bit 3. WATER ENCOUNTERED NIL 4. AIR LOSSES 7 – 10m. 5. AIR CURRENTS NIL			Reservoir : East of Trig. Beacon 242, Carletonville Intraconsult Consulting Engineers & Geologists Tel : (011) 465-8706		
			REF NO. IR417		
			FIG NO.		

BOREHOLE NO : ER6

SHEET : 1 OF 1

LOCALITY ; RESERVOIR CARLETONVILLE ; TRIG BEACON 242

CO-ORDINATES : X = see residual
Y = gravity map.

COLLAR ELEV : 1 578m amsl
WATER LEVEL : Dry

CONTRACTOR : Bennett Drilling

DATE COMPLETED : 14/8/2000

The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN,SEC/METRE)			KEY	Casing	
			REFERENCE	Air Loss	
			DESCRIPTION	Static water level	
0.11				0.0 – 2.0m : Angular, white to light grey, highly weathered chert with reddish brown SILTY SAND. CHERT RESIDUUM.	
0.13				2.0 – 3.0m : Angular, blue grey, unweathered DOLOMITE with angular, light to dark grey, medium weathered CHERT.	
3.01				DOLOMITE BEDROCK.	
		5			
		10			
		15			
		20			
		25			
		30			
		35			
		40			

PROFIED BY	GH/DB	ON	16/8/2000
2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE	750cfm delivering 250psi to a 155mm diameter button bit		
3. WATER ENCOUNTERED	NIL		
4. AIR LOSSES	NIL		
5. AIR CURRENTS	NIL		

Reservoir : East of Trig. Beacon 242,
Carletonville

Intraconsult
Consulting Engineers & Geologists
Tel : (011) 465-8706

REF
NO.
IR417FIG
NO.

PERCUSSION DRILLING REPORT				BOREHOLE NO : ER8 SHEET : 1 OF 1	
LOCALITY : RESERVOIR CARLETONVILLE : TRIG BEACON 242					
CO-ORDINATES : X = see residual Y =gravity map.		COLLAR ELEV : Beacon 1 578m amsl WATER LEVEL : Dry			
CONTRACTOR : Bennett Drilling					
DATE COMPLETED : 14/8/2000					
The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.					
PENETRATION (MIN,SEC/METRE)				KEY REFERENCE	Casing Air Loss Static water level
				DESCRIPTION	
0.13				0.0 – 2.0m : Angular, white to light grey, highly weathered chert with reddish brown SILTY SAND. CHERT RESIDUUM.	
0.16				2.0 – 3.0m : Dark, reddish brown SILTY SAND with abundant angular, white to light grey CHERT. CHERT RESIDUUM.	
0.22				3.0 – 4.0m : Angular, blue grey, unweathered DOLOMITE with angular, light to dark grey, medium weathered CHERT. DOLOMITE BEDROCK.	
3.19					
		5			
		10			
		15			
		20			
		25			
		30			
		35			
		40			
PROFILED BY GH/DB ON 16/8/2000 2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE 750cfm delivering 250psi to a 155mm diameter button bit 3. WATER ENCOUNTERED NIL 4. AIR LOSSES NIL 5. AIR CURRENTS NIL				Reservoir : East of Trig. Beacon 242, Carletonville Intraconsult Consulting Engineers & Geologists Tel : (011) 465-8706	
				REF NO. IR417	FIG NO.

PERCUSSION DRILLING REPORT				BOREHOLE NO : ER10	
				SHEET : 1 OF 1	
LOCALITY : RESERVOIR CARLETONVILLE : TRIG BEACON 242					
CO-ORDINATES		: X = see residual		COLLAR ELEV : Beacon 1 578m amsl	
		Y =gravity map.		WATER LEVEL : Dry	
CONTRACTOR : Bennett Drilling					
DATE COMPLETED : 17/8/2000					
The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.					
PENETRATION (MIN,SEC/METRE)				KEY REFERENCE	Casing Air Loss Static water level
				DESCRIPTION	
0.11				0.0 – 2.0m : Angular, white to light grey, highly weathered chert with reddish brown SILTY SAND. CHERT RESIDUUM.	
0.16				2.0 – 9.0m : Dark, reddish brown to black CLAYEY SILT (WAD) with angular, dark to light grey medium weathered chert. DOLOMITE & CHERT RESIDUUM.	
0.33					
0.33					
0.53		5			
1.01					
1.02					
0.55					
0.58					
3.13		10		9.0 – 10.0m : Angular, blue grey, unweathered DOLOMITE with angular, light to dark grey, medium weathered CHERT. DOLOMITE BEDROCK.	
		15			
		20			
		25			
		30			
		35			
		40			
PROFILED BY GH/DB ON 18/8/2000				Reservoir : East of Trig. Beacon 242,	
2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE				Carletonville	
750cfm delivering 250psi to a 155mm diameter button bit				REF NO. IR417	
3. WATER ENCOUNTERED NIL				Intraconsult	
4. AIR LOSSES NIL				Consulting Engineers & Geologists	
5. AIR CURRENTS NIL				Tel : (011) 465-8706	
				FIG NO.	

PERCUSSION DRILLING REPORT

BOREHOLE NO. AR 1
SHEET: 1 OF 1

LOCALITY: KHUTSONG BULK WATER SUPPLY: REVISED RESERVOIR SITE

CO-ORDINATES: X = SEE DRAWG.
Y =

COLLAR ELEV: 1578 m AMSL

WATER LEVEL: DRY

CONTRACTOR: BENNETT DRILLING

DATE COMPLETED: OCTOBER 1995

The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated

PENETRATION (MIN, SEC/METRE)	Key Reference	Depth(m)	Geological Column (Diagrammatic)	KEY REFERENCE	DESCRIPTION	Correlation
				 Casing  Air Loss  Static water level		
0,22					0,0m-0,6m Angular, light grey, medium weathered CHERT, with angular blue grey, medium to unweathered DOLOMITE; CHERT AND DOLOMITE.	
0,16						
0,33						
0,32						
0,38						
0,51		5				
2,56					6,0-12,0m Angular, blue grey, medium to unweathered DOLOMITE with angular, light grey medium weathered CHERT; DOLOMITE AND CHERT.	
2,31						
2,41						
3,19		10				
2,53						
3,09						
		15				
		20				
		25				
		30				
		35				
		40				

1. PROFILED BY GH/DB ON 18 / 10 / 95
2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750 cfm DELIVERING 250 psi TO
A 185mm DIA. BUTTON BIT
3. WATER ENCOUNTERED NIL
4. AIR LOSSES NIL FULL SAMPLE RETURN
5. AIR CURRENTS NIL

A REPORT TO THE WESTERN SERVICES
COUNCIL ON GEOTECHNICAL IN-
VESTIGATIONS FOR THE KHUTSONG BULK
WATER SUPPLY ALIGNMENT & STORAGE
SITE

REF NO

IR
111
BW

INTRACONSULT

Consulting Engineers & Geologists
Rivonia (011) 803 - 1105

FIG. NO

BOREHOLE NO. AR3
SHEET: 1 OF 1

LOCALITY: KHUTSONG BULK WATER SUPPLY: REVISED RESERVOIR SITE

CO-ORDINATES: X = *SEE DRWG.*
Y =

COLLAR ELEV: 1578 m AMSL

WATER LEVEL : DRY

CONTRACTOR : BENNETT DRILLING

DATE COMPLETED: OCTOBER 1995

The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated.

PENETRATION (MIN, SEC/METRE)	Key Reference	Depth(m)	Geological Column (Diagrammatic)	KEY REFERENCE — Casing ↔ Air Loss ≡ Static water level	DESCRIPTION	Correlation
0,29					0,0-2,0m Angular, white to light grey, medium to highly weathered CHERT, angular white unweathered calcite and reddish brown silty SAND; CHERT RESIDUUM.	
0,25						
1,16						
0,45						
0,52						
0,48		5				
0,31						
0,50						
2,49					2,0-8,0m Reddish brown clayey SILT (Ferroan Soil) with minor, angular, white to light grey, medium to highly weathered CHERT; DOLOMITE AND CHERT RESIDUUM.	
3,11		10				
2,37						
3,04						
2,53						
2,20						
		15			8,0-14,0m Angular, blue grey, medium weathered, DOLOMITE and light grey, medium weathered CHERT; DOLOMITE AND CHERT.	
		20				
		25				
		30				
		35				
		40				

1. PROFILED BY GH/DB ON 18 / 10 / 95
2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750 cfm DELIVERING 250 psi TO
A 185mm DIA. BUTTON BIT
3. WATER ENCOUNTERED NIL
4. AIR LOSSES NIL ! FULL SAMPLE RETURN
5. AIR CURRENTS NIL

A REPORT TO THE WESTERN SERVICES
COUNCIL ON GEOTECHNICAL IN-
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WATER SUPPLY ALIGNMENT & STORAGE
SITE

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FIG. NO.

BOREHOLE NO. AR 4
SHEET: 1 OF 1

CO-ORDINATES: X =
Y = see DRWB.

WATER LEVEL : DRY

DATE COMPLETED: OCTOBER 1995

PENETRATION (MIN, SEC/METRE)	Key Reference	Depth(m)	Geological Column (Diagrammatic)	KEY	Correlation
				REFERENCE	
				 Casing  Air Loss  Static water level	
				DESCRIPTION	
2,12				0,0-8,0m Angular, light grey medium weathered CHERT, with angular, blue grey medium weathered to unweathered DOLOMITE; CHERT AND DOLOMITE.	
3,43					
1,06					
2,53					
3,43					
3,25		5			
2,48					
3,11				8,0-14,0m Angular, blue grey, medium to unweathered DOLOMITE with abundant to equal amounts, white to light grey, medium weathered CHERT; DOLOMITE AND CHERT.	
3,52					
2,59		10			
3,40					
4,12					
3,34					
3,50					
		15			
		20			
		25			
		30			
		35			
		40			

1. PROFILED BY GH/DB ON 18 / 10 / 95
2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750 cfm DELIVERING 250 psi TO
A 185mm DIA. BUTTON BIT
3. WATER ENCOUNTERED NIL
4. AIR LOSSES NIL; FULL SAMPLE RETURN
5. AIR CURRENTS NIL

A REPORT TO THE WESTERN SERVICES
COUNCIL ON GEOTECHNICAL IN-
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WATER SUPPLY ALIGNMENT & STORAGE
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FIG. NO.

PERCUSSION DRILLING REPORT

BOREHOLE NO. AR6
SHEET: 1 OF 1

LOCALITY: KHUTSONG BULK WATER SUPPLY: REVISED RESERVOIR SITE

CO-ORDINATES: X = SEE DRAWG.
Y =

COLLAR ELEV: 1578 m AMSL

WATER LEVEL: DRY

CONTRACTOR: BENNETT DRILLING

DATE COMPLETED: OCTOBER 1995

The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated

PENETRATION (MIN, SEC/METRE)	Key Reference	Depth(m)	Geological Column (Diagrammatic)	KEY REFERENCE	— Casing ↔ Air Loss ⏚ Static water level	Correlation
				DESCRIPTION		
0,13				0,0-2,0m	Reddish brown silty SAND with angular dark grey to white, medium to highly weathered CHERT; CHERT RUBBLE.	
0,51		2,0-3,0m	Black to reddish brown, clayey SILT (Ferroan Soil) with minor to trace amounts of angular, light to dark grey, medium weathered chert and reddish brown silty sand; RESIDUAL DOLOMITE AND CHERT.			
1,07						
0,49						
2,00		5				
2,03						
2,48						
3,02		10				
3,01						
				3,0-4,0m	Angular, dark to light grey, medium weathered CHERT with reddish brown silty SAND; CHERT RESIDUUM.	
		15				
				4,0-9,0m	NO SAMPLE RETURN. Driller reports small fissure at 4m. Full resistance, regular hammer action corresponding to hard rock DOLOMITE.	
		20				
		25				
		30				
		35				
		40				

1. PROFILED BY GH/DB ON 18 / 10 / 95
2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750 cfm DELIVERING 250 psi TO
A 185mm DIA. BUTTON BIT
3. WATER ENCOUNTERED NIL
4. AIR LOSSES LOWES BELOW ± 4m
5. AIR CURRENTS NIL

A REPORT TO THE WESTERN SERVICES
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FIG. NO

BOREHOLE NO. AR 7
SHEET: 1 OF 1

CO-ORDINATES: $X =$
 $Y =$ SEE DRAW.

WATER LEVEL : DRY

DATE COMPLETED: OCTOBER 1995

The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated

PERCUSSION DRILLING REPORT

BOREHOLE NO. AR 9
SHEET: 1 OF 1

LOCALITY: KHUTSONG BULK WATER SUPPLY: REVISED RESERVOIR SITE

CO-ORDINATES: X =
Y =

COLLAR ELEV: 1578 m AMSL

WATER LEVEL: DRY

CONTRACTOR: BENNETT DRILLING

DATE COMPLETED: OCTOBER 1995

The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated

PENETRATION (MIN, SEC/METRE)	Key Reference	Depth(m)	Geological Column (Diagrammatic)	KEY REFERENCE	DESCRIPTION	Correlation
				 Casing  Air Loss  Static water level		
0,36					0,0-2,0m Angular, light grey to white medium weathered CHERT, angular, white unweathered CALCITE, trace reddish brown silty SAND; CHERT RESIDUUM.	
0,47						
1,48						
2,05						
0,46		5	NO SAMPLE		2,0-4,0m Angular, light grey, medium weathered CHERT; CHERT.	
0,31						
2,42						
3,02						
3,09		10			4,0-6,0m NO SAMPLE RETURN. Driller reports irregular hammer action and penetration times corresponding to LOOSE CHERT RUBBLE.	
2,57						
3,66						
		15				
		20			6,0-11,0m Angular, light grey, medium to unweathered DOLOMITE and angular light grey medium weathered CHERT; CHERT AND DOLOMITE	
		25				
		30				
		35				
		40				

1. PROFILED BY GH/DB ON 18 / 10 / 95
2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750 cfm DELIVERING 250 psi TO A 185mm DIA. BUTTON BIT
3. WATER ENCOUNTERED NIL
4. AIR LOSSES NO SAMPLE RETURN 4-6m
5. AIR CURRENTS NIL

A REPORT TO THE WESTERN SERVICES COUNCIL ON GEOTECHNICAL INVESTIGATIONS FOR THE KHUTSONG BULK WATER SUPPLY ALIGNMENT & STORAGE SITE

