Consulting Engineering Geologists

IntraSolutions

Intraconsult Specialist Services (Pty) Ltd t/a
Company No. 2015/268459/07

P.O. Box 604
Fourways
2055
Gauteng

Telephone : (011) 469 0854

EcoPartners
177 Weltevreden Road
Berario
2195

ATTENTION: MS SAN OOSTHUIZEN

Your reference	Our reference	Date
	IR2222	**10 JULY 2026**

TONKMETER WASTE DISPOSAL FACILITY: AREA E: DOLOMITE STABILITY REVIEW

SUMMARY

This document presents a review of dolomite stability conditions at the Tonkmeter Waste Disposal Facility, Area E in the context of present Facility Development proposals which entails increasing the height of landfill cells from 1 meter above ground to 25 meters above ground and associated infrastructure. The Facility as a whole is a Class GLB+ landfill designed to provide a reliable alternative to constrained municipal facilities in the area. Area E is 47,3 hectares in extent.

The Council for Geoscience supported the development of the larger site as a Waste Treatment Facility in comments dated 23 May 2013, referenced F3849-2 Rem Porton 81, Rietfontein 128-IR. This support is understood to remain in place provided certain conditions are met.

Area E is located on Karoo age deposits, which blanket dolomite rock at intermediate to great depth. In the past clays were quarried from this site.

The shallow groundwater levels reported in the 2011 and 2013 boreholes are confirmed by the 2013 geohydrological study to represent a perched aquifer. The groundwater level of the deeper aquifer is 20-40m deep at an elevation of 1570-1590m AMSL.

Based on available data and current best practice, Area E represents a **low to medium** susceptibility of sinkhole and subsidence formation with respect to ingress of water and a **low** susceptibility of sinkhole and subsidence formation with respect to anthropogenic groundwater level drawdown, i.e. Inherent Hazar Class 1/2//1. The Design Hazard Class is 2. In light of the land use, the Dolomite Area Designation is D3.

TONKMETER WASTE DISPOSAL FACILITY: AREA E: DOLOMITE STABILITY REVIEW

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1. INTRODUCTION

This document presents a review of dolomite stability conditions at the Tonkmeter Waste Disposal Facility, Area E in the context of present Facility Development proposals to increase the height of landfill cells from 1 meter above ground to 25 meters above ground.

2. TERMS OF REFERENCE AND SCOPE OF WORK

IntraSolutions is appointed by EcoPartners. The terms of reference and scope of the work were set out in Proposal Number IR2222P and IntraSolutions was instructed to proceed with the report accordingly.

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.

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 Wiegmans: Golder Associates", was consulted.

3.4. Existing Reports

- Dr J P Venter Consulting Services, Report Nr. 2011/02, dated July 2011, titled "Dolomite Stability Investigation of Part of Portion 81 of the Farm Rietfontein 128-IR for the Development of Waste Disposal Facilities".

- Dr J P Venter Consulting Services and J S Stiff (JD Geotechnical Services CC) Report Nr. 2013/03, dated May 2013, titled: “Dolomite Stability Investigation of Parts of Portion 81 of the Farm Rietfontein 128-IR for the Development of Waste Disposal Facilities Addendum Report”.

4. DESCRIPTION OF THE STUDY AREA

4.1. Locality

The Facility is located on the corner of Tonk Meter Road and Coaton Avenue in Springs, Gauteng, refer to Figure 1.

4.2. Site Description

The Facility is currently a Class GLB+ landfill designed to divert waste and provide a reliable alternative to constrained municipal facilities in the area. Area E is 47,3 hectares in extent. Refer to Figure 2.

The 2011 report indicates that old mine slimes dumps were removed from the southern part of the mined areas on Area E. Area E was mined by Corobrik for the manufacturing of bricks. The plastic and fire clays were mined, stockpiled and used for the manufacturing of refractory bricks by Verref.

The northern side of Area E is relatively undisturbed apart from some shallow excavations, probably for sand or construction materials. The natural slopes on the larger original farm portion have been disturbed. The natural drainage used to be at a shallow slope in a northeasterly direction towards the Klein Blesbok Spruit which drains towards the east north of the N17 freeway. Orthophoto maps show northeasterly slopes of about 1 percent across areas D and E.

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

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.

Use is made of existing gravity data, as compiled in the 2013 report (and referenced in Section 3.4.).

5.3. Rotary Percussion Boreholes

Existing boreholes were extracted from the reports provided (13). The borehole logs are presented in Appendix 1.

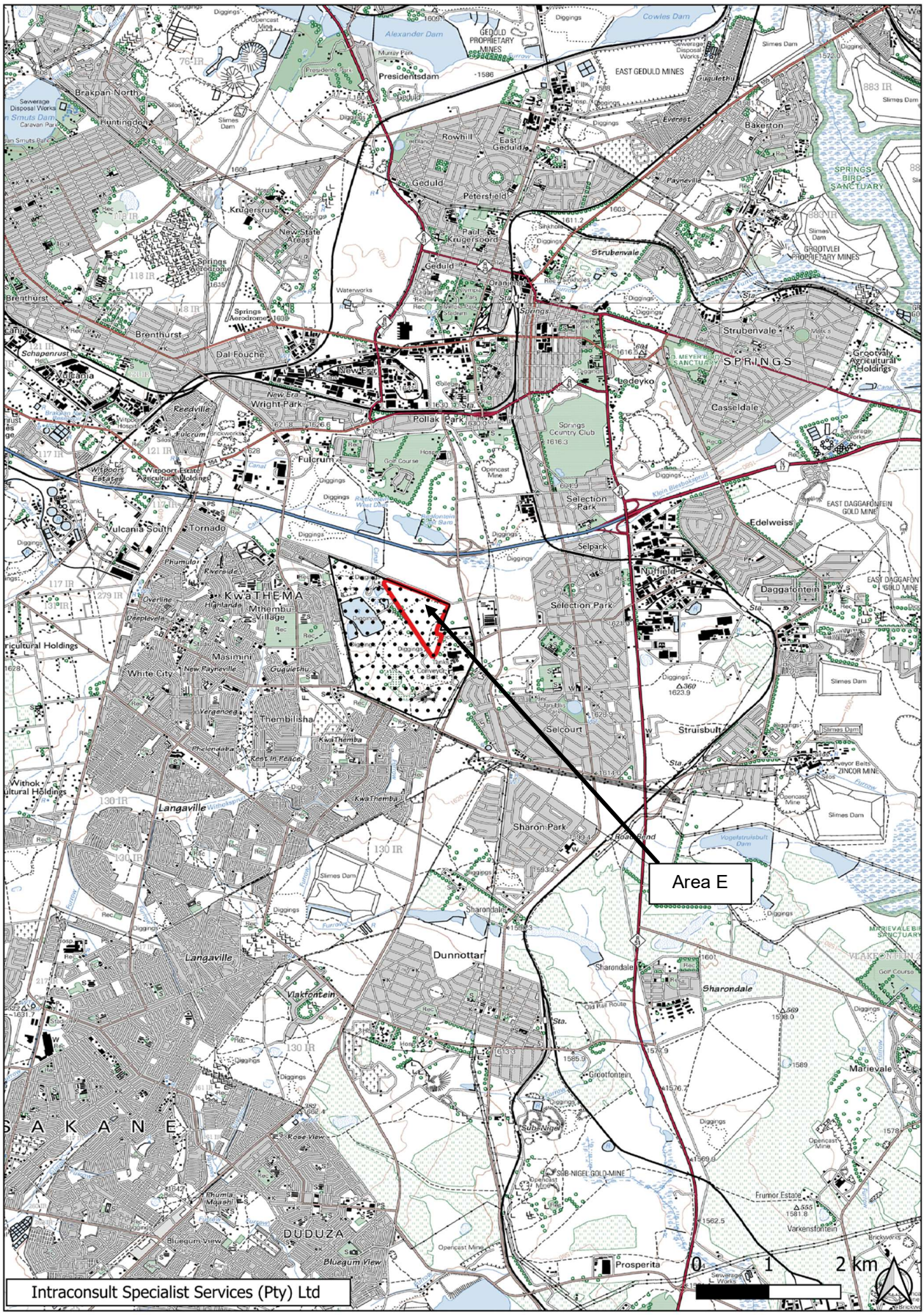
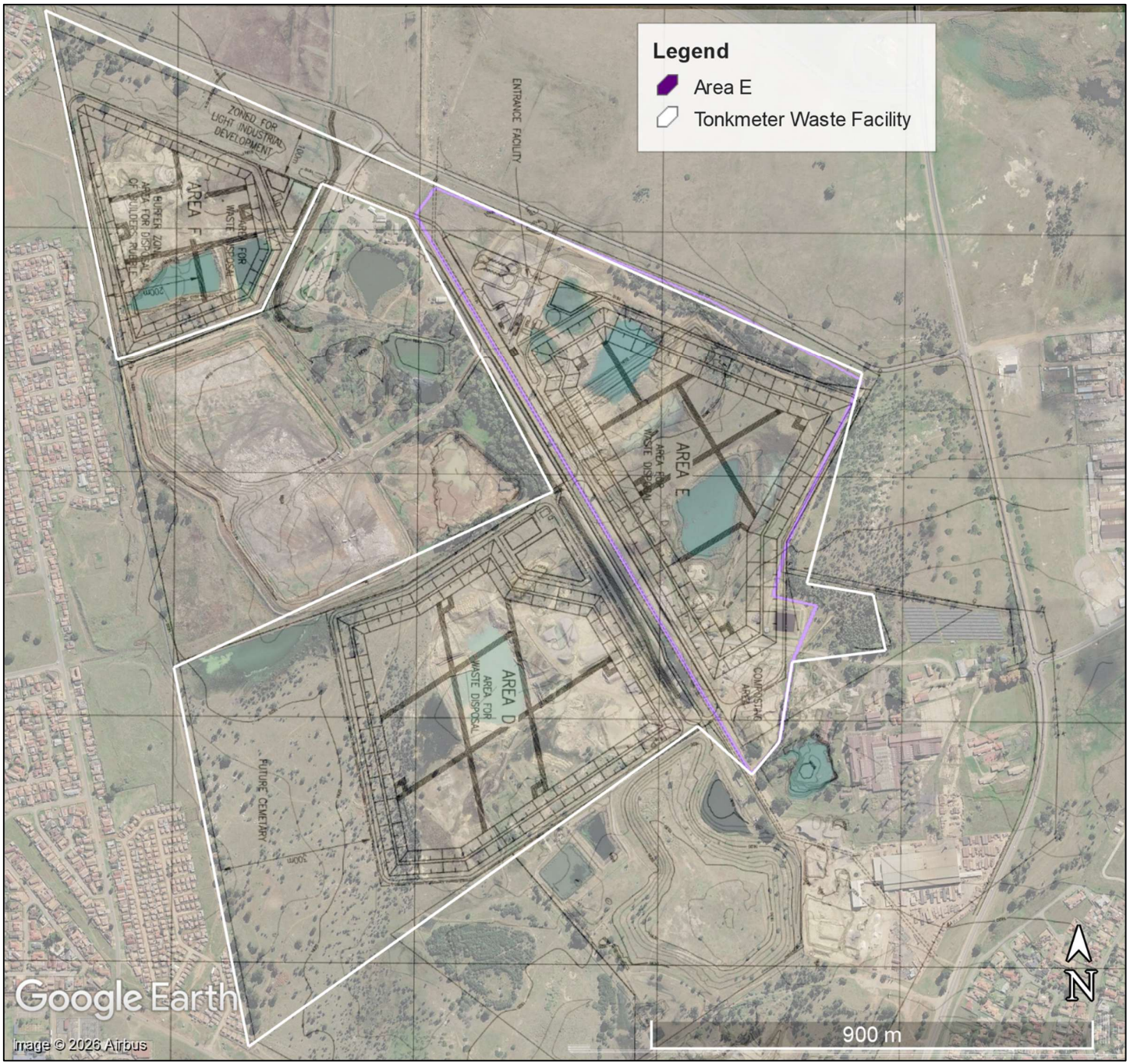


Figure 1: Locality (Regional)

Figure 2: Facility Layout



5.4. Hazard Characterisation Procedure

National Standards (SANS 1936, 2012) provide defined terminology (with previous term used) are given below:

5.4.1. Terminology

(i) Hazard

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

(ii) 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.