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FIG. NO

PERCUSSION DRILLING REPORT

BOREHOLE NO. AR10
SHEET: 1 OF 1

LOCALITY: KHUTSONG BULK WATER SUPPLY: REVISED RESERVOIR SITE

CO-ORDINATES: X =
Y =

COLLAR ELEV: 1578 m AMSL

WATER LEVEL: DRY

CONTRACTOR: BENNETT DRILLING

DATE COMPLETED: OCTOBER 1995

The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated

PENETRATION (MIN, SEC/METRE)	Key Reference	Depth(m)	Geological Column (Diagrammatic)	KEY REFERENCE	DESCRIPTION	Correlation
				 Casing  Air Loss  Static water level		
0,53					0,0-1,0m Reddish brown, silty SAND with angular, light grey to white, medium to highly weathered CHERT; COLLUVIUM.	
3,41						
3,34						
3,10						
2,44						
2,11		5			1,0-4,0m Angular, light grey, medium to unweathered CHERT; CHERT RUBBLE.	
-			NO SAMPLE			
-						
-		10			4,0-6,0m Angular, light grey, medium weathered CHERT; CHERT.	
-						
-						
-						
-		15			6,0-14,0m NO SAMPLE RETURN. Driller reports very irregular hammer action and penetration times, corresponding to alternating "horizons" of soft material such as residual dolomite and harder horizons of chert.	
-						
-		20				
-						
-						
-		25				
-						
-						
-		30				
-						
-						
-		35				
-						
-						
-		40				

1. PROFILED BY GH/DB ON 18 / 10 / 95
2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750 cfm DELIVERING 250 psi TO A 185mm DIA. BUTTON BIT
3. WATER ENCOUNTERED NIL
4. AIR LOSSES NO SAMPLE RETURN 6-14 m
5. AIR CURRENTS NIL

A REPORT TO THE WESTERN SERVICES COUNCIL ON GEOTECHNICAL INVESTIGATIONS FOR THE KHUTSONG BULK WATER SUPPLY ALIGNMENT & STORAGE SITE

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FIG. NO

PERCUSSION DRILLING REPORT

BOREHOLE NO. AR 11
SHEET: 1 OF 1

LOCALITY: KHUTSONG BULK WATER SUPPLY: REVISED RESERVOIR SITE

CO-ORDINATES: X = SEE DRAWG.
Y =

COLLAR ELEV: 1578 m AMSL

WATER LEVEL: DRY

CONTRACTOR: BENNETT DRILLING

DATE COMPLETED: OCTOBER 1995

The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated

PENETRATION (MIN, SEC/METRE)	Key Reference	Depth(m)	Geological Column (Diagrammatic)	KEY REFERENCE	DESCRIPTION	Correlation
				 Casing  Air Loss  Static water level		
0,55					0,0-1,0m Angular white and light grey unweathered CHERT with minor reddish brown SILTY SAND; CHERT RUBBLE.	
3,11						
3,14						
2,38						
3,02						
1,21		5			1,0-7,0m Angular light to dark grey medium weathered CHERT; CHERT AND DOLOMITE with minor to trace blue grey dolomite.	
2,48						
3,43						
2,48						
2,29						
2,14		10			7,0-11,0m Angular dark to light grey medium weathered chert with minor angular blue grey DOLOMITE.	
0,31			CAVITY			
2,46						
		15			11,0-12,0m No sample return. Drillers report; 1m cavity no drilling resistance air-loss.	
		20			12,0-13,0m Angular dark grey medium weathered chert with angular blue grey unweathered and medium weathered DOLOMITE.	
		25				
		30				
		35				
		40				

1. PROFILED BY GH/DB ON 18 / 10 / 95

2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750 cfm DELIVERING 250 psi TO
A 185mm DIA. BUTTON BIT

3. WATER ENCOUNTERED NIL

4. AIR LOSSES NO SAMPLE RETURN 11-12m

5. AIR CURRENTS NIL

A REPORT TO THE WESTERN SERVICES
COUNCIL ON GEOTECHNICAL IN-
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FIG. NO

PERCUSSION DRILLING REPORT

BOREHOLE NO. AR12
SHEET: 1 OF 1

LOCALITY: KHUTSONG BULK WATER SUPPLY: REVISED RESERVOIR SITE

CO-ORDINATES: X = SEE DRWG.
Y =

COLLAR ELEV: 1578 m AMSL

WATER LEVEL: DRY

CONTRACTOR: BENNETT DRILLING

DATE COMPLETED: OCTOBER 1995

The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated

PENETRATION (MIN, SEC/METRE)	Key Reference	Depth (m)	Geological Column (Diagrammatic)	KEY REFERENCE	Correlation
				— Casing ↔ Air Loss ⏏ Static water level	
0,20				0,0-2,0m Reddish brown SILTY SAND with equal amounts angular and subangular light grey to white highly weathered CHERT, and white unweathered CALCITE & trace angular dark blue grey dolomite; COLLUVIUM.	
1,46					
3,01				2,0-8,0m Angular blue grey medium to unweathered DOLOMITE with angular dark to light grey medium to unweathered CHERT; DOLOMITE RESIDUAL.	
3,16					
3,15		5			
3,11					
3,12					
3,08					
		10			
		15			
		20			
		25			
		30			
		35			
		40			

1. PROFILED BY GH/DB ON 18 / 10 / 95
2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750 cfm DELIVERING 250 psi TO A 185mm DIA. BUTTON BIT
3. WATER ENCOUNTERED NIL
4. AIR LOSSES NIL: FULL SAMPLE RETURN
5. AIR CURRENTS NIL

A REPORT TO THE WESTERN SERVICES COUNCIL ON GEOTECHNICAL INVESTIGATIONS FOR THE KHUTSONG BULK WATER SUPPLY ALIGNMENT & STORAGE SITE

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FIG. NO

BOREHOLE NO. AR13
SHEET: 1 OF 1

LOCALITY: KHUTSONG BULK WATER SUPPLY: REVISED RESERVOIR SITE

CO-ORDINATES: X = *SEE DRAWG.*
Y =

COLLAR ELEV: 1578 m AMSL

WATER LEVEL : DRY

CONTRACTOR: BENNETT DRILLING

DATE COMPLETED: OCTOBER 1995

The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated

[illegible]

1. PROFILED BY GH/DB ON 18 / 10 / 95
2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750 cfm DELIVERING 250 psi TO
A 185mm DIA. BUTTON BIT
3. WATER ENCOUNTERED NIL
4. AIR LOSSES NO SAMPLE RETURN 5-14 m
5. AIR CURRENTS NIL

A REPORT TO THE WESTERN SERVICES
COUNCIL ON GEOTECHNICAL IN-
VESTIGATIONS FOR THE KHUTSONG BULK
WATER SUPPLY ALIGNMENT & STORAGE
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REF NO

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BW

FIG. NO

PERCUSSION DRILLING REPORT				BOREHOLE NO : 009	
				SHEET : 1 OF 2	
LOCALITY : REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-035624 X2917412			GROUNDWATER STRIKE: NIL		
COLLAR ELEVATION: 1525m AMSL			WATER REST LEVEL: NIL		
CONTRACTOR : RUBICON			DATE COMPLETED: 21-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
0.21				0-3m: Reddish brown silty SAND; COLLUVIUM	
0.17					
0.40					
0.36				3-15m: Light pinkish brown and light grey clayey SILT with minor shale fragments; RESIDUAL SHALE	
0.43		5			
0.48					
0.35					
0.32					
0.40					
0.39		10			
0.46					
0.37					
0.34					
0.41					
0.39		15			
0.22				15-33m: Light brown sandy SILT with minor angular translucent blue grey highly weathered chert fragments and shale fragments; INTERLAYERED RESIDUAL SHALE AND CHERT RESIDUUM	
0.18					
0.30					
0.24					
0.23		20			
0.30					
0.31					
0.26					
0.26					
0.24		25			
0.26					
0.27					
0.34					
0.37					
0.33		30			
0.36					
0.39					
0.32					
0.20				33-47m: Brown silty CLAY with minor angular translucent blue grey highly weathered chert fragments, sub-angular brown grey dolomite fragments and traces of black silt (wad); DOLOMITE RESIDUUM	
0.17		35			
0.21					
0.23					
0.28					
0.25					
0.27		40			
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa 2. CASING: NIL 3. AIR AND SAMPLE LOSSES: NIL 4. NO WATER ADDED				PROFILED BY J. MEINTJES ON 02-12-2022	
				GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854	

PERCUSSION DRILLING REPORT				BOREHOLE NO : 009	
				SHEET : 2 OF 2	
LOCALITY : REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-035624 X2917412			GROUNDWATER STRIKE: NIL		
COLLAR ELEVATION: 1525m AMSL			WATER REST LEVEL: NIL		
CONTRACTOR : RUBICON			DATE COMPLETED: 21-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
0.30			/	33-47m: Brown silty CLAY with minor angular translucent blue grey highly weathered chert fragments, subangular brown grey dolomite fragments and traces of black silt (wad); DOLOMITE RESIDUUM	
0.36			/ /		
0.30			/		
0.24			/ /		
0.20		45	/		
0.14			/ /		
0.12			/		
2.07			/ /	47-48m: Subangular brown grey highly weathered soft rock DOLOMITE.	
3.19			/	48-54m: Subangular blue grey unweathered hard rock DOLOMITE.	
3.36		50	/ /		
3.40			/		
3.30			/ /		
3.37			/		
3.42			/ /		
		55		EOH	
		60			
		65			
		70			
		75			
		80			
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa			PROFILED BY J. MEINTJES ON 02-12-2022		
2. CASING: NIL					
3. AIR AND SAMPLE LOSSES: NIL					
4. NO WATER ADDED			GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854		

PERCUSSION DRILLING REPORT			BOREHOLE NO :022	
SHEET : 1 OF 2				
LOCALITY : REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ, CARLETONVILLE				
CO-ORDINATES: 27 Y-035762 X2918004			GROUNDWATER STRIKE: NIL	
COLLAR ELEVATION: 1534m AMSL			WATER REST LEVEL: NIL	
CONTRACTOR : RUBICON			DATE COMPLETED: 22-11-2022	
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated				
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION
0.17				0-2m: Reddish brown silty SAND; COLLUVIUM
0.21				
0.30				2-60m: Light brown sandy SILT with minor angular translucent blue grey highly weathered chert fragments and shale fragments; INTERLAYERED CHERT AND SHALE
0.46				
0.39	5			
0.45				
0.40				
0.41				
0.47				
0.49	10			
0.38				
0.52				
.056				
0.59				
0.48	15			
0.43				
0.47				
0.39				
0.30				
0.36	20			
0.30				
0.41				
0.39				
0.47				
0.46	25			
.042				
0.44				
0.45				
0.39				
0.43	30			
0.34				
0.37				
0.38				
0.41				
0.40	35			
0.35				
0.33				
0.36				
0.39				
0.37	40			
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa 2. CASING: NIL 3. AIR AND SAMPLE LOSSES: NIL 4. NO WATER ADDED			PROFILED BY J. MEINTJES ON 02-12-2022	
			GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854	

PERCUSSION DRILLING REPORT		BOREHOLE NO :022	
		SHEET : 2 OF 2	
LOCALITY : REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ, CARLETONVILLE			
CO-ORDINATES: 27 Y-035762 X2918004		GROUNDWATER STRIKE: NIL	
COLLAR ELEVATION: 1534m AMSL		WATER REST LEVEL: NIL	
CONTRACTOR : RUBICON		DATE COMPLETED: 22-11-2022	
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated			
PENETRATION (MIN.SEC/METRE)	DEPTH (m)		DESCRIPTION
0.46			2-60m: Light brown sandy SILT with minor angular translucent blue grey highly weathered chert fragments and shale fragments; INTERLAYERED CHERT AND SHALE
0.40			
0.41			
0.34			
0.39	45		
0.36			
0.41			
0.38			
0.42			
0.39	50		
0.26			
0.27			
0.24			
0.30			
0.21	55		
0.26			
0.25			
0.33			
0.30			
0.29	60		
	65		
	70		
	75		
	80		
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa		PROFILED BY J. MEINTJES ON 02-12-2022	
2. CASING: NIL			
3. AIR AND SAMPLE LOSSES: NIL			
4. NO WATER ADDED		GEOHAZARD SOLUTIONS	
		Consulting Engineering Geologists	
		Tel. (011) 469 0854	

PERCUSSION DRILLING REPORT				BOREHOLE NO :142	
				SHEET : 1 OF 2	
LOCALITY : REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-036026 X2918888			GROUNDWATER STRIKE: NIL		
COLLAR ELEVATION: 1549m AMSL			WATER REST LEVEL: NIL		
CONTRACTOR : RUBICON			DATE COMPLETED: 23-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
0.21			~~~	0-2m: Reddish brown clayey SAND with minor angular white highly weathered chert gravel; CHERT RESIDUUM	
0.26			~~~		
0.30			~~~	2-58m: Brown clayey SAND with minor angular white and translucent blue grey highly weathered chert fragments; CHERT RESIDUUM	
0.31			~~~		
0.27		5	~~~		
0.39			~~~		
0.32			~~~		
0.33			~~~		
0.35			~~~		
0.30		10	~~~		
0.27			~~~		
0.30			~~~		
0.26			~~~		
0.43			~~~		
0.29		15	~~~		
0.27			~~~		
0.32			~~~		
0.39			~~~		
0.32			~~~		
0.35		20	~~~		
0.40			~~~		
0.36			~~~		
0.27			~~~		
0.41			~~~		
0.46		25	~~~		
0.34			~~~		
0.30			~~~		
0.32			~~~		
0.31			~~~		
0.38		30	~~~		
0.37			~~~		
0.41			~~~		
0.36			~~~		
0.30			~~~		
0.35		35	~~~		
0.44			~~~		
0.34			~~~		
0.42			~~~		
0.43			~~~		
0.37		40	~~~		
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa 2. CASING: NIL 3. AIR AND SAMPLE LOSSES: NIL 4. NO WATER ADDED				PROFILED BY J. MEINTJES ON 02-12-2022	
				GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854	

PERCUSSION DRILLING REPORT				BOREHOLE NO :142 SHEET : 2 OF 2	
LOCALITY : REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-036026 X2918888 COLLAR ELEVATION: 1549m AMSL			GROUNDWATER STRIKE: NIL WATER REST LEVEL: NIL		
CONTRACTOR : RUBICON			DATE COMPLETED: 23-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
0.41			~~~	2-58m: Brown clayey SAND with minor angular white and translucent blue grey highly weathered chert fragments; CHERT RESIDUUM	
0.36			~~~		
0.37			~~~		
0.35			~~~		
0.42		45	~~~		
0.26			~~~		
0.21			~~~		
0.27			~~~		
0.30			~~~		
0.31		50	~~~		
0.26			~~~		
0.28			~~~		
0.45			~~~		
0.32			~~~		
0.29		55	~~~		
0.20			~~~		
0.35			~~~		
0.41			~~~		
0.36			/	58-60m: Subangular brown grey highly weathered soft rock DOLOMITE. EOH	
0.47		60	/ /		
		65			
		70			
		75			
		80			
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa 2. CASING: NIL 3. AIR AND SAMPLE LOSSES: NIL 4. NO WATER ADDED			PROFILED BY J. MEINTJES ON 02-12-2022		
			GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854		

PERCUSSION DRILLING REPORT			BOREHOLE NO : 225 SHEET : 1 OF 1	
LOCALITY : REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ, CARLETONVILLE				
CO-ORDINATES: 27 Y-036838 X2919032 COLLAR ELEVATION: 1555m AMSL			GROUNDWATER STRIKE: NIL WATER REST LEVEL: NIL	
CONTRACTOR : RUBICON			DATE COMPLETED: 24-11-2022	
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated				
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION
0.12			~~~	0-4m: Reddish brown clayey SAND with minor angular white highly weathered chert gravel; CHERT RESIDUUM
0.26			~~~	
0.27			~~~	
0.31			~~~	4-6m: Brown clayey SAND with minor angular white and translucent blue grey highly weathered chert fragments; CHERT RESIDUUM
0.29		5	~~~	
0.27			~~~	
1.27			/	6-7m: Subangular brown grey highly weathered soft rock DOLOMITE.
3.48			/ /	7-13m: Subangular blue grey unweathered hard rock DOLOMITE.
3.40			/	
3.51		10	/ /	
3.01			/	
3.50			/ /	
3.43			/	
				EOH
		15		
		20		
		25		
		30		
		35		
		40		
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa 2. CASING: NIL 3. AIR AND SAMPLE LOSSES: NIL 4. NO WATER ADDED			PROFILED BY J. MEINTJES ON 02-12-2022	
			GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854	

PERCUSSION DRILLING REPORT				BOREHOLE NO : 264	
SHEET : 1 OF 2					
LOCALITY : REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-037187 X2918306			GROUNDWATER STRIKE: NIL		
COLLAR ELEVATION: 1538m AMSL			WATER REST LEVEL: NIL		
CONTRACTOR : RUBICON			DATE COMPLETED: 24-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
0.27				0-2m: Reddish brown silty SAND; COLLUVIUM	
0.20					
0.17				2-60m: Light brown sandy SILT with minor angular translucent blue grey highly weathered chert fragments and shale fragments; INTERLAYERED SHALE AND CHERT	
0.25					
0.54		5			
0.30					
0.38					
0.37					
0.40					
0.35		10			
0.31					
0.46					
0.38					
0.40					
0.41		15			
0.40					
0.31					
0.39					
0.54					
0.43		20			
0.45					
0.41					
0.38					
0.37					
0.39		25			
0.42					
0.47					
0.45					
0.40					
0.36		30			
0.36					
0.41					
0.39					
0.45					
0.42		35			
0.50					
0.47					
0.38					
0.29					
0.30		40			
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa 2. CASING: NIL 3. AIR AND SAMPLE LOSSES: NIL 4. NO WATER ADDED			PROFILED BY J. MEINTJES ON 02-12-2022		
			GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854		

PERCUSSION DRILLING REPORT				BOREHOLE NO : 264	
SHEET : 2 OF 2					
LOCALITY : REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-037187 X2918306			GROUNDWATER STRIKE: NIL		
COLLAR ELEVATION: 1524m AMSL			WATER REST LEVEL: NIL		
CONTRACTOR : RUBICON			DATE COMPLETED: 24-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
0.29				2-60m: Light brown sandy SILT with minor angular translucent blue grey highly weathered chert fragments and shale fragments; INTERLAYERED SHALE AND CHERT	
0.34					
0.36					
0.34					
0.37		45			
0.39					
0.41					
0.42					
0.36					
0.47		50			
0.44					
0.45					
0.35					
0.41					
0.30		55			
0.35					
0.41					
0.40					
0.36					
0.35		60			
		55			
		70			
		75			
		80			
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa			PROFILED BY J. MEINTJES ON 02-12-2022		
2. CASING: NIL					
3. AIR AND SAMPLE LOSSES: NIL					
4. NO WATER ADDED			GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854		

PERCUSSION DRILLING REPORT				BOREHOLE NO : 299 SHEET : 1 OF 1	
LOCALITY : PORTION 5 OF THE FARM VARKENSLAAGTE 19-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-030000 X2922037 COLLAR ELEVATION: 1545m AMSL			GROUNDWATER STRIKE: NIL WATER REST LEVEL: NIL		
CONTRACTOR : RUBICON			DATE COMPLETED: 25-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
0.15			~~~	0-3m: Reddish brown clayey SAND with minor angular white highly weathered chert gravel; CHERT RESIDUUM	
0.31			~~~		
0.46			~~~		
3.29			/	3-9m: Subangular blue grey unweathered hard rock DOLOMITE.	
3.38	5		/ /		
3.40			/		
3.42			/ /		
3.48			/		
3.45			/ /	EOH	
	10				
	15				
	20				
	25				
	30				
	35				
	40				
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa 2. CASING: NIL 3. AIR AND SAMPLE LOSSES: NIL 4. NO WATER ADDED			PROFILED BY J. MEINTJES ON 02-12-2022		
			GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854		

PERCUSSION DRILLING REPORT				BOREHOLE NO : 338	
				SHEET : 1 OF 2	
LOCALITY : PORTION 5 OF THE FARM VARKENSLAAGTE 19-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-029732 X2921494			GROUNDWATER STRIKE: NIL		
COLLAR ELEVATION: 1531m AMSL			WATER REST LEVEL: NIL		
CONTRACTOR : RUBICON			DATE COMPLETED: 24-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
0.11			~~~	0-3m: Reddish brown clayey SAND with minor angular white highly weathered chert gravel; CHERT RESIDUUM	
0.36			~~~		
0.27					
0.34		5		3-60m: Light brown sandy SILT with minor angular translucent blue grey highly weathered chert fragments and shale fragments; INTERLAYERED SHALE AND CHERT	
0.30					
0.36					
0.31					
0.33					
0.58					
0.39		10			
0.40					
0.41					
0.34					
0.32					
0.38		15			
0.35					
0.41					
0.34					
0.29					
0.30		20			
0.27					
0.36					
0.39					
0.40					
0.42		25			
0.44					
0.41					
0.35					
0.37					
0.32		30			
0.32					
0.33					
0.28					
0.25					
0.39		35			
0.35					
0.30					
0.31					
0.31					
0.37		40			
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa 2. CASING: NIL 3. AIR AND SAMPLE LOSSES: NIL 4. NO WATER ADDED				PROFILED BY J. MEINTJES ON 02-12-2022	
				GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854	

PERCUSSION DRILLING REPORT		BOREHOLE NO : 338	
		SHEET : 2 OF 2	
LOCALITY : PORTION 5 OF THE FARM VARKENSLAAGTE 19-IQ, CARLETONVILLE			
CO-ORDINATES: 27 Y-029732 X2921494		GROUNDWATER STRIKE: NIL	
COLLAR ELEVATION: 1531m AMSL		WATER REST LEVEL: NIL	
CONTRACTOR : RUBICON		DATE COMPLETED: 24-11-2022	
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated			
PENETRATION (MIN.SEC/METRE)	DEPTH (m)		DESCRIPTION
0.35			3-60m: Light brown sandy SILT with minor angular translucent blue grey highly weathered chert fragments and shale fragments; INTERLAYERED SHALE AND CHERT
0.33			
0.58			
0.40			
0.35	45		
0.32			
0.47			
0.50			
0.51			
0.56	50		
0.48			
0.43			
0.44			
0.41			
0.48	55		
0.49			
0.52			
0.47			
0.50			
0.53	60		
	65		
	70		
	75		
	80		
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa		PROFILED BY J. MEINTJES ON 02-12-2022	
2. CASING: NIL			
3. AIR AND SAMPLE LOSSES: NIL			
4. NO WATER ADDED		GEOHAZARD SOLUTIONS	
		Consulting Engineering Geologists	
		Tel. (011) 469 0854	

PERCUSSION DRILLING REPORT			BOREHOLE NO :364 SHEET : 1 OF 1	
LOCALITY : PORTION 5 OF THE FARM VARKENSLAAGTE 19-IQ, CARLETONVILLE				
CO-ORDINATES: 27 Y-030134 X2923150 COLLAR ELEVATION: 1551m AMSL			GROUNDWATER STRIKE: NIL WATER REST LEVEL: NIL	
CONTRACTOR : RUBICON			DATE COMPLETED: 25-11-2022	
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated				
PENETRATION (MIN.SEC/METRE)	DEPTH (m)		DESCRIPTION	
0.14		~~~	0-3m: Reddish brown clayey SAND with minor angular white highly weathered chert gravel; CHERT RESIDUUM	
0.21		~~~		
0.27		~~~		
0.29	5	~~~	3-7m: Brown clayey SAND with minor angular white and translucent blue grey highly weathered chert fragments; CHERT RESIDUUM	
0.21		~~~		
0.36		~~~		
0.31		~~~		
3.40	10	/	7-13m: Subangular blue grey unweathered hard rock DOLOMITE. EOH	
3.47		/ /		
3.44		/		
3.39		/ /		
3.42		/		
3.50		/ /		
	15			
	20			
	25			
	30			
	35			
	40			
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa 2. CASING: NIL 3. AIR AND SAMPLE LOSSES: NIL 4. NO WATER ADDED			PROFILED BY J. MEINTJES ON 02-12-2022 GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854	

PERCUSSION DRILLING REPORT			BOREHOLE NO : 379B	
			SHEET : 1 OF 1	
LOCALITY : PORTION 5 OF THE FARM VARKENSLAAGTE 19-IQ, CARLETONVILLE				
CO-ORDINATES: 27 Y-029952 X2922748			GROUNDWATER STRIKE: NIL	
COLLAR ELEVATION: 1540m AMSL			WATER REST LEVEL: NIL	
CONTRACTOR : RUBICON			DATE COMPLETED: 25-11-2022	
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated				
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION
0.12			~~~	0-3m: Reddish brown clayey SAND with minor angular white highly weathered chert gravel; CHERT RESIDUUM
0.19			~~~	
0.20			~~~	
0.36			~~~	3-27m: Angular white to translucent blue grey highly weathered CHERT fragments with minor silty sand; CHERT RESIDUUM
0.38		5	~~~	
0.32			~~~	
0.30			~~~	
0.34			~~~	
0.38			~~~	
0.33		10	~~~	
0.55			~~~	
0.41			~~~	
0.40			~~~	
0.37			~~~	
0.32		15	~~~	
0.39			~~~	
0.47			~~~	
0.32			~~~	
0.36			~~~	
0.40		20	~~~	
0.31			~~~	
0.37			~~~	
0.34			~~~	
0.39			~~~	
0.41		25	~~~	
0.40			~~~	
0.36			~~~	
0.37			~~~	
0.31			~~~	
0.27		30	~~~	
3.46			~~~	NO SAMPLE RETURN; INTERPRETED AS HARD ROCK
		35		
		40		
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa 2. CASING: NIL 3. AIR AND SAMPLE LOSSES: NO SAMPLE RETURN FROM 28m 4. NO WATER ADDED			PROFILED BY J. MEINTJES ON 02-12-2022	
			GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854	

PERCUSSION DRILLING REPORT				BOREHOLE NO :512	
				SHEET : 1 OF 1	
LOCALITY : REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-035651 X2919310			GROUNDWATER STRIKE: NIL		
COLLAR ELEVATION: 1556m AMSL			WATER REST LEVEL: NIL		
CONTRACTOR : RUBICON			DATE COMPLETED: 23-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
0.17			~~~	0-2m: Reddish brown clayey SAND with minor angular white highly weathered chert gravel; CHERT RESIDUUM	
0.22			~~~		
0.34			~~~	2-6m: Brown clayey SAND with minor angular white and translucent blue grey highly weathered chert fragments; CHERT RESIDUUM	
0.36			~~~		
0.30		5	~~~		
0.31			~~~		
0.21			/	6-14m: Brown silty CLAY with minor angular translucent blue grey highly weathered chert fragments, subangular brown grey dolomite fragments and traces of black silt(wad); DOLOMITE RESIDUUM	
0.26			/ /		
0.19			/		
0.21		10	/ /		
0.22			/		
0.36			/ /		
0.21			/		
0.25			/ /		
2.07		15	/	14-15m: Subangular brown grey highly weathered soft rock DOLOMITE.	
3.29			/ /	15-21m: Subangular blue grey unweathered hard rock DOLOMITE.	
3.07			/		
3.57			/ /		
3.36			/		
3.44		20	/ /		
3.41			/		
		25			
		30			
		35			
		40			
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa 2. CASING: NIL 3. AIR AND SAMPLE LOSSES: NIL 4. NO WATER ADDED				PROFILED BY J. MEINTJES ON 02-12-2022	
				GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854	

PERCUSSION DRILLING REPORT				BOREHOLE NO :524	
SHEET : 1 OF 2					
LOCALITY : REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-035507 X2918626			GROUNDWATER STRIKE: NIL		
COLLAR ELEVATION: 1542m AMSL			WATER REST LEVEL:21m		
CONTRACTOR : RUBICON			DATE COMPLETED: 22-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
.017				0-3m: Reddish brown silty SAND; COLLUVIUM	
0.23					
0.20					
0.36				3-60m: Light pinkish brown and light grey clayey SILT with minor shale fragments; KAROO AGE SHALE	
0.40		5			
0.43					
0.41					
0.30					
0.44					
0.39		10			
0.46					
0.50					
0.24					
0.37					
0.41		15			
0.44					
0.40					
0.46					
0.38					
0.43		20			
0.35					
0.46					
0.41					
0.43					
0.43		25			
0.40					
0.37					
0.35					
0.42					
0.35		30			
0.37					
0.34					
0.41					
0.40					
0.36		35			
0.39					
0.45					
0.37					
0.46					
0.48		40			
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa 2. CASING: NIL 3. AIR AND SAMPLE LOSSES: NIL 4. NO WATER ADDED			PROFILED BY J. MEINTJES ON 02-12-2022		
			GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854		