(iii) 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).

(iv) 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.

(v) 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.

(vi) Dolomite Land

Land underlain by dolomite or limestone residuum or bedrock (or both), within the Malmani Subgroup and Campbell Rand Subgroup, typically at depths of no more than:

a) 60m in areas where no de-watering has taken place and the local authority has jurisdiction, is monitoring and has control over the groundwater levels in 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.

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.

*In the context of this report the concepts of thickness and depths for subsurface horizons are used as follows:

Depths		**Thicknesses (Alluvium / Colluvium / Residuum)**	
Range in m	**Appellation**	**Range in m**	**Appellation**
0-2/4	Near-surface	0-8/12	Thin
2/4-8/12	Shallow	8/12-16/24	Intermediate
8/12-16/24	Intermediate	16/24-36/44	Thick
16/24-36/44	Great Depth	36/44 and greater	Very Thick
More than 40	Very Great Depth	-	-

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 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.

5.5. Design Hazard Class

While various combinations of Inherent Hazard Classes may be assigned to a particular zone, for example 4(1)//7, for development planning and design purposes a single Design Hazard Class is to be selected. This selection is dependent on factors such as groundwater monitoring and control and the like. In the stated example the Design Class may be 4 in an area where there is groundwater level control by the relevant authorities and 7 where no or only limited control is in place.

5.6. Dolomite Area Designation (SANS 1936 Part 2 (2012))

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.
D4	Additional site-specific precautionary measures are required.*

*Section 4.3.4 states the following specific measures for D4 areas:

a) site characterization, analysis and design, specification of precautionary measures, supervision of implementation and formulation of dolomite risk management plan shall be undertaken by a Competence Level 4 geo-professional;

b) the foundation design and design of the structure, precautionary measures and dolomite risk management plan shall specifically address and effectively mitigate the dolomite risks *(should read hazard)* present on the site;

c) the site characterization, foundation design and design of the structure, precautionary measures and dolomite risk management requirements shall be reviewed and approved by an independent Competence Level 4 geo-professional and, where relevant, by a structural engineer with a similar level of competence; and

d) all aspects of the development proposal shall be reviewed and approved by the local authority who may request a further review by an authority-designated Competence Level 4 peer if required.

5.7. Permissible Land Use (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)
	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

Land Use Class Definitions	
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 ≤ 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 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	

5.8. Monitoring Designations (SANS 1936-4, 2012)

According to SANS 1936 Part 4 (2012) Monitoring Designations must be identified and delineated according to the Inherent Susceptibility characterisation of the site and knowledge of problems which could impact on the infrastructure on site. The generic Monitoring Activities considered appropriate for dolomite land are as follows:

Annotation	Activity*	Reaction	Purpose
A	**Visual inspections of ground, structures and above ground infrastructure** (e.g. buildings, taps, gardens, private and public open space etc.) and **dry services, sleeves, ducts, manholes and facility chambers for water ingress**: • Examine buildings for cracks. • Visual checks for outside dripping taps and pressure valves. • Visual checks for damp or moss grown areas. • Visual check for over-wetting of gardens. • Visual check for blocked drainage ports in garden walls. • Visual check for cracks in the ground.	Any evidence of cracking or ground settlement should immediately be reported and investigated. Any evidence of blockages should be reported and cleared immediately, or cracks repaired once settlement is halted. Any water ingress in dry services, sleeves, ducts, manholes and facility chambers shall be reported and point of entry repaired and investigated.	Monitor, control and prevention of concentrated ingress of water
B	**Visual inspection of stormwater systems**: • Visual checks for debris in open storm water channels at, for example, the start of the rainy season and after heavy storms. • Visual checks for water flowing out of stormwater manholes at the start of the rainy season and after heavy storms. • Search for ground cracks and cracks in lined and unlined channels.		
C	**Testing of wet-services for leaks**: • Regular air and water tests on wet-services. • In waste water and stormwater pipes with a diameter greater than 100 mm wet-services to be inspected by camera.	Any leaks to be reported and repaired immediately.	
D	**Monitoring of structures and ground levels:** In many instances visual inspections may not be sufficient: It may be necessary to undertake precision ground-surface levelling, particularly in areas that have been rehabilitated after a ground movement event. Such levelling must be undertaken by a surveyor, recorded and stored in the databank and appropriate actions taken when excessive settlement continues.	Any evidence of movement must be reported and investigated and appropriate repair work undertaken.	Monitor the effects of concentrated ingress of water or groundwater level drawdown

Annotation	Activity*	Reaction	Purpose
E	**Monitoring of the groundwater level:** This activity not only entails the measuring and recording of the groundwater level, but also the analysis and understanding of groundwater level trends over time and the control of excessive [beyond seasonal fluctuations] groundwater level drawdown: • Drill and equip strategic boreholes with the necessary equipment to measure the groundwater level. • Recorded groundwater level, monitoring well number, date and other relevant observations. • Analyse groundwater level trend over time on a regular basis. • Report artificial/excessive groundwater level drawdown to Municipality and the Department of Water Affairs. • Investigate cause of artificial/excessive groundwater level drawdown. • Arrest artificial/excessive groundwater level drawdown.	Evidence of lowering (exceeding 6 m) must be reported to Municipality and the Department of Water Affairs and appropriate action taken to ensure the groundwater level returns to within natural seasonal fluctuations.	Monitor, control and prevention of groundwater level drawdown
*If there is no evidence of a particular problem, this result should be recorded.			

Note that in SANS 1936 Part 4 (2012), pg. 15, the *visual inspection of dry services, sleeves, ducts, manholes and facility chambers* is included as a separate monitoring activity (as Annotation D), with the Annotations D and E as listed above, annotated as E and F. For simplicity sake this activity has been included in Annotation A above.

The Frequency with which each Activity is to be performed is selected from the following categories:

Annotation	Frequency
$()^{DAILY}$	Activities to be undertaken daily.
$()^{WEEKLY}$	Activities to be undertaken weekly.
$()^{1}$	Activities to be undertaken once a month.
$()^{3}$	Activities to be undertaken quarterly.
$()^{6}$	Activities to be undertaken bi-annually.
$()^{12}$	Activities to be undertaken annually.
$()^{24}$	Activities to be undertaken once every two years.
$()^{NA}$	NO ACTION REQUIRED CURRENTLY
$()^{tbd}$	TO BE DETERMINED

6. GEOLOGY

6.1. Regional Geological Setting

The lithological units (and their weathered derivatives), anticipated according to regional geological mapping information are as follows (refer to Figure 3):

Lithology	Lithostratigraphic Unit
Dolerite dykes and sills (Drakensburg Group age/150 Ma)	- (di)
Shale/sandstone/siltstone/mudstone etc. and soil derivatives	Ecca and Dwyka Groups, Karoo Supergroup (Pv, C-Pd, Pe)

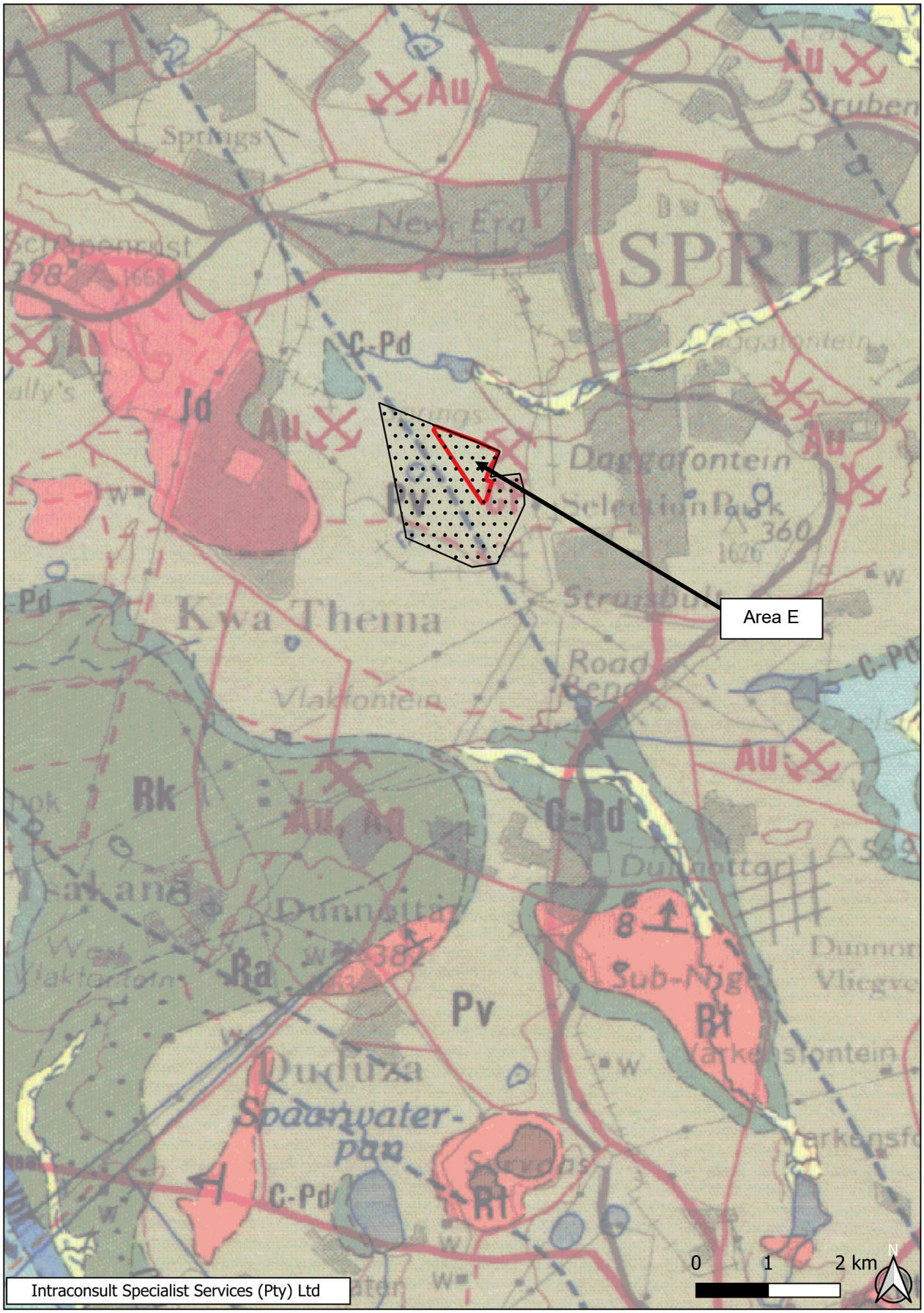


Figure 3: Excerpt of 1:250 000 scale Geological Map (Sheet 2628 East Rand)

Lithology	Lithostratigraphic Unit
Syenite dykes (Pilanesberg dyke swarm age/1120-1310 Ma)	- (sy)
Diabase dykes and sills (Bushveld Igneous Complex age/2061 Ma)	- (di)
Shale, quartzite and soil derivatives	Pretoria Group, Transvaal Supergroup (Vt, Vb, Vh & Vha)
Chert, chert gravel, silty clay and clayey silt, dolomite, dolomite residuum and associated chert breccia	Eccles Formation, Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup (Vmd)
Dolomite, dolomite residuum	Lyttelton Formation, Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup (Vmd)
Chert, chert gravel, silty clay and clayey silt, dolomite, dolomite residuum and associated chert breccia	Monte Christo Formation, Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup (Vmd)
Dolomite, dolomite residuum	Oaktree Formation, , Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup (Vmd)

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), manganocrete (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)

The site is located on dolomite land. Karst development has led to a highly variable dolomite and chert bedrock topography, with deep weathering having taken place along linear features such as fractures. Cavernous conditions can be expected both within the bedrock and the overburden. The process of dissolution has resulted in a vertically zoned succession of residual products, which in turn are generally overlain by geologically younger formations or soils.

Hard, unweathered dolomitic bedrock is overlain by slightly weathered jointed bedrock and thereafter, through a sudden, dramatic transition, to totally weathered and low strength, insoluble residual material consisting of mainly manganese oxides (wad), chert and iron oxides that reflect the original insoluble matrix structure.

6.2. Site Specific Conditions (2011/2013)

- The southern part of Area E was excavated by Corobrik for “clays”. Backfilled areas exist over large areas.
- Dolerite was intercepted in the borehole drilled in the Rand Water servitude near the inferred position of the dyke.
- Dwyka age sediments were identified in five of the nine holes drilled in 2011. Dwyka sediments were profiled at depths ranging from 17-28m.
- The depth to dolomite bedrock varies from 20-38m.
- In the boreholes in the quarry area dolomite rock was encountered is 16m and 18m below the backfill

level in boreholes 5414 and 5212 respectively. The dolomite is overlain by low permeability materials.

- The contact zones between the Dwyka Formation or the Vryheid Formation and the dolomite not highly leached. Low density and erodible materials were not intercepted.
- Sample and air loss was recorded in one of the 2013 boreholes (Borehole 40/12A).

Summaries of the horizons intercepted are captured in the respective reports and presented below:

BOREHOLE NR.	COLLAR ELEVATION m)	TRANSPORTED (T)	TRANSPORTED (T) RESIDUAL (R) PEDOCRETE (P)	KAROO (VRYHEID)	DOLERITE (WEATHERED)	DOLERITE (HARD ROCK)	DWYKA	NO SAMPLE	CAVITY	DOLOMITE BEDROCK (slightly leached (m - m)	DOLOMITE BEDROCK (hard rock)	DEPTH OF HOLE (m)	GROUNDWATER LEVEL (m)
4414			0-13 (Fill)	13-19 (Mr)						19-21	21-29	29	4,8
4911			0-18 (Fill)	18-30 (Mr)						30-33	33-41	41	5,5
5017			0-8 (Fill)	8-21 (Mr)			21-26			26-30	30-38	38	3,7
5212			0-9 (Fill)	9-16 (Mr)			16-18				18-21	21	1.0
5414			0-8,4 (Fill)	8,4-10 (Mr)			10-16				16-24	24	4,3
5507		1-2	0-1 (Fill); 2-6 (P)	6-32 (Mr)						32-33	33-40	40	2.0
5521/5422		0-1	1-4 (Fe)	4-22 (Mr); 22-25 (Mr, Carb); 25-34 (Mr)						34-38	38-47	47	14,8
5818		0-8	8-9 (Fe)	9-25 (Mr); 25-37 (Mr, Carb)						37-41	41-48	48	16,8
6024		0-2		2-17 (Mr)			17-20			20-24,5	24,5-33	33	1,2
F		3-5	0-3 (Fill)	5->19 (Mr)									6.0
7/24		0-4,5		4,5-12 (Mr)	26-41		12-21?			21-26	41-54	54	46.0
V10			0-9 (Fill)	9-13			13-20,5				20,5-27	27	Coll
40/12A			0-19 (Fill)				19-31,3 (N/S)	19-37			31,3-37 (N/S)	37	2,8
61/21		0-1		1-14,5			14,5-18			18-22,2	22,2-28	28	7,9

6.3. Past Sinkholes and Subsidences

Records suggest that no sinkholes or subsidences have occurred on or in close proximity to the site.

7. GEOHYDROLOGY

7.1. Quaternary Catchment Area

According to the country wide Quaternary Catchment data the site is located in Catchment C21E.

7.2. Groundwater Management Area (WMA)

According to the country wide Water Management Areas data the sites are located in the **Upper Vaal WMA.**

7.3. Dolomite Groundwater Management Area

According to the Water Geosciences Consulting Dolomite Hydrogeological Compartment Map[1] (2009) the site is located in the **East Rand Basin GMA.**

7.4. Dolomite Groundwater Levels Regionally

According to the Water Research Commission report of 2014, Number TT 553/14, Section 1.3.3 Groundwater Levels, the DWS operates and maintains 129 groundwater level monitoring stations in Region 10 (The Karst Belt). All of these target the dolomitic groundwater resource. The statistical characteristics for each dolomitic groundwater compartment or area are presented in Table 11.3.

[1] *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 DWS. However, the delineation does not necessarily represent a dolomite compartment or unit.*

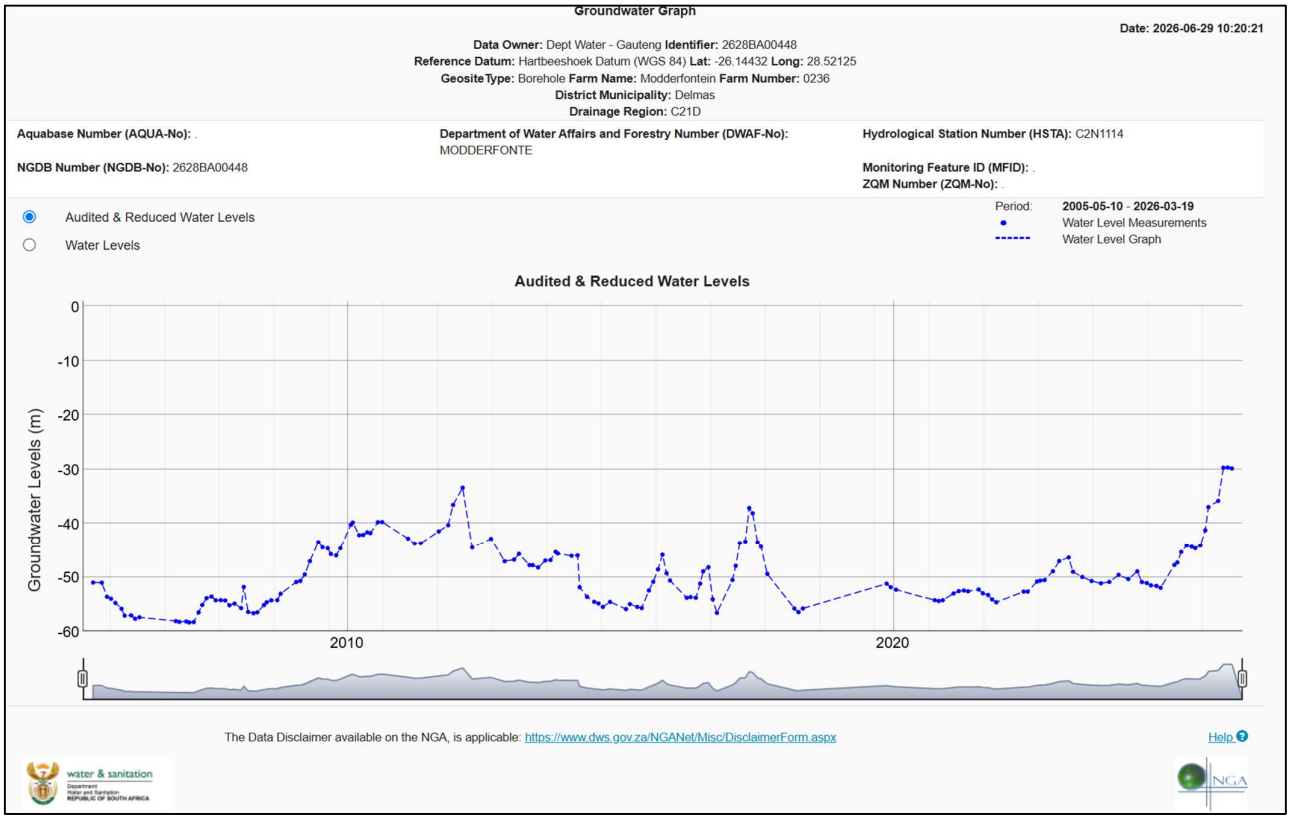
Table 11.3. Groundwater level information for dolomitic compartments.

Compartment	Groundwater level depth (m.b.g.s)			Groundwater level elevation (m.a.m.s.l.)		
	10 percentile	Mean	90 percentile	10 percentile	Mean	90 percentile
Rietvlei	9.66	16.44	36.74	1478.40	1483.50	1489.91
Witkoppies	1.73	37.30	71.77	1500.20	1505.62	1517.61
Elandsfontein	27.09	43.56	64.95	1544.44	1580.82	1603.73
Bapsfontein	49.12	79.20	79.94	1528.33	1559.57	1559.95
Varkfontein-Knoppiesfontein	6.03	9.65	18.51	1605.03	1610.35	1621.51
Delmas	5.53	17.29	44.97	1539.02	1560.45	1583.90
East Rand	50.13	51.81	53.49	1568.29	1569.29	1570.28

The monitoring stations identified in the East Rand Basing are indicated in Table 11.4 of report TT 553/14:

Compartment/ Area	Station	Depth to Groundwater Level (m.b.g.s)				Complete Record Late 1980s to 2007		Selected Record 1997 to 2007
		Min.	Mean	Median	Max.	Max Δh	Cumulative Δh	Cumulative Δh
Varkfontein-Knoppies-fontein	C2N891	6.70	8.87	9.06	10.75	4.05	-0.20	-2.18
	C2N893	2.29	4.84	4.57	8.47	6.18	+2.88	-1.38
	A2N0783*	16.20	18.93	18.96	20.76	4.56	-	-2.56
East Rand Basin	C2N1113*	42.52	52.08	53.23	54.27	11.75	-	4.32
	C2N1114*	51.03	55.92	56.79	58.36	7.33	-	-0.25

The groundwater levels in Station C2N1114 over time is indicated below:



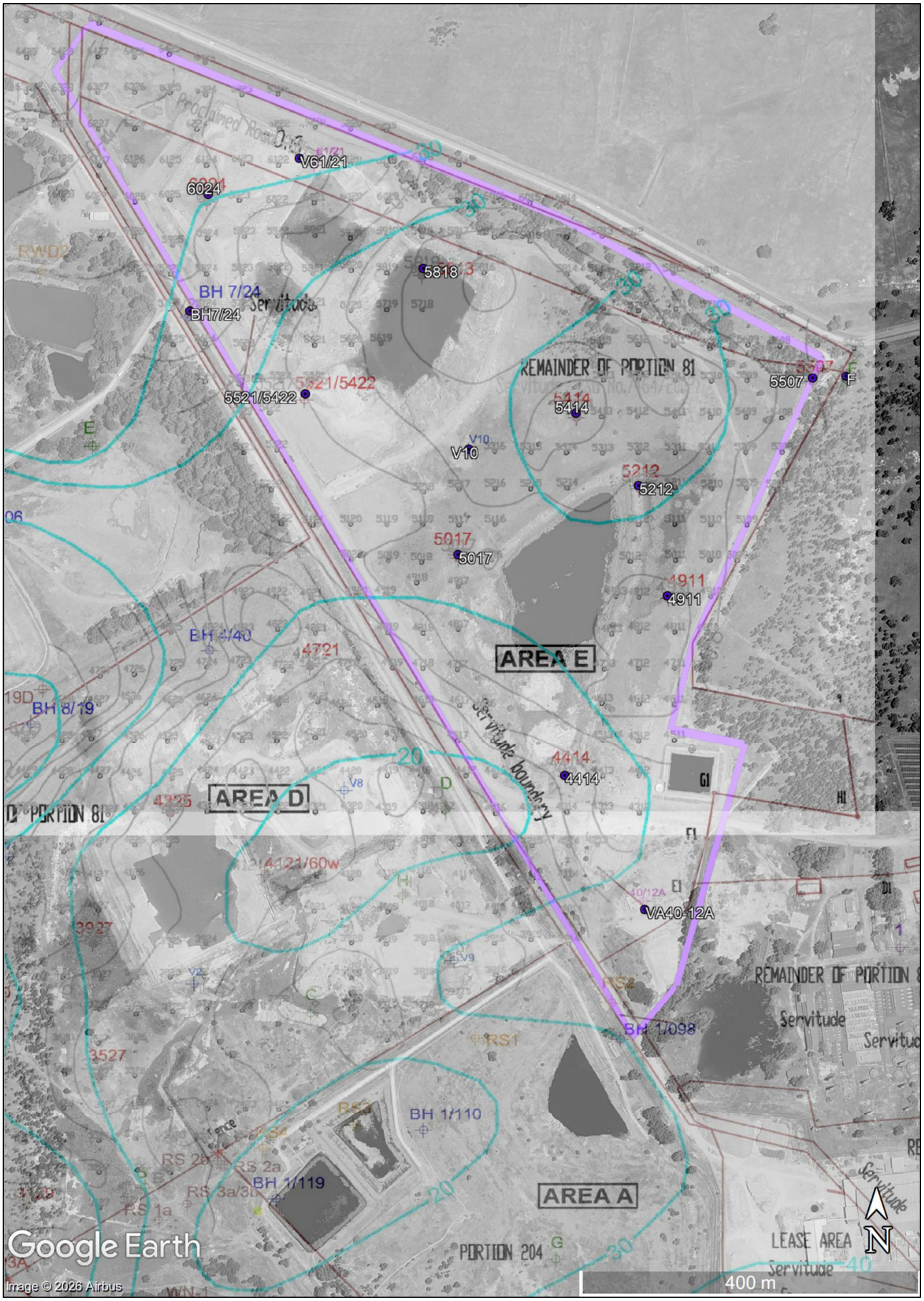


Figure 4: Residual Gravity and Borehole Positions (2013)

7.5. Groundwater Depths (Site Specific)

During the drilling process the driller notes the depth of groundwater strike/s. The driller also observes the hole after drilling (typically 24 hours after completion) for the presence of groundwater, using a dip meter tool. The depths (if reported) are typically reproduced on the borehole log. A summary of pertinent information follows:

No.	Borehole number	Depth of borehole (m)	Groundwater rest depth (m)
1	4414	29	4,8
2	4911	41	5,5
3	5017	38	3,7
4	5212	21	1,0
5	5414	24	4,3
6	5507	40	2,0
7	5521/5422	47	14,8
8	5818	48	16,8
9	6024	33	1,2
10	7/24	54	46
11	V10	27	collapsed
12	V40/12A	37	2,8
13	V61/21	28	7,9

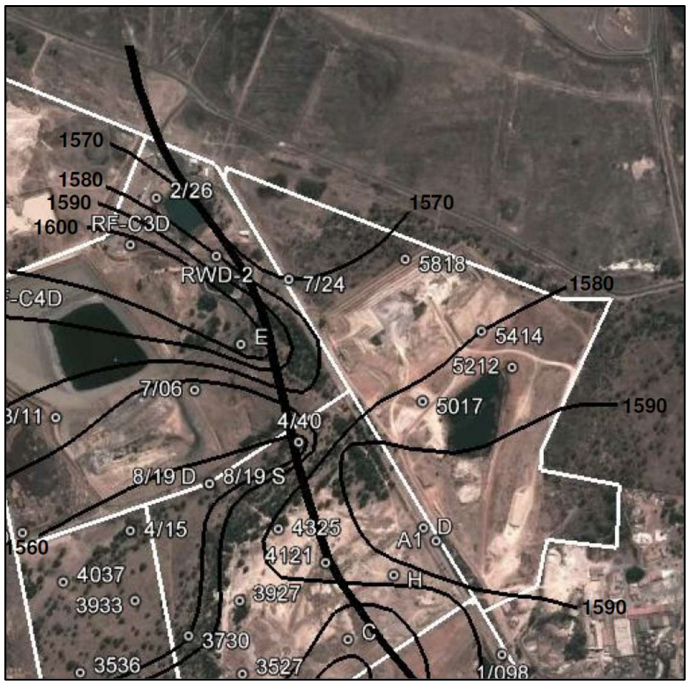
The 2011 reports states the following regarding groundwater:

- The depth to water level varies considerably across the site.
- In severely disturbed areas, due to the mining of clay and excavation of material for road building purposes (for example Areas E and F), ponding of rain and storm water occurs and elevated or perched piezometric levels are observed that do not reflect the natural static groundwater level.
- More representative and deeper static water levels are expected towards the end of the winter once surface water has dried up. Some boreholes in this area drilled into dolomite have water levels in excess of 55 m below ground level.
- Representative static water levels across the area are expected to indicate a north-westerly ground water flow direction towards the Blesbokspruit.
- To what degree, if at all, the dyke intrusion influences groundwater movement is not yet clear.

The following report provides information with respect to the deeper groundwater aquifer:

Titled: “An Assessment Of The Geohydrological Conditions At The Proposed Tonk Meter Road Landfill Site Springs, Gauteng Province”, by by R Meyer R Meyer, dated February 2013, Report No. 01/2013.

The report indicates that the groundwater level elevations range from 1570m AMSL in the north to 1590m AMSL in the south of Area E.



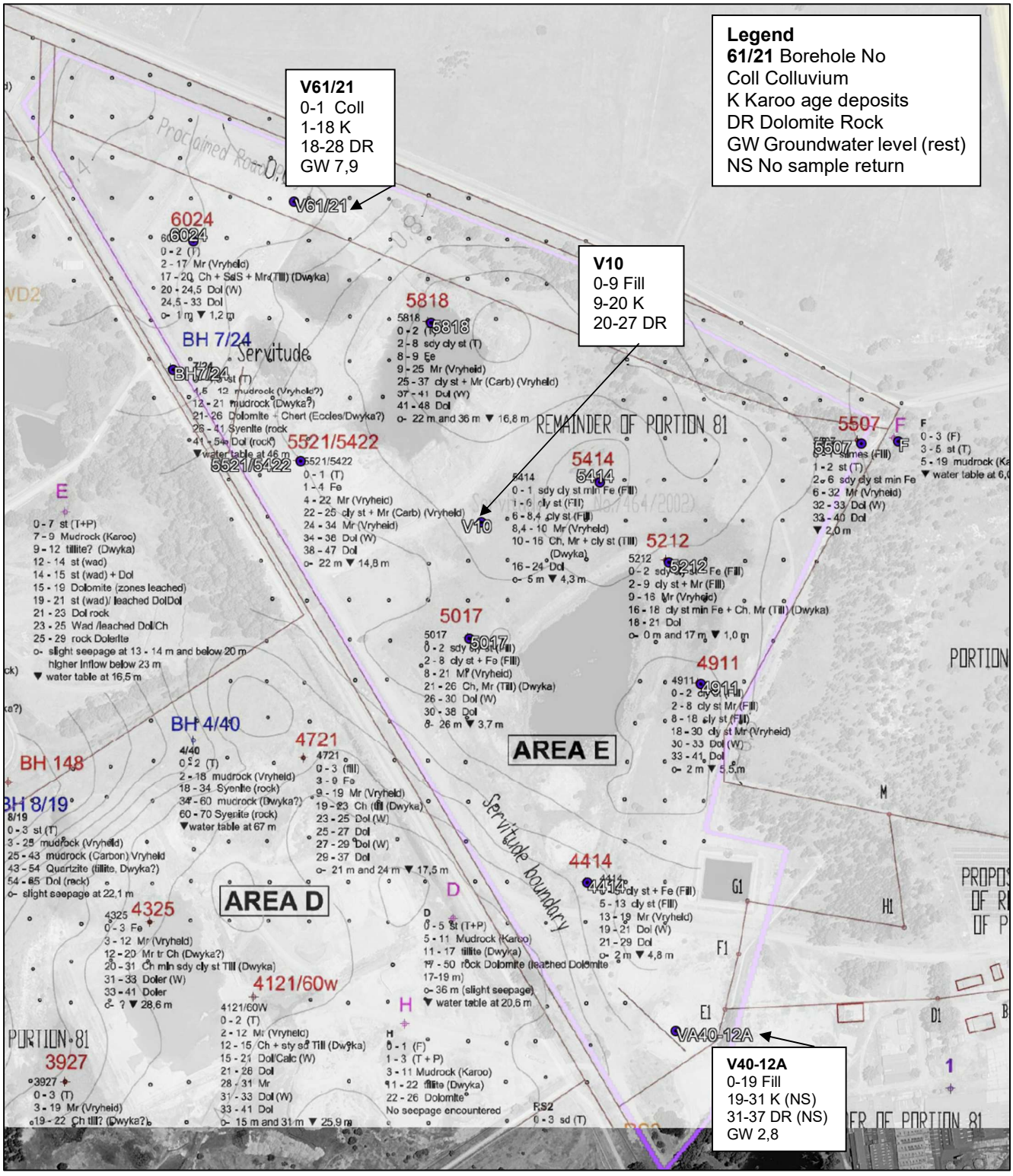


Figure 5: Borehole Summaries

8. DOLOMITE STABILITY CHARACTERISATION

8.1. Dolomite Hazard Assessment (2011)

According to the 2011 study:

- The Rand Water pipeline forms the southwestern boundary.
- The southern part of the area has been excavated by Corobrik for “clays”. Rehabilitation has started on the southern part of the excavated area which resulted in backfill being present over

large areas. Most of the southern holes i.e. 4414, 4911, 5017, 5212, and 5414, have therefore been drilled through backfill.