PERCUSSION DRILLING REPORT				BOREHOLE NO :524	
SHEET : 2 OF 2					
LOCALITY : REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-035507 X2918626			GROUNDWATER STRIKE: NIL		
COLLAR ELEVATION: 1542m AMSL			WATER REST LEVEL: 21m		
CONTRACTOR : RUBICON			DATE COMPLETED: 22-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
0.46				3-60m: Light pinkish brown and light grey clayey SILT with minor shale fragments; KAROO AGE SHALE	
0.48					
0.46					
0.41					
0.37		45			
0.41					
0.36					
0.49					
0.42					
0.45		50			
0.41					
0.35					
0.36					
0.41					
0.39		55			
0.42					
0.44					
0.49					
0.45					
0.42		60			
		65			
		70			
		75			
		80			
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa			PROFILED BY J. MEINTJES ON 02-12-2022		
2. CASING: NIL					
3. AIR AND SAMPLE LOSSES: NIL					
4. NO WATER ADDED			GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854		

PERCUSSION DRILLING REPORT				BOREHOLE NO :615	
				SHEET : 1 OF 1	
LOCALITY : REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-034964 X2919564			GROUNDWATER STRIKE: NIL		
COLLAR ELEVATION: 1569m AMSL			WATER REST LEVEL: NIL		
CONTRACTOR : RUBICON			DATE COMPLETED: 23-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
0.21			~~~	0-6m: Reddish brown clayey SAND with minor angular white highly weathered chert gravel; CHERT RESIDUUM	
0.17			~~~		
0.38			~~~		
0.27			~~~		
0.30		5	~~~		
0.36			~~~		
0.24			~~~	6-8m: Brown clayey SAND with minor angular white and translucent blue grey highly weathered chert fragments; CHERT RESIDUUM	
0.20			~~~		
0.21			/	8-15m: Brown silty CLAY with minor angular translucent blue grey highly weathered chert fragments, subangular brown grey dolomite fragments and traces of black silt(wad); DOLOMITE RESIDUUM	
0.30		10	/ /		
0.21			/		
0.53			/ /		
0.30			/		
0.31			/ /		
0.36		15	/		
1.57				15-16m: Subangular brown grey highly weathered soft rock DOLOMITE.	
3.04				16-17m: Subangular blue grey unweathered hard rock DOLOMITE EOH	
		20			
		25			
		30			
		35			
		40			
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa			PROFILED BY J. MEINTJES ON 02-12-2022		
2. CASING: NIL			GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854		
3. AIR AND SAMPLE LOSSES: NIL					
4. NO WATER ADDED					

PERCUSSION DRILLING REPORT				BOREHOLE NO : 759B	
LOCALITY : REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-037783 X2918655			GROUNDWATER STRIKE: NIL		
COLLAR ELEVATION: 1542m AMSL			WATER REST LEVEL: NIL		
CONTRACTOR : RUBICON			DATE COMPLETED: 24-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
0.24				0-5m: Reddish brown silty SAND; COLLUVIUM	
0.36					
0.41					
0.43					
0.27		5			
0.39				5-60m: Light pinkish brown and light grey clayey SILT with minor shale fragments; KAROO AGE SHALE	
0.40					
0.43					
0.44					
0.38		10			
0.47					
0.50					
0.38					
0.45					
0.39		15			
0.32					
0.33					
0.47					
0.40					
0.36		20			
0.35					
0.38					
0.41					
0.45					
0.46		25			
0.41					
0.43					
0.35					
0.37					
0.34		30			
0.41					
0.32					
0.33					
0.45					
0.39		35			
0.30					
0.44					
0.36					
0.42					
0.47		40			
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa			PROFILED BY J. MEINTJES ON 02-12-2022		
2. CASING: NIL					
3. AIR AND SAMPLE LOSSES: NIL					
4. NO WATER ADDED			GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854		

PERCUSSION DRILLING REPORT		BOREHOLE NO : 759B SHEET : 2 OF 2	
LOCALITY : REMAINDER OF THE FARM TWYFELVLAKTE 105-IQ, CARLETONVILLE			
CO-ORDINATES: 27 Y-037783 X2918655		GROUNDWATER STRIKE: NIL	
COLLAR ELEVATION: 1542m AMSL		WATER REST LEVEL: NIL	
CONTRACTOR : RUBICON		DATE COMPLETED: 24-11-2022	
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated			
PENETRATION (MIN.SEC/METRE)	DEPTH (m)		DESCRIPTION
0.38			5-60m: Light pinkish brown and light grey clayey SILT with minor shale fragments; KAROO AGE SHALE
0.35			
0.41			
0.40			
0.35	45		
0.46			
0.37			
0.39			
0.35			
0.47	50		
0.52			
0.35			
0.48			
0.50			
0.40	55		
0.47			
0.36			
0.34			
0.41			
0.48	60		
	65		
	70		
	75		
	80		
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa		PROFILED BY J. MEINTJES ON 02-12-2022	
2. CASING: NIL			
3. AIR AND SAMPLE LOSSES: NIL			
4. NO WATER ADDED		GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854	

PERCUSSION DRILLING REPORT				BOREHOLE NO : 822	
SHEET : 1 OF 2					
LOCALITY : PORTION 5 OF THE FARM VARKENSLAAGTE 19-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-030153 X2921157			GROUNDWATER STRIKE: NIL		
COLLAR ELEVATION: 1540m AMSL			WATER REST LEVEL: NIL		
CONTRACTOR : RUBICON			DATE COMPLETED: 24-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
0.17			~~~	0-3m: Reddish brown clayey SAND with minor angular white highly weathered chert gravel; CHERT RESIDUUM	
0.27			~~~		
0.32			~~~		
0.34			~~~	3-60m: Angular white to translucent blue grey highly weathered CHERT fragments with minor silty sand; CHERT RESIDUUM	
0.50		5	~~~		
0.46			~~~		
0.49			~~~		
0.52			~~~		
0.39			~~~		
0.27		10	~~~		
0.36			~~~		
0.30			~~~		
0.40			~~~		
0.51			~~~		
0.48		15	~~~		
0.29			~~~		
0.36			~~~		
0.37			~~~		
0.31			~~~		
0.24		20	~~~		
0.51			~~~		
0.30			~~~		
0.40			~~~		
0.34			~~~		
0.35		25	~~~		
0.37			~~~		
0.56			~~~		
0.30			~~~		
0.27			~~~		
0.31		30	~~~		
0.31			~~~		
0.36			~~~		
0.41			~~~		
0.39			~~~		
0.37		35	~~~		
0.34			~~~		
0.33			~~~		
0.36			~~~		
0.42			~~~		
0.44		40	~~~		
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa 2. CASING: NIL 3. AIR AND SAMPLE LOSSES: NIL 4. NO WATER ADDED				PROFILED BY J. MEINTJES ON 02-12-2022	
				GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854	

PERCUSSION DRILLING REPORT				BOREHOLE NO : 822	
SHEET : 2 OF 2					
LOCALITY : PORTION 5 OF THE FARM VARKENSLAAGTE 19-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-030153 X2921157			GROUNDWATER STRIKE: NIL		
COLLAR ELEVATION: 1540m AMSL			WATER REST LEVEL: NIL		
CONTRACTOR : RUBICON			DATE COMPLETED: 24-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
0.46			~~~	3-60m: Angular white to translucent blue grey highly weathered CHERT fragments with minor silty sand; CHERT RESIDUUM	
0.50			~~~		
0.37			~~~		
0.39			~~~		
0.35		45	~~~		
0.58			~~~		
0.40			~~~		
0.41			~~~		
0.46			~~~		
0.32		50	~~~		
0.34			~~~		
0.35			~~~		
0.39			~~~		
0.36			~~~		
0.43		55	~~~		
0.41			~~~		
0.40			~~~		
0.39			~~~		
0.32			~~~		
0.40		60	~~~		
			EOH		
		65			
		70			
		75			
		80			
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa			PROFILED BY J. MEINTJES ON 02-12-2022		
2. CASING: NIL					
3. AIR AND SAMPLE LOSSES: NIL					
4. NO WATER ADDED			GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854		

PERCUSSION DRILLING REPORT			BOREHOLE NO : 843B	
SHEET : 1 OF 1				
LOCALITY : PORTION 5 OF THE FARM VARKENSLAAGTE 19-IQ, CARLETONVILLE				
CO-ORDINATES: 27 Y-030350 X2922137			GROUNDWATER STRIKE: NIL	
COLLAR ELEVATION: 1543m AMSL			WATER REST LEVEL: NIL	
CONTRACTOR : RUBICON			DATE COMPLETED: 25-11-2022	
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated				
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION
0.17			~~~	0-3m: Reddish brown clayey SAND with minor angular white highly weathered chert gravel; CHERT RESIDUUM
0.12			~~~	
0.16			~~~	
0.15			~~~	3-18m: Angular white to translucent blue grey highly weathered CHERT fragments with minor silty sand; CHERT RESIDUUM
0.37		5	~~~	
0.41			~~~	
0.37			~~~	
0.51			~~~	
0.40			~~~	
0.48		10	~~~	
0.35			~~~	
0.33			~~~	
0.36			~~~	
0.39			~~~	
0.39		15	~~~	
0.40			~~~	
0.31			~~~	
0.36			~~~	
1.27			/	18-19m: Subangular brown grey highly weathered soft rock DOLOMITE.
3.41		20	/ /	19-25m: Subangular blue grey unweathered hard rock DOLOMITE
3.46			/	
3.38			/ /	
3.50			/	
3.29			/ /	
3.41		25	/	
				EOH
		30		
		35		
		40		
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa			PROFILED BY J. MEINTJES ON 02-12-2022	
2. CASING: NIL				
3. AIR AND SAMPLE LOSSES: NIL				
4. NO WATER ADDED			GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854	

PERCUSSION DRILLING REPORT				BOREHOLE NO :861B	
				SHEET : 1 OF 1	
LOCALITY : PORTION 5 OF THE FARM VARKENSLAAGTE 19-IQ, CARLETONVILLE					
CO-ORDINATES: 27 Y-030622 X2923123			GROUNDWATER STRIKE: NIL		
COLLAR ELEVATION: 1571m AMSL			WATER REST LEVEL: NIL		
CONTRACTOR : RUBICON			DATE COMPLETED: 25-11-2022		
The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated					
PENETRATION (MIN.SEC/METRE)		DEPTH (m)		DESCRIPTION	
0.11			~~~	0-1m: Reddish brown clayey SAND with minor angular white highly weathered chert gravel; CHERT RESIDUUM	
0.37			~~~		
0.41			~~~	1-20m: Brown clayey SAND with minor angular white and translucent blue grey highly weathered chert fragments; CHERT RESIDUUM	
0.32			~~~		
0.39		5	~~~		
0.41			~~~		
0.39			~~~		
0.48			~~~		
0.33			~~~		
0.35		10	~~~		
0.36			~~~		
0.39			~~~		
0.40			~~~		
0.39			~~~		
0.34		15	~~~		
0.42			~~~		
0.36			~~~		
0.20			~~~		
0.25			~~~		
0.23		20	~~~		
0.30			/	20-24m: Brown silty CLAY with minor angular translucent blue grey highly weathered chert fragments, subangular brown grey dolomite fragments and traces of black silt(wad); DOLOMITE RESIDUUM	
0.25			/ /		
0.27			/		
0.21			/ /	24-30m: Subangular blue grey unweathered hard rock DOLOMITE.	
3.43		25	/		
3.40			/ /		
3.36			/		
3.39			/ /		
3.42			/		
3.41		30	/ /		
				EOH	
		35			
		40			
1. COMPRESSOR DELIVERY: 27m3/min (950cfm) at 1800kPa			PROFILED BY J. MEINTJES ON 02-12-2022		
2. CASING: NIL					
3. AIR AND SAMPLE LOSSES: NIL					
4. NO WATER ADDED			GEOHAZARD SOLUTIONS Consulting Engineering Geologists Tel. (011) 469 0854		

PERCUSSION DRILLING REPORT

BOREHOLE NO. 6
SHEET: 1 OF 1

LOCALITY: KHUTSONG BULK WATER SUPPLY

CO-ORDINATES: X =
Y =

COLLAR ELEV: 1564 m AMSL

WATER LEVEL: DRY

CONTRACTOR: BENNETT DRILLING

DATE COMPLETED: AUGUST 1995

The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated

PENETRATION (MIN, SEC/METRE)	Key Reference	Depth(m)	Geological Column (Diagrammatic)	KEY REFERENCE	DESCRIPTION	Correlation
				— Casing ↔ Air Loss ▽ Static water level		
0,41					0,0-3,0m Reddish brown SILTY SAND with minor white highly weathered chert; COLLUVIUM.	
1,03						
1,17						
1,08						
2,25						
1,04		5			3,0-15,0m Reddish brown SILTY SAND with equal amounts angular dark grey medium weathered chert; CHERT RESIDUUM.	
1,39						
1,08						
1,19						
1,11		10			15,0-19,0m Black CLAYEY SILT (wad) with minor angular dark grey medium weathered chert; DOLOMITE RESIDUUM.	
1,40						
1,17						
1,13						
1,36						
1,00		15				
1,12						
1,02						
1,08						
AIR						
LOSSES		20				
NO						
SAMPLE						
RETURN						
		25			Driller reports air loss below ± 18m with no sample return.	
					Hole stopped at 30m.	
		30				
		35				
		40				

1. PROFILED BY GH/DB ON 7 / 8 / 95
2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750 cfm DELIVERING 250 psi TO
A 185mm DIA. BUTTON BIT
3. WATER ENCOUNTERED NIL
4. AIR LOSSES BELOW ± 20m
5. AIR CURRENTS NONE IN HOLE AFTER DRILLING

A REPORT TO THE WESTERN SERVICES
COUNCIL ON GEOTECHNICAL IN-
VESTIGATIONS FOR THE KHUTSONG BULK
WATER SUPPLY ALIGNMENT & STORAGE
SITE

REF NO
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Rivonia (011) 803 - 1105

FIG. NO

PERCUSSION DRILLING REPORT

BOREHOLE NO. 5
SHEET: 1 OF 1

LOCALITY: KHUTSONG BULK WATER SUPPLY

CO-ORDINATES: X =
Y =

COLLAR ELEV: 1528,3 m AMSL

WATER LEVEL: DRY

CONTRACTOR: BENNETT DRILLING

DATE COMPLETED: AUGUST 1995

The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated

PENETRATION (MIN, SEC/METRE)	Key Reference	Depth(m)	Geological Column (Diagrammatic)	KEY	Correlation
				REFERENCE	
				— Casing ↔ Air Loss ⌵ Static water level	
				DESCRIPTION	
0,36				0,0-4,0m Reddish brown, SILTY SAND with abundant angular chert gravels & ferricrete nodules; partially ferruginised COLLUVIUM.	
1,02		5			
0,59				4,0-30,0m White, purple, yellowey brown, CLAYEY SILT & SILTY CLAY with minor amounts light grey, angular, medium weathered chert, KAROO DEQUENCE ROCKS.	
0,47					
1,03					
1,22					
1,11					
0,55					
1,00					
0,59		10			
0,56					
0,52					
0,57					
0,55					
0,53		15			
1,26					
1,19					
1,11					
1,04					
1,29		20			
1,26					
1,39					
1,01					
0,50					
1,05		25			
1,31					
1,29					
1,39					
1,26		30			
1,45					
				Hole stopped at 30m in above.	
		35			
		40			