- Some temporary earth dams are also present on the backfilled area and the area south of the northern excavated face is filled with water.
- Some trenches and old deep partly backfilled excavations are present near the southeastern boundary while some shallow water filled excavations are also present on the northern area. High unnatural water tables are therefore present and this resulted in difficult drilling conditions and contamination in some of the holes.
- Corobrik orthophoto plans indicate a natural ground elevation of about 1609m AMSL parallel to the northeastern boundary and an elevation of 1615m AMSL at the northeastern corner of Area A (the Ekurhuleni waste disposal site).
- A magnetic anomaly shows a dyke to be present west of the RW pipeline and a number of intersections of dolerite sheets or sills were encountered in some of the boreholes. In Area E only BH 7/24 intersected dolerite. According to the magnetic surveys this location should be close to the dyke. No dolerite was found in any of the other boreholes drilled in Area E. If dolerite is present on Area E it must therefore be at deeper levels.
- Dwyka age sediments were profiled in 5 of the 9 holes (BH F was only drilled to 19 m in Vryheid Formation mudrocks). The Dwyka material was found at depths ranging from 1728m (from collar elevation) and the thicknesses of the Dwyka vary between 2-9m.
- The depth to dolomite correlates reasonably well with the gravity data. Dolomite is shallower on the northern area and deeper near the present northern quarry face. It is shallower in the central part and southern corner which have been mined and deeper on the eastern boundary and central southwestern boundary.
- Dolomite residuum is absent (as for Area D) but a slightly leached dolomite rock with penetration times about of 1 to 2 min/m is also present near the contact with the Dwyka or Vryheid Formation sediments
- The whole area is overlain by Karoo mudrocks.
- The upper part of the Karoo mudrock profile can be seen in the northern quarry face. It consists of sandy ferruginised material near surface with nodular ferricrete lower down. This changes into ferruginised residual mudrock followed by mainly structureless reworked slightly ferruginised clayey silt (completely weathered mudrock). All the above is referred to as “overburden” by the quarry operators. This is followed by a soft to very soft rock shale (“yellow clay”), in turn followed by a purplish shale (plastic clay) with the fire clays (a grey mudrock) further down. The fire clay is below the present water level in the quarry and is about at the depth to which the area was mined (about 15 – 22 m). Borehole 5521/5422 indicates that some carbonaceous shale often underlies these sediments.
- The floor levels of the future waste cells have not been determined and it is highly unlikely that they will ever reach the dolomite level but it will be a requirement to leave at least a 3m well consolidated layer above the dolomite followed by the base preparation layer, the under drainage and monitoring layer, the upper lining layers and the leachate collection layer.
- The Inherent Hazard Class is IHC 1, the Dolomite Area Designation is D2.

8.2. **Supplementary Dolomite Stability Investigation (2013)**

The report states the following salient points-

Servitude area

- Three boreholes are situated close to the southern boundary of the servitude (boreholes 60/24, 58/18 and 55/07).
- Dolomite rock was encountered at 20m, 37m and 32m in the three boreholes respectively.
- The dolomite is overlain by Vryheid Formation rocks which include some carbonaceous material in hole 58/18. Dwyka Group (tillite) is present above the dolomite in 60/24.
- Slightly weathered dolomite rock is present from 18,0 to 22,2 m followed by unweathered rock down to 28,0 m (EOH). No air or sample loss occurred in the hole.

Southern area

- Borehole 40/12A was drilled in the southern area where the existing gravity survey was extended. Old quarry plans show that the area was previously excavated.
- The drilling results confirm that the area was excavated in the past and then backfilled. Backfilled material consisting of brick, ash and mudrock, in a matrix of silty clay, is present down to 19,0m and no samples could be recovered from below the fill/rock contact.
- The material from 31,3-37 m is rock with penetration times varying from 3:19 – 3:44 min:sec/m indicating hard rock.
- The Inherent Hazard Class is IHC 1, the Dolomite Area Designation is D2.

8.3. Dolomite Hazard Assessment Review (2026)

The investigation and hazard assessment procedures are presented in Sections 5 of this report.

A summary of subsurface conditions intercepted in boreholes drilled in Area E follows:

Borehole Number	Transported material (m-m)	Pre or Post Malmani Subgroup (m-m)	Chert Residuum		Dolomite Residuum (m-m)	Weathered dolomite rock (m-m)	Dolomite Bedrock m	Ground water rest level
			Fines subordinate (m-m)	Fines predominant (m-m)				
4414	0-13 Fill	13-19 K	-	-	-	19-21	21-29	4,8
4911	0-18 Fill	18-30 K	-	-	-	30-33	33-41	5,5
5017	0-8 Fill	8-26 K	-	-	-	26-30	30-38	3,7
5212	0-9 Fill	9-18 K	-	-	-	-	18-21	1,0
5414	0-8 Fill	8-16 K	-	-	-	-	16-24	4,3
5507	1-20-1 Fill, 2-6 Pedo	6-32 K	-	-	-	**32-33**	**33-40**	**2,0**
5521/5422	0-1,1-4 Pedo	4-34 K	-	-	-	34-38	38-47	14,8
5818	0-88-9 Pedo	9-37 K	-	-	-	37-41	41-48	16,8
6024	0-2	2-20 K	-	-	-	20-24	24-33	1,2
F	0-3 Pedo, 3-5	5-19 K	-	-	-			6,0
7/24	0-4	4-21 K 26-41 Dolerite	-	-	-	21-26	41-45	45,0
V10	0-9 Fill	9-20 K	-	-	-	-	20-27	
V40/12A	0-19 Fill	19-31 NSR	-	-	-	-	31-37 NSR	2,8
V61/21	0-1	1-18 K	-	-	-	18-22	22-28	7,9

It appears that Boreholes 5212 and 5414 were drilled in a gravity high anomaly. To the east, west and south of this anomaly, the depth to and thickness of the Karoo material increases.

i. Blanketing Layer

The blanketing layer is of **great thickness**, consisting of relatively thick horizons of Karoo deposits. 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, 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)

Considering the anticipated low permeability of materials above dolomite bedrock, the area exhibits a low susceptibility of sinkhole and subsidence formation. In areas where Karoo cover thins a medium susceptibility of sinkhole and subsidence formation is anticipated.

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

The dolomite groundwater level is recorded at 51m deep in 2005 in the nearest Department of Water and Sanitation dolomite aquifer monitoring station. The current groundwater level is 29m deep. The mean groundwater level elevation is 1469m AMSL, as determined by the Water Research Commission, refer to Section 7.4).

The shallow groundwater levels reported in the 2011 and 2013 boreholes may represent perched groundwater. The deeper groundwater level recorded in Borehole 7/24 (45m deep) may represent the dolomite groundwater level. The groundwater level elevation as determined by the R Meyer report is 1570m to 1590m AMSL across Area E, some 20-40m deep.

Anticipating the possibility of artificial groundwater level drawdown, drawdown would typically occur within dolomite rock. The susceptibility to sinkhole and subsidence formation is considered to be low.

ii. 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 (6m or more), the hazard classification remains unchanged.

Area E is broadly characterised in terms of a single primary Inherent Hazard Class area, described as follows:

Inherent Hazard Class	Description
1/2//1	An area reflecting a **low to medium** susceptibility of sinkhole and subsidence formation with respect to ingress of water and a **low** susceptibility of all-size sinkhole and subsidence formation with respect to anthropogenic groundwater level drawdown.

9. CONCLUSIONS

9.1. Geology

Area E is located on Karoo age deposits, which blanket dolomite rock at intermediate to great depth. In the past clays were quarried from this site. These areas have apparently been backfilled.

9.2. Geohydrology

The shallow groundwater levels reported in the 2011 and 2013 boreholes may be perched groundwater. The deeper groundwater level recorded in Borehole 7/24 (45m deep) may represent the dolomite groundwater level.

The dolomite groundwater level was 51m deep in 2005 in the nearest Department of Water and Sanitation dolomite aquifer monitoring station. The current groundwater level is 29m deep. The mean groundwater level elevation is 1469m AMSL according to the Water Research Commission (2014).

Acknowledging the significant difference between the current groundwater level depth at Monitoring Station C2N1114 on the farm Modderfontein and Borehole 7/24 (drilled in 2012), monitoring of the site specific groundwater level (of the dolomite aquifer) is recommended.

9.3. Dolomite Hazard Assessment

Based on available data and current best practice, Area E represents a **low to medium** susceptibility of sinkhole and subsidence formation with respect to ingress of water and a **low** susceptibility of all-size sinkhole and subsidence formation with respect to anthropogenic groundwater level drawdown, i.e. Inherent Hazar Class 1/2//1.

9.4. Design Hazard Class

The Design Hazard Class is 2. In light of the land use, the Dolomite Area Designation is D3.

10. RECOMMENDATIONS

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

Development normally results in a disturbance of the meta-stable conditions in the dolomite environment. Consequently, factors such as the basic design of services, construction and service installation procedures, and ongoing infrastructure maintenance programmes are key elements in the overall strategy to reduce the probability of generating ground movement events. Risk management consists of key elements such as **implementation of precautionary measures** to prevent the concentrated ingress of water into the ground, **monitoring actions** to detect problems which could lead to ground movement and **maintenance** of infrastructure.

According to SANS 1936 (2012) Part 1, Table 3, landfill is permissible:

Infrastructure and social facilities		**Inherent hazard class determined in accordance with the requirements of SANS 1936-2**							
Designa-tion	**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	

The following conditions were set for support of the development by the Council for Geoscience in May 203:

1) A Dolomite Risk Management Plan must be compiled and implemented for the site since it is underlain by dolomite.

2) The professional team involved shall carefully consider the appropriate water precautionary measures and then ensure and finally certify that these have been implemented.

3) The design of a waste disposal site should ensure the following:
   - 3-1 No polluted water or liquids leak into the underlying soils or rooks.
   - 3-2 All stormwater be diverted away from the site to natural water courses.
   - 3-3 All water precipitated from undeveloped parts of the site be diverted away from the waste body and released into the natural water courses.
   - 3-4 The recommended standard lining system should be installed during the development of the site.
   - 3-5 If any leakage is detected steps must be taken to rectify the situation.

4) The precautionary measures as stipulated in SANS 1936-3:2012 document for waste disposal facilities should be implemented.

10.2. Precautionary Measures (SANS1936-3, 2012)

The site is subject to dolomite precautionary measures and designated as D3.