1. PROFILED BY GH/DB ON 7 / 8 / 95
2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750 cfm DELIVERING 250 psi TO A 185mm DIA. BUTTON BIT
3. WATER ENCOUNTERED NIL
4. AIR LOSSES NIL: FULL SAMPLE RETURN
5. AIR CURRENTS NONE IN HOLE AFTER DRILLING

A REPORT TO THE WESTERN SERVICES COUNCIL ON GEOTECHNICAL INVESTIGATIONS FOR THE KHUTSONG BULK WATER SUPPLY ALIGNMENT & STORAGE SITE

REF NO
IR
111
BW

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Rivonia (011) 803 - 1105

FIG. NO

PERCUSSION DRILLING REPORT

BOREHOLE NO. 4
SHEET: 1 OF 2

LOCALITY: KHUTSONG BULK WATER SUPPLY

CO-ORDINATES: X =
Y =

COLLAR ELEV: 1519,8 m AMSL
WATER LEVEL: DRY

CONTRACTOR: BENNETT DRILLING

DATE COMPLETED: AUGUST 1995

The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated

PENETRATION (MIN, SEC/METRE)	Key Reference	Depth (m)	Geological Column (Diagrammatic)	KEY REFERENCE	DESCRIPTION	Correlation
				 Casing  Air Loss  Static water level		
0,53					0,0-3,0m Reddish brown SILTY SAND with trace amounts gravels of mixed origin; COLLUVIUM.	
1,57						
2,33						
2,58						
3,02		5			3,0-10,0m Yellowey brown SILTY SAND with minor amounts of subrounded gravels & ferricrete nodules; ferruginised COLLUVIUM.	
3,10						
3,21						
0,55						
0,42						
1,16		10			10,0-24,0m White light pink, yellowey brown & orange CLAYEY & SANDY SILT with equal to minor amounts of light grey angular medium weathered chert; KAROO SEQUENCE ROCKS.	
1,48						
2,51						
3,04						
3,11						
3,27		15				
2,44						
2,55						
2,43						
2,36						
3,42		20			24,0-43,0m Greyish brown, & yellowish brown SILTY SAND with abundant to equal amounts angular dark grey medium weathered chert; CHERT RESIDUUM.	
3,57						
3,29						
3,32						
2,47						
1,01		25				
1,23						
1,37						
1,54						
1,21						
1,38		30				
1,42						
1,30						
1,41						
1,56						
2,94		35				
2,51						
4,13						
1,09						
1,54						
1,46		40				

1. PROFILED BY GH/DB ON 7 / 8 / 95
2. COMPRESSOR DELIVERY & PRESSURE BIT TYPE
750 cfm DELIVERING 250 psi TO
A 185mm DIA. BUTTON BIT
3. WATER ENCOUNTERED NIL
4. AIR LOSSES NIL: FULL SAMPLE RETURN
5. AIR CURRENTS NONE IN HOLE AFTER DRILLING

A REPORT TO THE WESTERN SERVICES
COUNCIL ON GEOTECHNICAL IN-
VESTIGATIONS FOR THE KHUTSONG BULK
WATER SUPPLY ALIGNMENT & STORAGE
SITE

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REF NO
IR
111
BW

FIG. NO

BOREHOLE NO. 4
SHEET: 2 OF 2

LOCALITY: KHUTSONG BULK WATER SUPPLY

CO-ORDINATES: X =
Y =

COLLAR ELEV: 1519,8 m AMSL

WATER LEVEL : DRY

CONTRACTOR: BENNETT DRILLING

DATE COMPLETED: AUGUST 1995

The 'Geological Column' is diagrammatic and is not intended nor implied to represent the precise geological strata at the depths indicated

[illegible]

PERCUSSION DRILLING REPORT			BOREHOLE NO : 1800		
			SHEET : 1 OF 2		
LOCALITY : KHUTSONG BULK WATER SUPPLY					
CO-ORDINATES		COLLAR ELEV : 1516mAMSL			
: X = +2917968 Y = -034273		OWL : 1424mAMSL			
WGS84, Lo27°E					
CONTRACTOR : RUBICON BORE					
DATE COMPLETED : 12.07.12					
The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.					
PENETRATION (MIN,SEC/METRE)				KEY REFERENCE	Casing Air Loss Static water level
				DESCRIPTION	
1.16				0-6m: Reddish brown mottled black and orange SANDY CLAYEY SILT with traces of angular and sub-angular white and black highly weathered CHERT; FERRUGINISED KAROO.	
1.29					
1.34					
1.51					
1.28		5			
1.32				6-34m: Reddish brown SANDY CLAYEY SILT with traces of angular grey white and translucent highly weathered CHERT; KAROO.	
1.54					
1.37					
1.29					
1.21		10			
1.08					
1.53					
2.10					
1.36					
1.52		15			
1.33					
1.21					
1.07					
1.18					
1.29		20			
1.21					
1.37					
1.16					
1.24					
1.31		25			
1.42					
1.39					
1.56					
1.22					
1.31		30			
1.44					
1.20					
1.21					
1.06					
0.48		35		34-48m: Reddish brown blotched orange SANDY CLAYEY SILT with minor angular white and grey highly weathered CHERT; KAROO.	
0.41					
0.42					
0.37					
0.44					
0.38		40			
PROFILED BY BB ON 12.07.12 1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE 1800kPa delivering 25,4m³/min to a 165mm button bit 2. OWL : 92m 3. AIR LOSSES : Nil				KHUTSONG BULK WATER SUPPLY Intraconsult Consulting Engineering Geologists Tel : (011) 469-0854	
				REF NO. IR1105	
				FIG NO.	

PERCUSSION DRILLING REPORT			BOREHOLE NO : 1800		
LOCALITY : KHUTSONG BULK WATER SUPPLY					
CO-ORDINATES : X = +2917968			COLLAR ELEV : 1516mAMSL		
Y = -034273			WATER REST LEVEL : 1424mAMSL		
WGS84, Lo27°E					
CONTRACTOR : RUBICON BORE					
DATE COMPLETED : 12.07.12					
The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.					
PENETRATION (MIN,SEC/METRE)				KEY REFERENCE	Casing Air Loss Static water level
				DESCRIPTION	
0.41				34-48m: Reddish brown blotched orange SANDY CLAYEY SILT with minor angular white and grey highly weathered CHERT; KAROO.	
0.49					
1.00					
1.10					
1.03	45				
1.17					
1.31				48-55m: Reddish orange SANDY CLAYEY SILT with minor to traces of angular grey and translucent medium weathered CHERT; KAROO.	
1.22					
1.04					
1.16	50				
1.18					
1.22					
1.09				55-63m: Angular black and grey medium weathered CHERT and abundant black CLAYEY SILT WAD; CHERT AND DOLOMITE RESIDUUM.	
1.20					
1.14	55				
1.11					
0.54					
0.42					
1.38				63-69m: Angular blue grey unweathered HARD ROCK DOLOMITE.	
0.56	60				
0.48					
1.06					
2.02					
3.41					
4.26					
4.04	65				
3.58					
3.53					
4.11					
	70				
	75				
	80				
PROFILED BY BB ON 1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE 1800kPa delivering 25,4m³/min to a 165mm button bit 2. OWL : 92m 3. AIR LOSSES : Nil				KHUTSONG BULK WATER SUPPLY Intraconsult Consulting Engineering Geologists Tel : (011) 469-0854	
				REF NO. IR1105	
				FIG NO.	

PERCUSSION DRILLING REPORT			BOREHOLE NO : 2300 SHEET : 1 OF 2		
LOCALITY : KHUTSONG BULK WATER SUPPLY					
CO-ORDINATES : X = +2918475 Y = -034309		COLLAR ELEV : 1524mAMS OWL : 1424mAMS			
WGS84, Lo27°E					
CONTRACTOR : RUBICON BORE					
DATE COMPLETED : 12.07.12					
The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.					
PENETRATION (MIN,SEC/METRE)				KEY REFERENCE	Casing Air Loss Static water level
				DESCRIPTION	
1.43				0-4m: Reddish brown mottled black CLAYEY SILT and ferruginised concretions; FERRUGINISED KAROO.	
1.50					
1.26					
1.21					
1.34		5		4-8m: Reddish brown blotched orange CLAYEY SILT with traces of sub-angular white highly weathered CHERT; KAROO.	
1.19					
1.04					
0.36					
0.31				8-29m: Grey blotched orange CLAYEY SILT with minor light grey completely weathered very soft ROCK SHALE; KAROO.	
0.34		10			
0.28					
0.30					
0.31					
0.26					
0.24		15			
0.27					
0.25					
0.24					
0.30					
0.31		20			
0.34					
0.33					
0.26					
0.29					
0.29		25			
0.28					
0.25					
0.30					
0.38					
0.26		30		29-31m: Dusky red CLAYEY SILTY SAND; KAROO.	
0.30				31-42m: Yellowish orange CLAYEY SILT with traces of angular grey and white highly weathered CHERT; KAROO.	
0.35					
0.31					
0.36					
0.33		35			
0.28					
0.29					
0.31					
0.33					
0.28		40			
PROFILED BY BB ON 12.07.12 1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE 1800kPa delivering 25,4m³/min to a 165mm button bit 2. OWL : 100m 3. AIR LOSSES : Nil				KHUTSONG BULK WATER SUPPLY Intraconsult Consulting Engineering Geologists Tel : (011) 469-0854	
				REF NO. IR1105	
				FIG NO.	

PERCUSSION DRILLING REPORT			BOREHOLE NO : 2300	
SHEET : 2 OF 2				
LOCALITY : KHUTSONG BULK WATER SUPPLY				
CO-ORDINATES : X = +2918475		COLLAR ELEV : 1524mAMSL		
Y = -034309		WATER REST LEVEL : 1424mAMSL		
WGS84, Lo27°E				
CONTRACTOR : RUBICON BORE				
DATE COMPLETED : 12.07.12				
The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.				
PENETRATION (MIN,SEC/METRE)			KEY REFERENCE	Casing Air Loss Static water level
			DESCRIPTION	
0.29			31-42m: Yellowish orange CLAYEY SILT with traces of angular grey and white highly weathered CHERT; KAROO.	
0.25				
0.24			42-60m: Angular dark grey, black, translucent and white medium and highly weathered CHERT with minor dark grey brown SILTY SAND; CHERT RESIDUUM.	
0.27				
0.31	45			
0.38				
0.26				
0.38				
0.26				
0.29	50			
0.25				
0.24				
0.31				
0.38				
0.30	55			
0.36				
0.25				
0.29				
0.24				
0.26	60			
	65			
	70			
	75			
	80			
PROFILED BY BB ON 12.07.12 1. COMPRESSOR DELIVERY & PRESSURE BIT TYPE 1800kPa delivering 25,4m³/min to a 165mm button bit 2. OWL : 100m 3. AIR LOSSES : Nil			KHUTSONG BULK WATER SUPPLY Intraconsult Consulting Engineering Geologists Tel : (011) 469-0854	
			REF NO. IR1105	
			FIG NO.	

PERCUSSION DRILLING REPORT			BOREHOLE NO : 1293-03 SHEET : 1 OF 2		
LOCALITY: KHUTSONG SOUTH					
CO-ORDINATES : X = 2917121 Y = -035422			COLLAR ELEV : 1520m AMSL WATER REST LEVEL : DRY		
CONTRACTOR :			RUBICON		
DATE COMPLETED:			31-05-2022		
The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.					
PENETRATION (MIN,SEC/METRE)		DEPTH (m)			
				DESCRIPTION	
0-17				0-1m: light brown silty SAND with minor nodular ferricrete; COLLUVIUM 1-17m: Reddish brown clayey SAND with minor subrounded white and translucent blue grey highly weathered chert gravel; TRANSPORTED MATERIAL	
0-14					
0-16					
0-30					
1-26		5			
1-11					
1-21					
1-31					
1-25					
1-27		10			
1-38					
1-18					
1-25					
1-23					
1-20		15			
1-33					
0-56					
0-41			~~~	17-43m: Brown clayey SAND with minor angular translucent blue grey CHERT fragments; CHERT RESIDUUM.	
0-48			~~~		
0-45		20	~~~		
0-50			~~~		
0-47			~~~		
0-53			~~~		
0-51			~~~		
0-44		25	~~~		
0-43			~~~		
0-41			~~~		
0-38			~~~		
0-35			~~~		
0-56		30	~~~		
0-50			~~~		
0-51			~~~		
0-39			~~~		
0-46			~~~		
0-28		35	~~~		
0-23			~~~		
1-26			~~~		
0-34			~~~		
1-21			~~~		
1-34		40	~~~		
			~~~		
PROFILED BY J. MEINTJES ON 02-06-2022 1. COMPRESSOR DELIVERY & PRESSURE, BIT TYPE/SIZE 27m3/min (950cfm) at 1800kPa/BUTTON/ 216mm 2. WATER ENCOUNTERED: NIL 3. AIR LOSSES: NIL 1-34				KHUTSONG SOUTH AUXILIARY BULK PIPELINE GEOHAZARD SOLUTIONS Consulting Engineering Geologists & Engineers Tel. (011) 469 0854	REF NO. GHS1293 FIG NO.

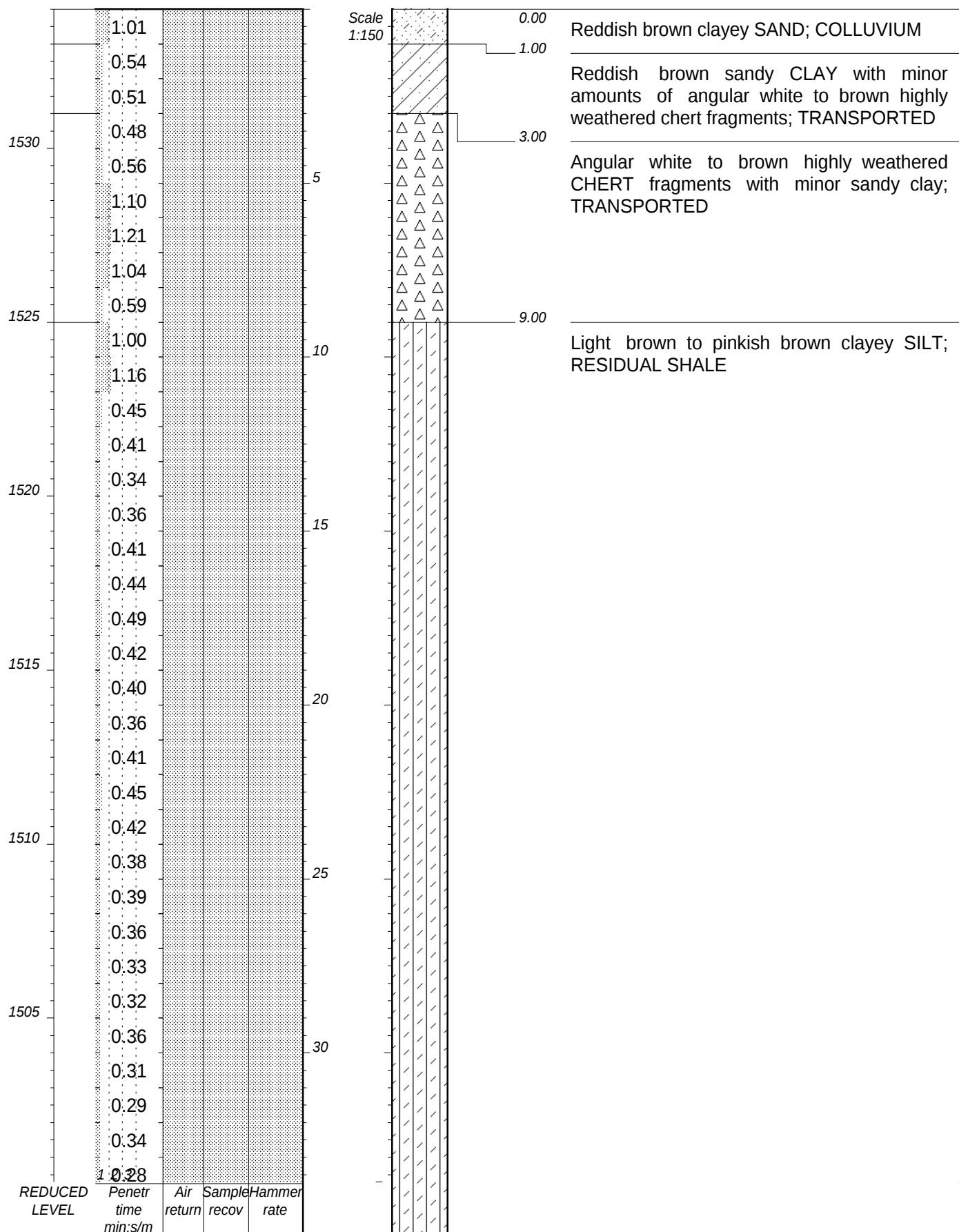
PERCUSSION DRILLING REPORT			BOREHOLE NO : 1293-03 SHEET : 2 OF 2		
LOCALITY: KHUTSONG SOUTH					
CO-ORDINATES : X = Y =		COLLAR ELEV : m AMSL WATER REST LEVEL : DRY			
CONTRACTOR :		RUBICON			
DATE COMPLETED:					
The 'Geological Column' is diagrammatic and it is not intended nor implied to represent the precise geological strata at the depths indicated.					
PENETRATION (MIN,SEC/METRE)		DEPTH (m)		DESCRIPTION	
1-38			~~~	17-43m: Brown clayey SAND with minor angular translucent blue grey CHERT fragments; CHERT RESIDUUM	
1-42			~~~		
1-39			~~~		
0-19		45	/	43-49m: Dark brown silty CLAY with minor angular translucent blue grey chert fragments and black silt (WAD); DOLOMITE RESIDUUM	
0-27			/		
0-30			/		
0-22			/		
0-26			/		
0-21			/		
3-40		50	/	49-55m: Sub-angular blue grey unweathered hard rock DOLOMITE.	
3-31			/ /		
3-26			/		
3-35			/ /		
3-44			/		
3-50		55	/ /	EOH	
		60		<b>Notes</b> No sample or air loss No groundwater intercepted	
		65			
		70			
		75			
		80			
PROFILED BY J. MEINTJES ON 26-05-2022			<b>KHUTSONG SOUTH AUXILIARY BULK PIPELINE</b>		REF NO. GHS1293
1. COMPRESSOR DELIVERY & PRESSURE, BIT TYPE/SIZE 27m3/min (950cfm) at 1800kPa/BUTTON/ 216mm					
2. WATER ENCOUNTERED: NIL					
3. AIR LOSSES: NIL			<b>GEOHAZARD SOLUTIONS</b> Consulting Engineering Geologists & Engineers Tel. (011) 469 0854		FIG NO.

SELMOND CONSULTING & ASSOCIATES  
KHUTSONG EXTENSION 1, 2 & 3 RESERVOIRS: NEW BLYBANK RESERVOIR AND  