SANS 1936 (2012) Part 3 indicates the following with respect to waste disposal facilities:

"9.2 Additional precautionary measures on dolomite area designation D3 sites

9.2.1 *Swimming pools and liquid-retaining structures shall be designed so that any leakage that might occur during their lifetime can readily be detected or remedied.*

9.2.2 *Other liquid-retaining structures, including public swimming pools, shall not be placed within 50m of residential buildings and 30 m of non-residential structures.*

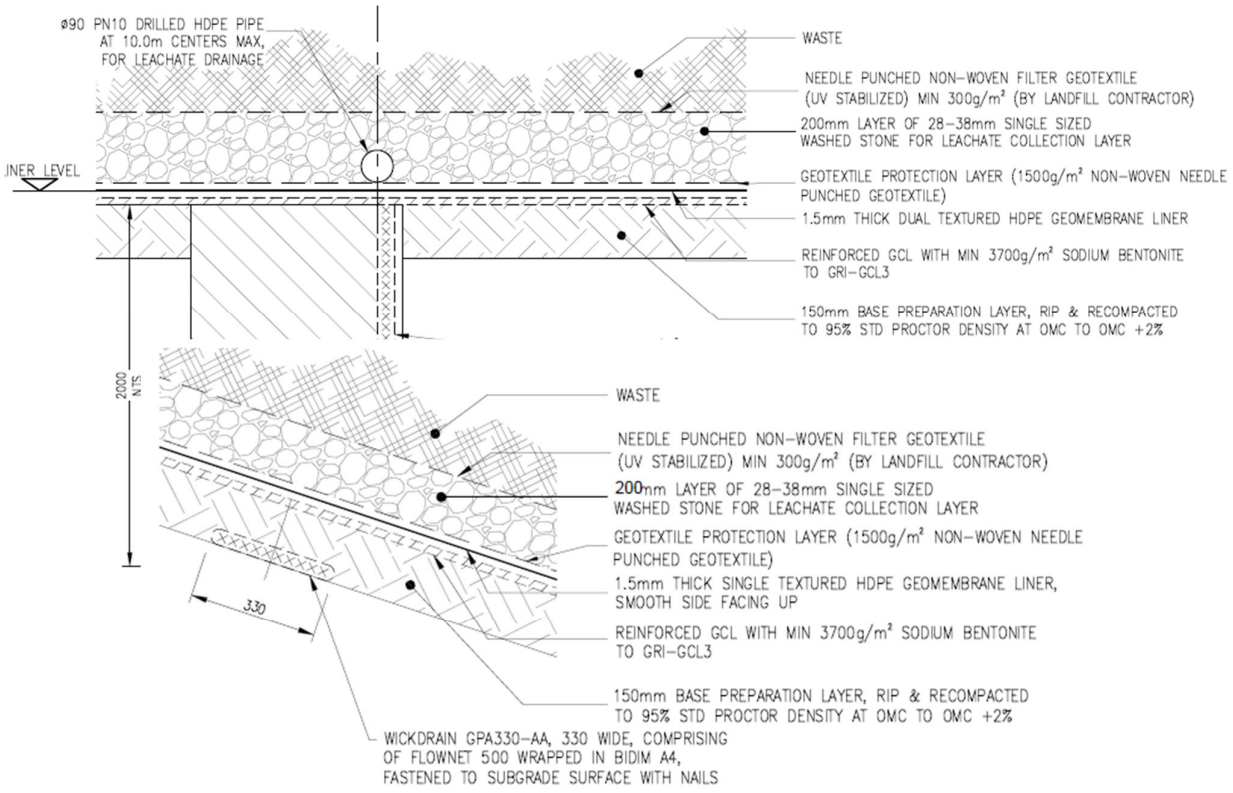
NOTE ***An impervious lining might be necessary*** *to prevent leakage in attenuation and retention ponds for stormwater management, artificial lakes, slimes dams and waste disposal facilities"*

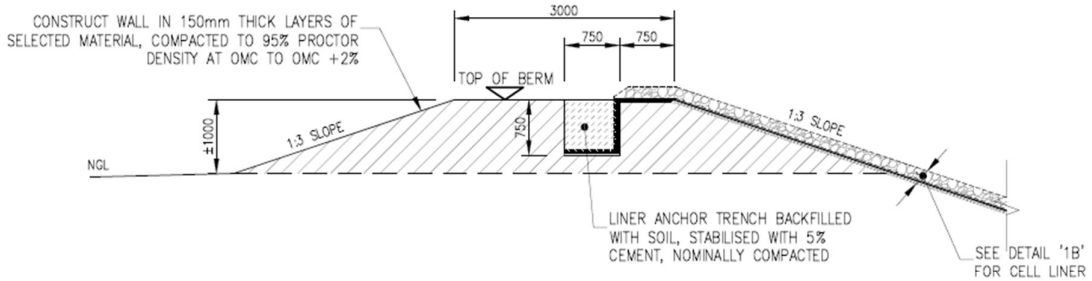
In addition, the standard calls for stormwater management, as a point of departure. This has been addressed and should be reassessed after the first rains of the rainy season as part of dolomite risk management.

The site-specific depth to and elevation of the dolomite groundwater level should be established and monitored. In the event that the dolomite groundwater level is recorded above dolomite bedrock, the need for further investigations should be considered.

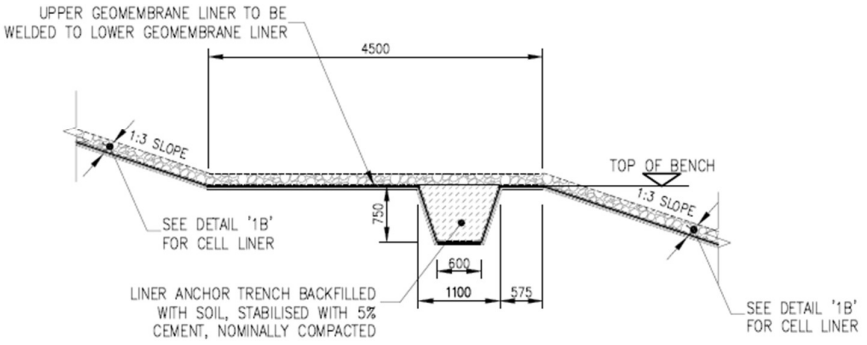
10.3. Design Considerations

The cell base liner design should comply with SANS 1936 (2012) Part 3, Section 9.2.1.

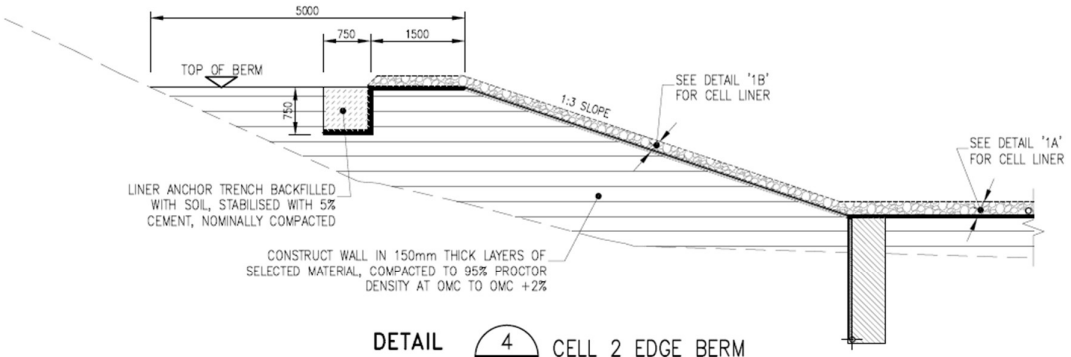




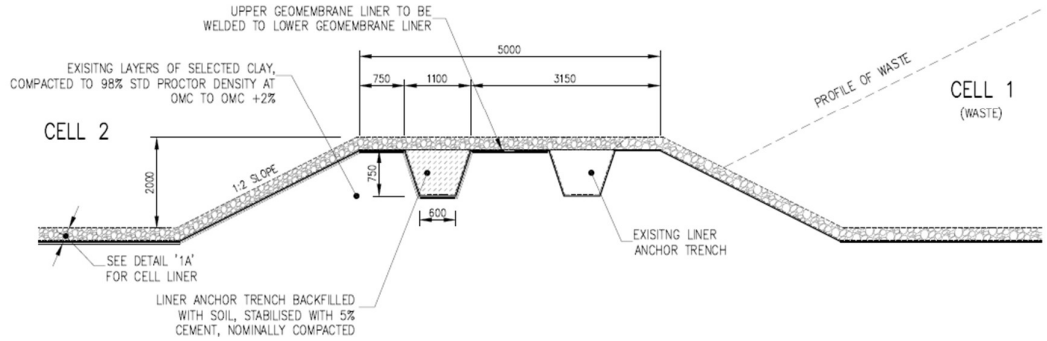
DETAIL 2 — PERIMETER BERM
SCALE 1:50



DETAIL 3 — BENCH
SCALE 1:50



DETAIL 4 — CELL 2 EDGE BERM
SCALE 1:50



DETAIL 5 — CELL DIVISION BERM
SCALE 1:50



Figure 6: Area E, Cells 1 and 2 in relation to boreholes drilled

10.4. Dolomite Risk Management

It is recommended that the owner of the Facility ensure that monitoring from a dolomite risk management perspective takes place.

The results of the visual inspection should be captured in a report.

In the event that any ground cracks develop, or stormwater ponds and does not effectively flow into the larger stormwater system, this should be appropriately addressed. The inspection should include date, time, person responsible and photographs, even if no problems are identified/observed.

10.5. Future Extensions

Refer to Figure 7. According to existing reports, the backfill area within Area E is delineated. The nature of the backfill operation and extent to which material was compacted is not known to this author. Development of waste cells in the future in this area should consider the risks, including differential movement and infiltration of concentrated water to the deeper dolomite aquifer and potential for subsurface erosion. Prior to approval of any expansion over areas of backfill, it should be determined if leaks from the cell could negatively impact dolomite stability and the like.

Areas considered for storage of water (relate to landfill operations) are to meet the requirements of SANS 1936 Part 2 (2012) and may require footprint specific dolomite stability assessment.

11. GENERAL

11.1. Verification Process

The findings in this report are based upon our interpretation of existing data. 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. IntraSolutions, its members and personnel cannot be held responsible for these divergent views or consequential damages.

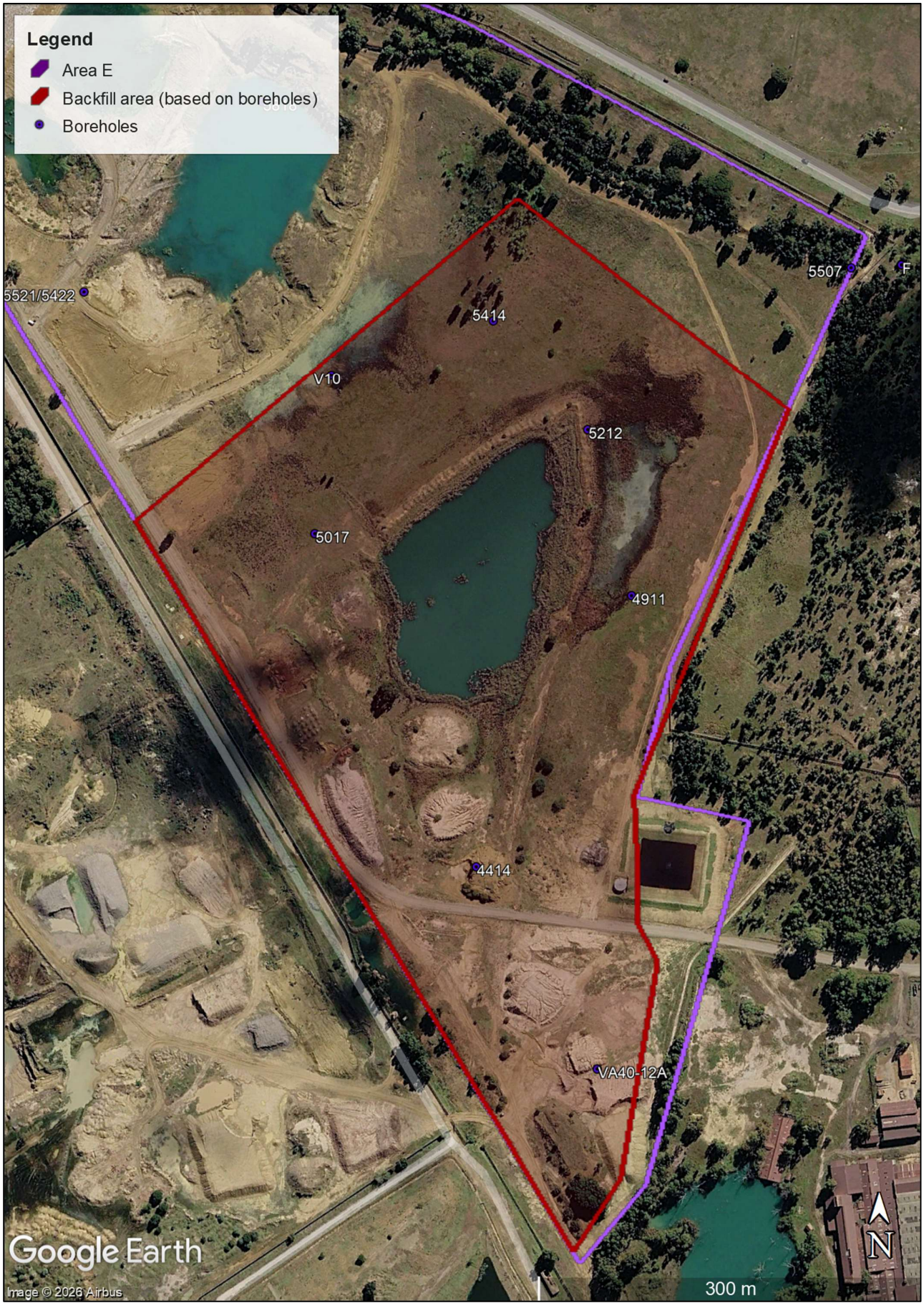


Figure 7: Backfill area (southern portion of Area E)

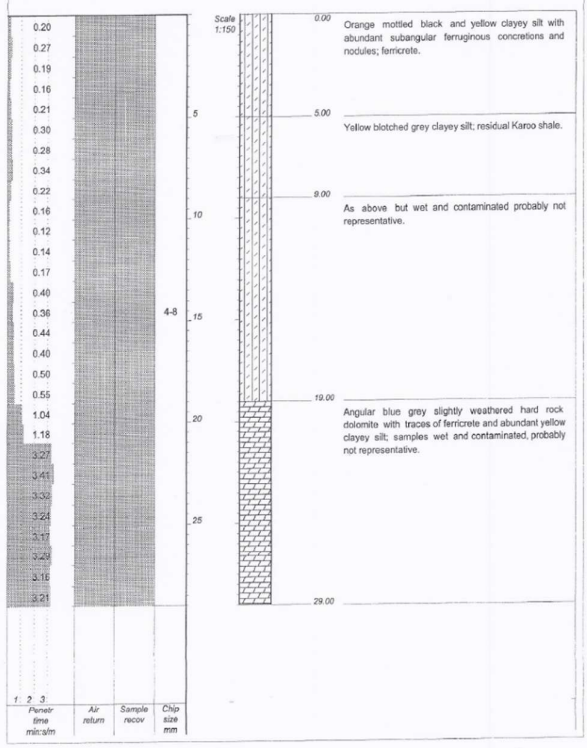
APPENDICES

BOREHOLE LOGS APPENDIX 1

VERREF RIETFONTEIN
Rietfontein Waste Disposal Site

HOLE No: BH 4414
Sheet 1 of 2

JOB NUMBER: 2011/02



0.00 Orange mottled black and yellow clayey silt with abundant subangular ferruginous concretions and nodules; ferricrete.

5.00 Yellow blotched grey clayey silt; residual Karoo shale.

9.00 As above but wet and contaminated probably not representative.

19.00 Angular blue grey slightly weathered hard rock dolomite with traces of ferricrete and abundant yellow clayey silt; samples wet and contaminated, probably not representative.

29.00

VERREF RIETFONTEIN
Rietfontein Waste Disposal Site

HOLE No: BH 4414
Sheet 2 of 2

JOB NUMBER: 2011/02

NOTES

1) Driller records hard rock dolomite from 21 m with soft rock from 19 m.

1 2 3
Penetr time min:s/m | Air return | Sample recov | Chip size mm

CONTRACTOR : HENNIE ERWEE
MACHINE : Super Rock
DRILLED BY : Paulus
PROFILED BY : B Bolitho

TYPE SET BY : K Stewart
SETUP FILE : PERCUSS.SET

INCLINATION :
DIAM : 165mm
DATE : 2011-05-26
DATE : 2011-06-15

DATE : 23/06/11 22:13
TEXT : ..C:\DOTFILES\M22HOL~1.TXT

ELEVATION :
X-COORD : -2909792.0175
Y-COORD : -57 388.3760

HOLE No: BH 4414

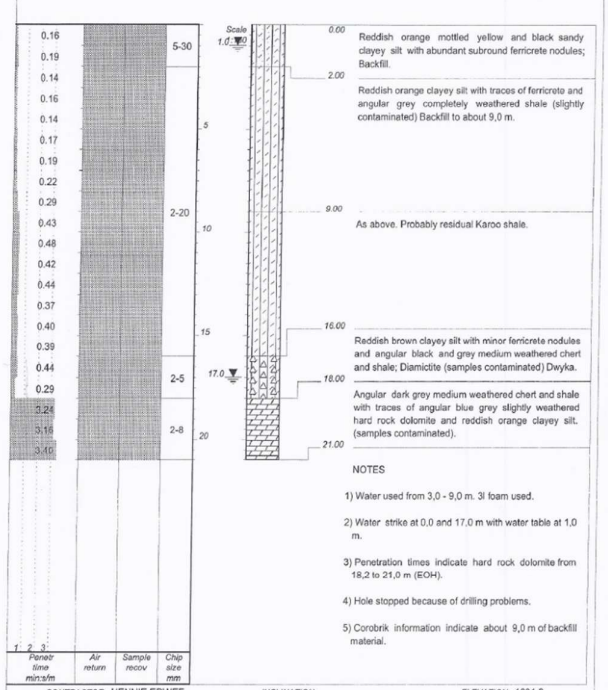
D039 JD GEOTECHNICAL SERVICES CC

dotPLOT 6005 PBp

VERREF RIETFONTEIN
Rietfontein Waste Disposal Site

HOLE No: BH 5212
Sheet 1 of 1

JOB NUMBER: 2011/02



0.00 Reddish orange mottled yellow and black sandy clayey silt with abundant subround ferricrete nodules; Backfill.

2.00 Reddish orange clayey silt with traces of ferricrete and angular grey completely weathered shale (slightly contaminated) Backfill to about 9,0 m.

9.00 As above. Probably residual Karoo shale.

16.00 Reddish brown clayey silt with minor ferricrete nodules and angular black and grey medium weathered chert and shale; Diamictite (samples contaminated) Dwyka.

18.00 Angular dark grey medium weathered chert and shale with traces of angular blue grey slightly weathered hard rock dolomite and reddish orange clayey silt. (samples contaminated).

21.00

NOTES

1) Water used from 3,0 - 9,0 m. 3l foam used.

2) Water strike at 0,0 and 17,0 m with water table at 1,0 m.

3) Penetration times indicate hard rock dolomite from 18,2 to 21,0 m (EOH).

4) Hole stopped because of drilling problems.

5) Corobrik information indicate about 9,0 m of backfill material.

CONTRACTOR : HENNIE ERWEE
MACHINE : Super Rock
DRILLED BY : Paulus
PROFILED BY : B Bolitho

TYPE SET BY : K Stewart
SETUP FILE : PERCUSS.SET

INCLINATION :
DIAM : 165mm
DATE : 2011-05-26
DATE : 2011-06-16

DATE : 21/07/11 15:32
TEXT : ..C:\DOTFILES\22HOLE~2.TXT

ELEVATION : 1601.8
X-COORD : -2909452.2307
Y-COORD : -57 302.8742

HOLE No: BH 5212

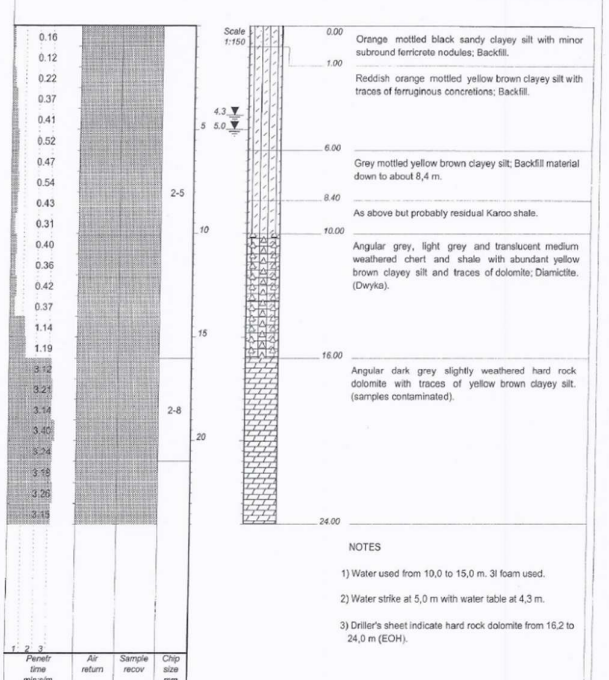
D039 JD GEOTECHNICAL SERVICES CC

dotPLOT 6005 PBp

VERREF RIETFONTEIN
Rietfontein Waste Disposal Site

HOLE No: BH 5414
Sheet 1 of 1

JOB NUMBER: 2011/02



0.00 Orange mottled black sandy clayey silt with minor subround ferricrete nodules; Backfill.

1.00 Reddish orange mottled yellow brown clayey silt with traces of ferruginous concretions; Backfill.

6.00 Grey mottled yellow brown clayey silt; Backfill material down to about 8,4 m.

8.40 As above but probably residual Karoo shale.

10.00 Angular grey, light grey and translucent medium weathered chert and shale with abundant yellow brown clayey silt and traces of dolomite; Diamictite. (Dwyka).

16.00 Angular dark grey slightly weathered hard rock dolomite with traces of yellow brown clayey silt. (samples contaminated).

24.00

NOTES

1) Water used from 10,0 to 15,0 m. 3l foam used.

2) Water strike at 5,0 m with water table at 4,3 m.

3) Driller's sheet indicate hard rock dolomite from 16,2 to 24,0 m (EOH).

CONTRACTOR : HENNIE ERWEE
MACHINE : Super Rock
DRILLED BY : Paulus
PROFILED BY : B Bolitho

TYPE SET BY : K Stewart
SETUP FILE : PERCUSS.SET

INCLINATION :
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DATE : 2011-06-20