SUPPLY PIPELINES: PROPOSED RESERVOIR LOCATION AND PIPELINE ROUTES

HOLE No: 1234

Sheet 1 of 2

JOB NUMBER: VGI3366

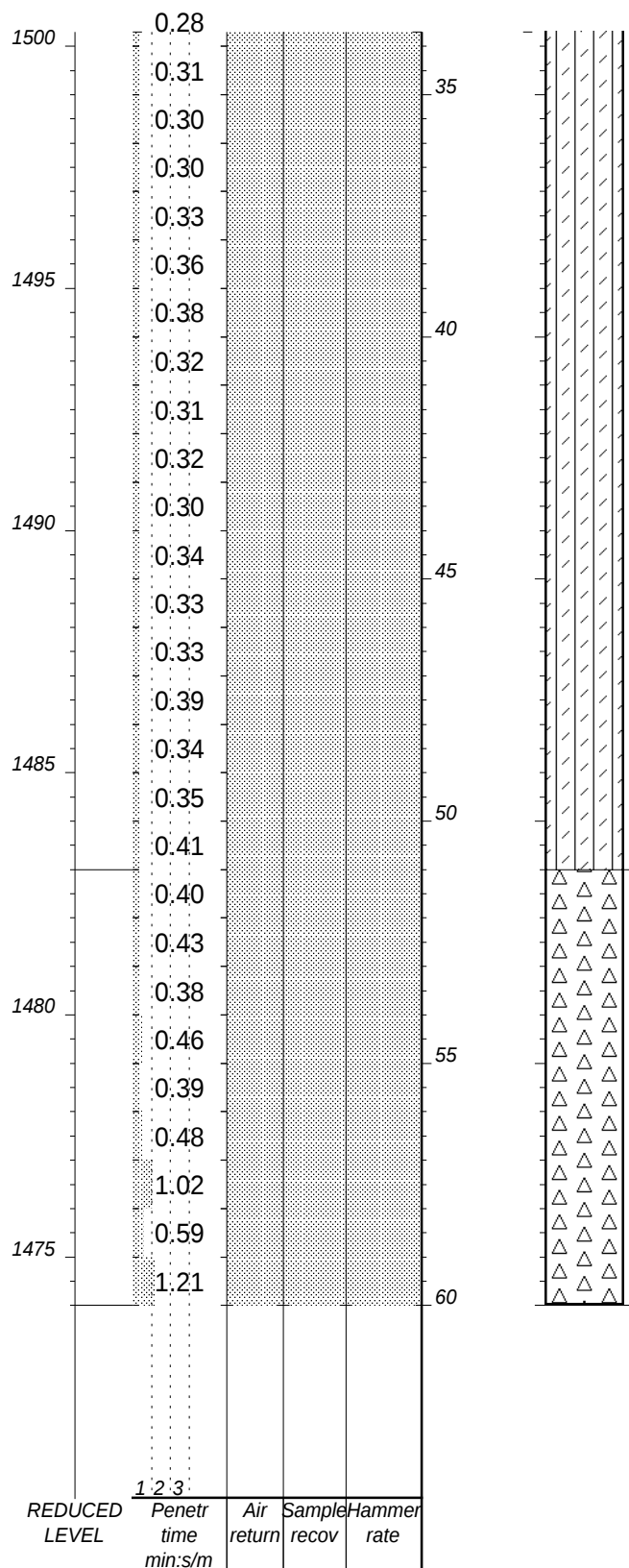


SELMOND CONSULTING & ASSOCIATES  
KHUTSONG EXTENSION 1, 2 & 3 RESERVOIRS: NEW BLYBANK RESERVOIR AND  
SUPPLY PIPELINES: PROPOSED RESERVOIR LOCATION AND PIPELINE ROUTES

HOLE No: 1234

Sheet 2 of 2

JOB NUMBER: VGI3366



51.00

Angular white to brown highly weathered  
CHERT fragments with minor sandy clay;  
CHERT RESIDUUM

60.00

#### NOTES

- 1) Driller reports no solid conditions to 60 m, drilling terminated at 60 m in line with industry standards
- 2) No groundwater intercepted
- 3) No groundwater rest level recorded
- 4) Original Dolomite Aquifer Groundwater Level (OWL) 1424 m - 1425 m AMSL
- 5) Boskop - Turffontein Dolomite Groundwater Compartment
- 6) No water added
- 7) Driller reports no air loss and no sample loss
- 8) Driller reports no hole collapse
- 9) Projection Information: CM 27 degrees E, Transverse Mercator, WGS 84

CONTRACTOR : RUBICON BORE  
MACHINE : ROCK GIANT  
DRILLED BY : S. MORELE  
PROFILED BY : J.C. MEINTJES

TYPE SET BY : J.C. MEINTJES  
SETUP FILE : SETUP.SET

INCLINATION : 90 DEGREES

DIAM : 165 mm  
DATE : 2010/09/20  
DATE :

DATE : 13/10/10 15:15

TEXT : ..\BACKGR-1\201010-1.TXT

ELEVATION : 1534m AMSL

X-COORD : 2917978  
Y-COORD : 36154

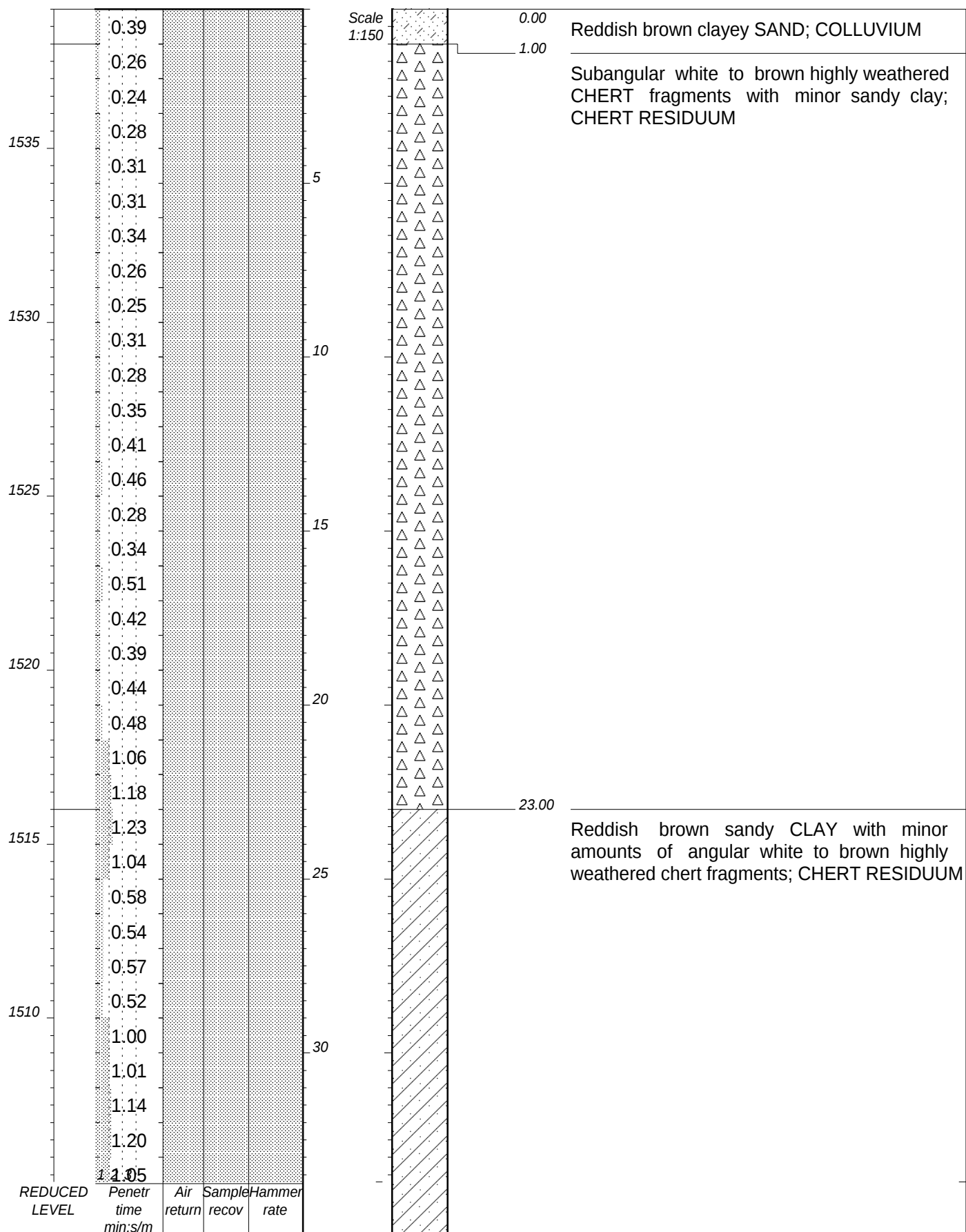
HOLE No: 1234

SELMOND CONSULTING & ASSOCIATES  
KHUTSONG EXTENSION 1, 2 & 3 RESERVOIRS: NEW BLYBANK RESERVOIR AND  
SUPPLY PIPELINES: PROPOSED RESERVOIR LOCATION AND PIPELINE ROUTES

HOLE No: 1205

Sheet 1 of 2

JOB NUMBER: VGI3366

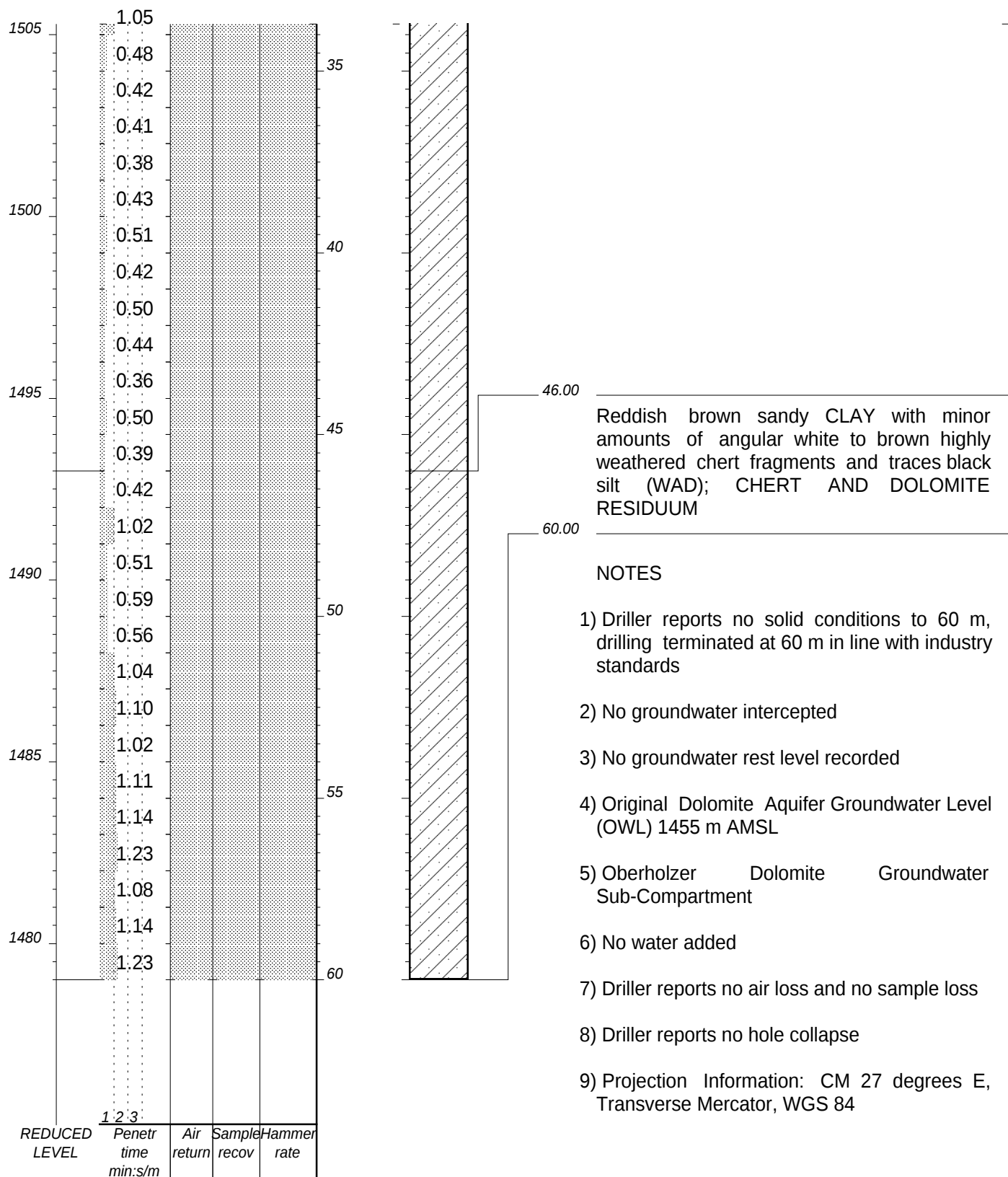


SELMOND CONSULTING & ASSOCIATES  
KHUTSONG EXTENSION 1, 2 & 3 RESERVOIRS: NEW BLYBANK RESERVOIR AND  
SUPPLY PIPELINES: PROPOSED RESERVOIR LOCATION AND PIPELINE ROUTES

HOLE No: 1205

Sheet 2 of 2

JOB NUMBER: VGI3366



CONTRACTOR : RUBICON BORE  
MACHINE : ROCK GIANT  
DRILLED BY : S. MORELE  
PROFIED BY : J.C. MEINTJES

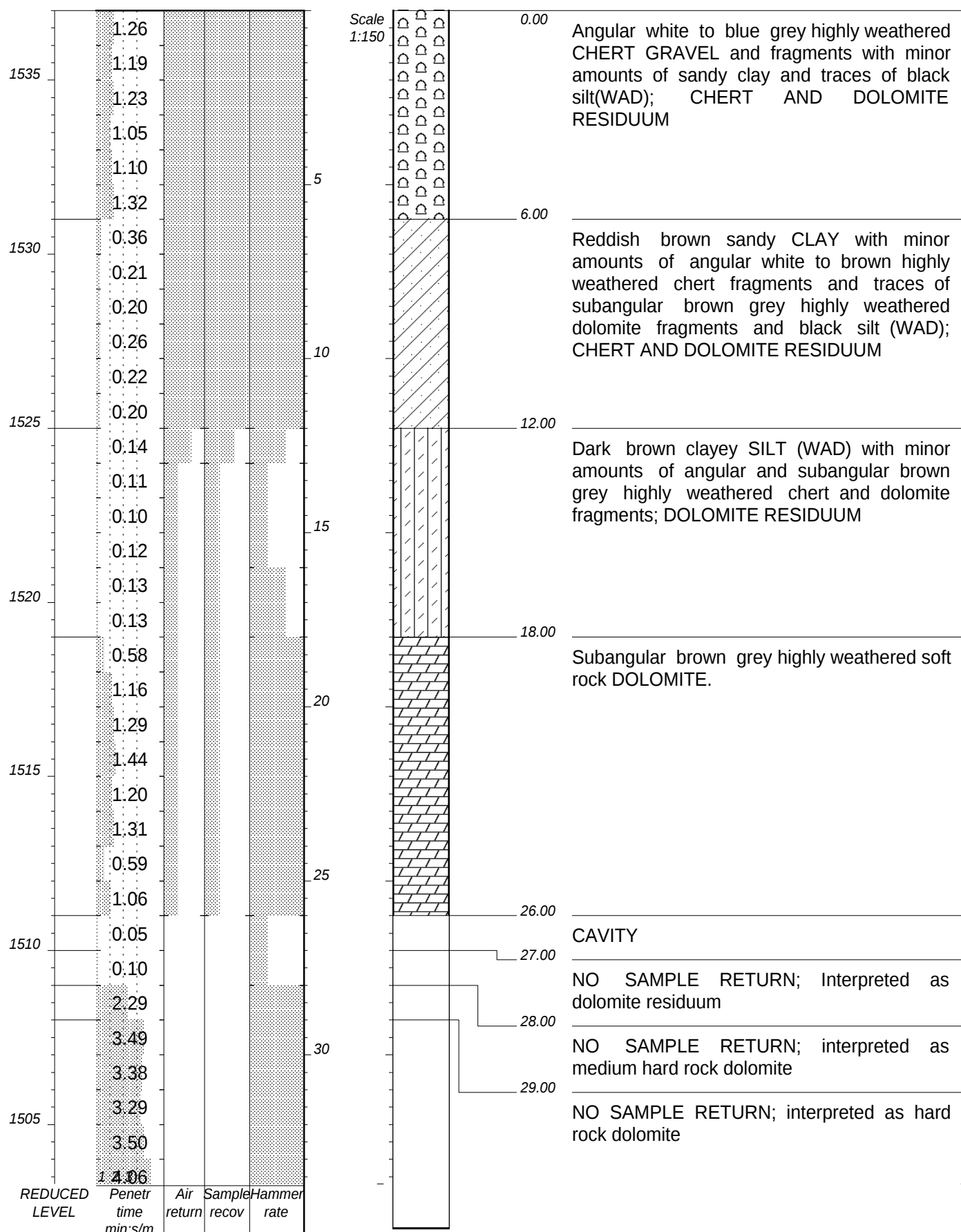
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SETUP FILE : SETUP.SET

INCLINATION : 90 DEGREES  
DIAM : 165 mm  
DATE : 2010/09/20  
DATE :

DATE : 13/10/10 15:15  
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ELEVATION : 1539m AMSL  
X-COORD : 2918249  
Y-COORD : 36327

HOLE No: 1205

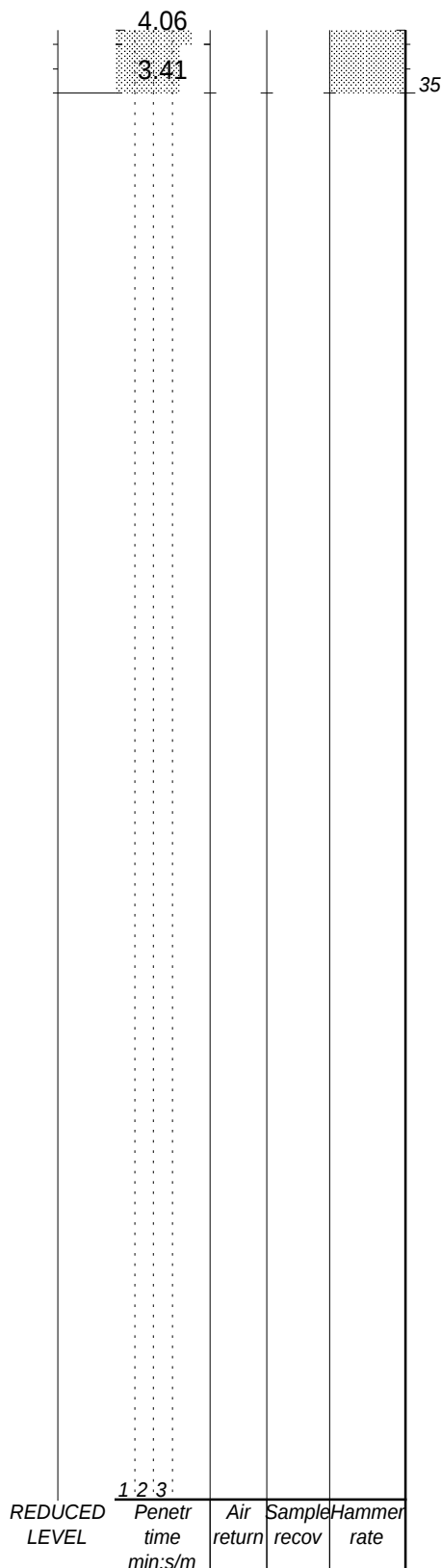


SELMOND CONSULTING & ASSOCIATES  
KHUTSONG EXTENSION 1, 2 & 3 RESERVOIRS: NEW BLYBANK RESERVOIR AND  
SUPPLY PIPELINES: PROPOSED RESERVOIR LOCATION AND PIPELINE ROUTES

HOLE No: 1086

Sheet 2 of 2

JOB NUMBER: VGI3366



NOTES

- 1) Driller reports solid conditions from 29 m to 35 m
- 2) No groundwater intercepted
- 3) No groundwater rest level recorded
- 4) Original Dolomite Aquifer Groundwater Level (OWL) 1424 m - 1425 m AMSL
- 5) Boskop - Turffontein Dolomite Groundwater Compartment
- 6) No water added
- 7) Driller reports slight air loss from 12 m to 13 m and medium air loss from 13 m to 26 m and total air loss from 26 m to 35 m and medium sample loss from 12 m to 13 m and poor sample loss from 13 m to 26 m and 26 m to 35 m
- 8) Driller reports no hole collapse
- 9) Projection Information: CM 27 degrees E, Transverse Mercator, WGS 84

CONTRACTOR : RUBICON BORE  
MACHINE : ROCK GIANT  
DRILLED BY : S. MORELE  
PROFIED BY : J.C. MEINTJES  
TYPE SET BY : J.C. MEINTJES  
SETUP FILE : SETUP.SET

INCLINATION : 90 DEGREES  
DIAM : 165 mm  
DATE : 2010/09/21  
DATE :

ELEVATION : 1537m AMSL  
X-COORD : 2918522  
Y-COORD : 34780

HOLE No: 1086

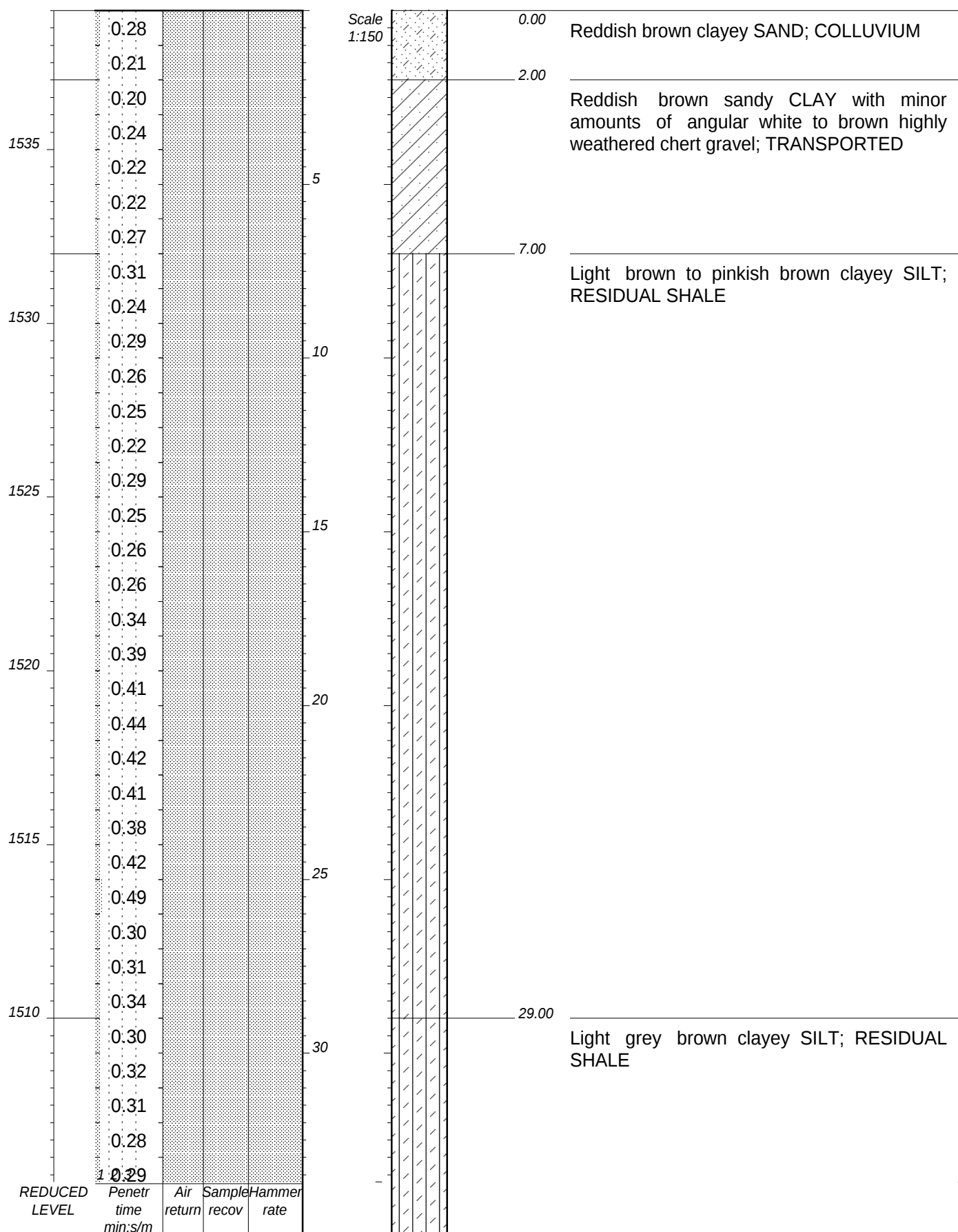
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SELMOND CONSULTING & ASSOCIATES  
KHUTSONG EXTENSION 1, 2 & 3 RESERVOIRS: NEW BLYBANK RESERVOIR AND  
SUPPLY PIPELINES: PROPOSED RESERVOIR LOCATION AND PIPELINE ROUTES

HOLE No: 1032

Sheet 1 of 2

JOB NUMBER: VGI3366

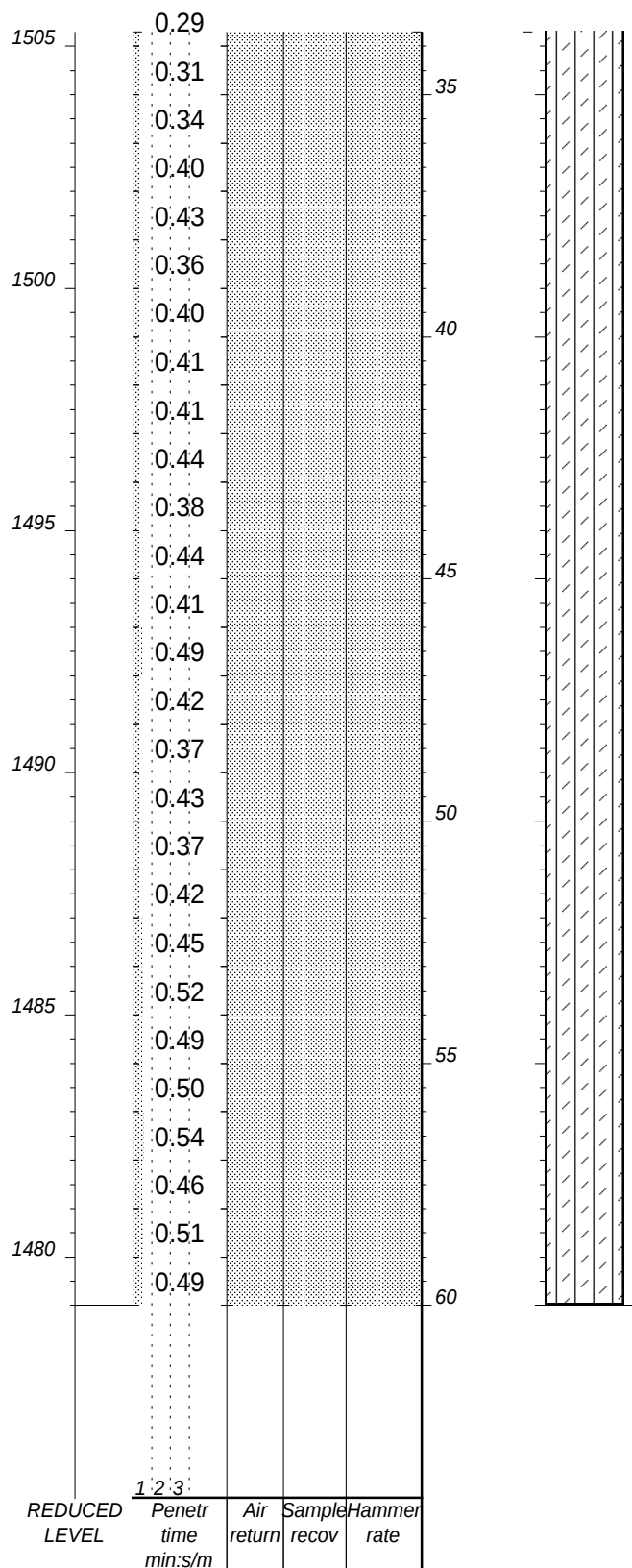


SELMOND CONSULTING & ASSOCIATES  
KHUTSONG EXTENSION 1, 2 & 3 RESERVOIRS: NEW BLYBANK RESERVOIR AND  
SUPPLY PIPELINES: PROPOSED RESERVOIR LOCATION AND PIPELINE ROUTES

HOLE No: 1032

Sheet 2 of 2

JOB NUMBER: VGI3366



60.00

NOTES

- 1) Driller reports no solid conditions to 60 m, drilling terminated at 60 m in line with industry standards
- 2) No groundwater intercepted
- 3) No groundwater rest level recorded
- 4) Original Dolomite Aquifer Groundwater Level (OWL) 1424 m - 1425 m AMSL
- 5) Boskop - Turffontein Dolomite Groundwater Compartment
- 6) No water added
- 7) Driller reports no air loss and no sample loss
- 8) Driller reports no hole collapse
- 9) Projection Information: CM 27 degrees E, Transverse Mercator, WGS 84

CONTRACTOR : RUBICON BORE  
MACHINE : ROCK GIANT  
DRILLED BY : S. MORELE  
PROFIED BY : J.C. MEINTJES  
TYPE SET BY : J.C. MEINTJES  
SETUP FILE : SETUP.SET

INCLINATION : 90 DEGREES  
DIAM : 165 mm  
DATE : 2010/09/20  
DATE :

ELEVATION : 1539m AMSL  
X-COORD : 2918404  
Y-COORD : 35305

HOLE No: 1032

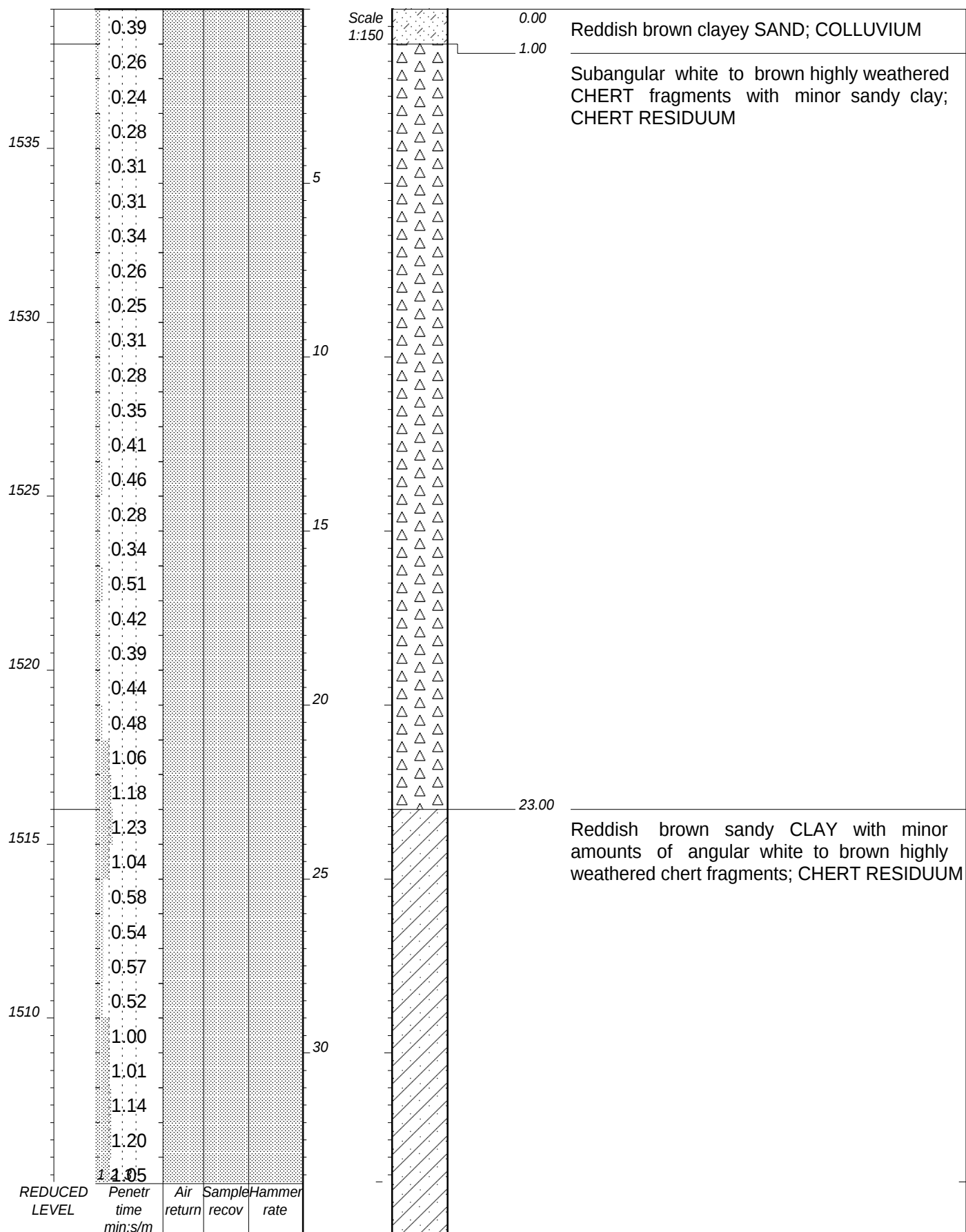
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SELMOND CONSULTING & ASSOCIATES  
KHUTSONG EXTENSION 1, 2 & 3 RESERVOIRS: NEW BLYBANK RESERVOIR AND  
SUPPLY PIPELINES: PROPOSED RESERVOIR LOCATION AND PIPELINE ROUTES

HOLE No: 1205

Sheet 1 of 2

JOB NUMBER: VGI3366

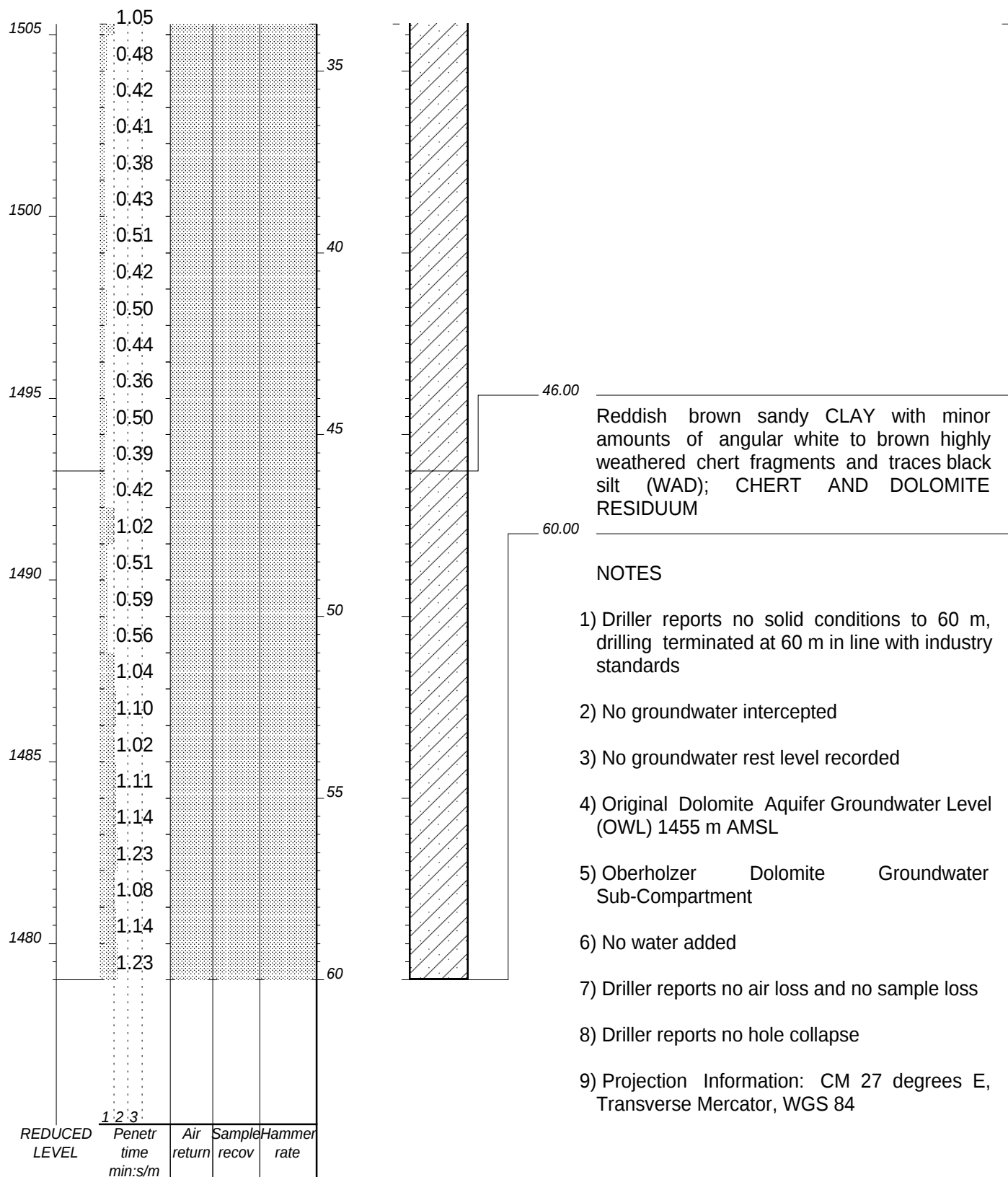


SELMOND CONSULTING & ASSOCIATES  
KHUTSONG EXTENSION 1, 2 & 3 RESERVOIRS: NEW BLYBANK RESERVOIR AND  
SUPPLY PIPELINES: PROPOSED RESERVOIR LOCATION AND PIPELINE ROUTES

HOLE No: 1205

Sheet 2 of 2

JOB NUMBER: VGI3366



CONTRACTOR : RUBICON BORE  
MACHINE : ROCK GIANT  
DRILLED BY : S. MORELE  
PROFIED BY : J.C. MEINTJES  
TYPE SET BY : J.C. MEINTJES  
SETUP FILE : SETUP.SET

INCLINATION : 90 DEGREES  
DIAM : 165 mm  
DATE : 2010/09/20  
DATE :

ELEVATION : 1539m AMSL  
X-COORD : 2918249  
Y-COORD : 36327

HOLE No: 1205

DATE : 13/10/10 15:15  
TEXT : ..\BACKGR-1\201010-1.TXT