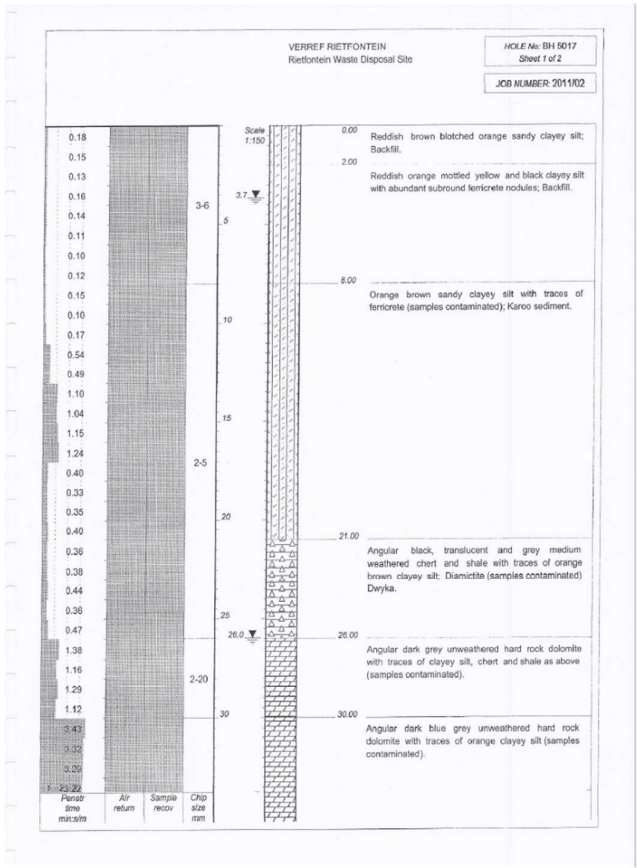
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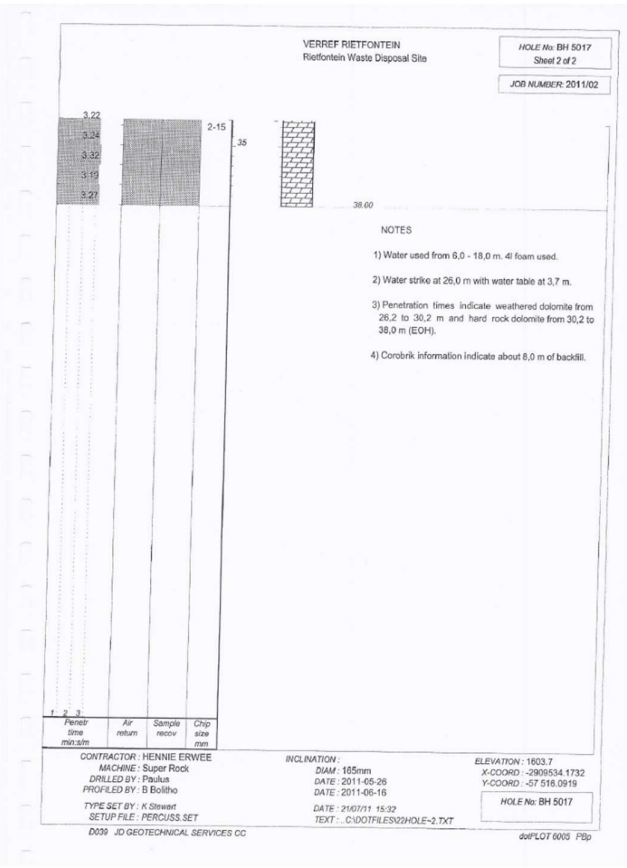
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Y-COORD : -57 377.0560

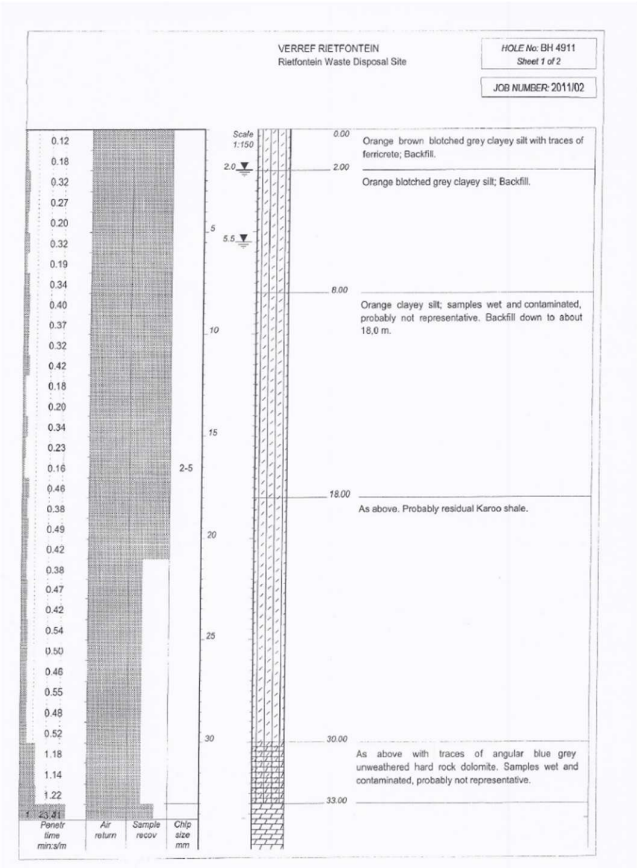
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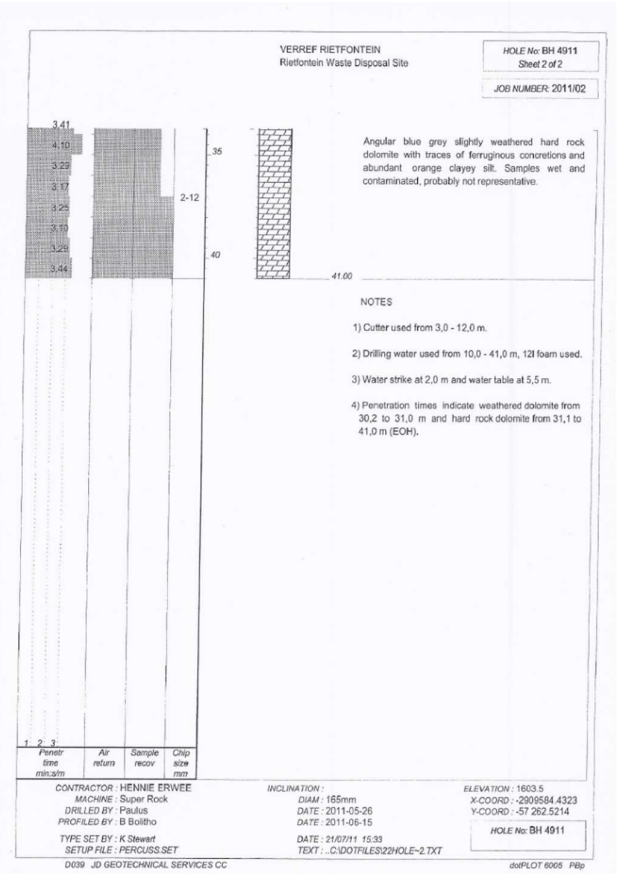
D039 JD GEOTECHNICAL SERVICES CC

dotPLOT 6005 PBp


VERREF RIETFONTEIN
Rietfontein Waste Disposal Site
HOLE No: BH 5017
Sheet 1 of 2
JOB NUMBER: 2011/02
Scale 1:150
0.00 Reddish brown blotched orange sandy clayey silt; Backfill.
2.00 Reddish orange mottled yellow and black clayey silt with abundant subround ferricrete nodules; Backfill.
3.7
8.00 Orange brown sandy clayey silt with traces of ferricrete (samples contaminated); Karoo sediment.
21.00 Angular black, translucent and grey medium weathered chert and shale with traces of orange brown clayey silt; Diamictite (samples contaminated) Dwyka.
26.0
26.00 Angular dark grey unweathered hard rock dolomite with traces of clayey silt, chert and shale as above (samples contaminated).
30.00 Angular dark blue grey unweathered hard rock dolomite with traces of orange clayey silt (samples contaminated).
3-6
2-5
2-20
Penetr time min:s/m
Air return
Sample recov
Chip size mm


VERREF RIETFONTEIN
Rietfontein Waste Disposal Site
HOLE No: BH 5017
Sheet 2 of 2
JOB NUMBER: 2011/02
2-15
38.00
NOTES
1) Water used from 6,0 - 18,0 m. 4l foam used.
2) Water strike at 26,0 m with water table at 3,7 m.
3) Penetration times indicate weathered dolomite from 26,2 to 30,2 m and hard rock dolomite from 30,2 to 38,0 m (EOH).
4) Corobrik information indicate about 8,0 m of backfill.
CONTRACTOR : HENNIE ERWEE
MACHINE : Super Rock
DRILLED BY : Paulus
PROFILED BY : B Bolitho
TYPE SET BY : K Stewart
SETUP FILE : PERCUSS.SET
INCLINATION :
DIAM : 165mm
DATE : 2011-05-26
DATE : 2011-06-16
DATE : 21/07/11 15:32
TEXT : ..C:\DOTFILES\22HOLE~2.TXT
ELEVATION : 1603.7
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Y-COORD : -57 516.0919
HOLE No: BH 5017
D039 JD GEOTECHNICAL SERVICES CC
dotPLOT 6005 PBp

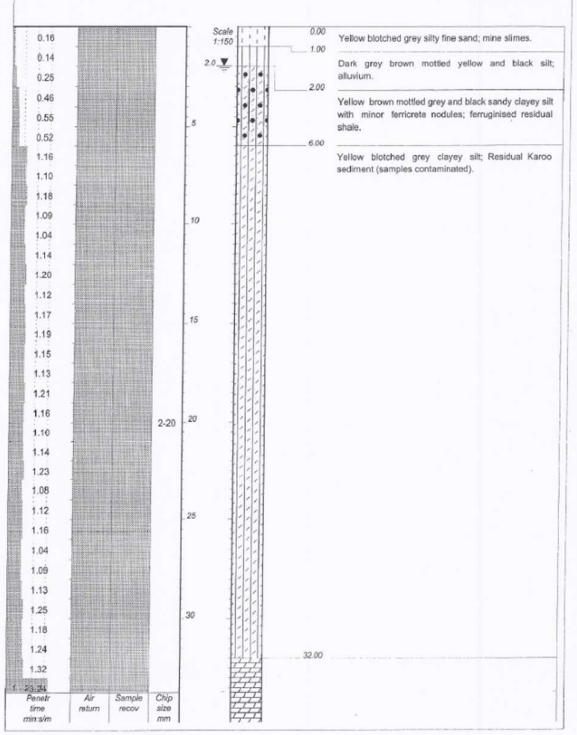

VERREF RIETFONTEIN
Rietfontein Waste Disposal Site
HOLE No: BH 4911
Sheet 1 of 2
JOB NUMBER: 2011/02
Scale 1:150
0.00 Orange brown blotched grey clayey silt with traces of ferricrete; Backfill.
2.0
2.00 Orange blotched grey clayey silt; Backfill.
5.5
8.00 Orange clayey silt; samples wet and contaminated, probably not representative. Backfill down to about 18,0 m.
18.00 As above. Probably residual Karoo shale.
30.00 As above with traces of angular blue grey unweathered hard rock dolomite. Samples wet and contaminated, probably not representative.
33.00
2-5
Penetr time min:s/m
Air return
Sample recov
Chip size mm


VERREF RIETFONTEIN
Rietfontein Waste Disposal Site
HOLE No: BH 4911
Sheet 2 of 2
JOB NUMBER: 2011/02
2-12
41.00
Angular blue grey slightly weathered hard rock dolomite with traces of ferruginous concretions and abundant orange clayey silt. Samples wet and contaminated, probably not representative.
NOTES
1) Cutter used from 3,0 - 12,0 m.
2) Drilling water used from 10,0 - 41,0 m, 12l foam used.
3) Water strike at 2,0 m and water table at 5,5 m.
4) Penetration times indicate weathered dolomite from 30,2 to 31,0 m and hard rock dolomite from 31,1 to 41,0 m (EOH).
CONTRACTOR : HENNIE ERWEE
MACHINE : Super Rock
DRILLED BY : Paulus
PROFILED BY : B Bolitho
TYPE SET BY : K Stewart
SETUP FILE : PERCUSS.SET
INCLINATION :
DIAM : 165mm
DATE : 2011-05-26
DATE : 2011-06-15
DATE : 21/07/11 15:33
TEXT : ..C:\DOTFILES\22HOLE~2.TXT
ELEVATION : 1603.5
X-COORD : -2909584.4323
Y-COORD : -57 262.5214
HOLE No: BH 4911
D039 JD GEOTECHNICAL SERVICES CC
dotPLOT 6005 PBp

VERREF RIETFONTEIN
Rietfontein Waste Disposal Site

HOLE No: BH 5507
Sheet 1 of 2

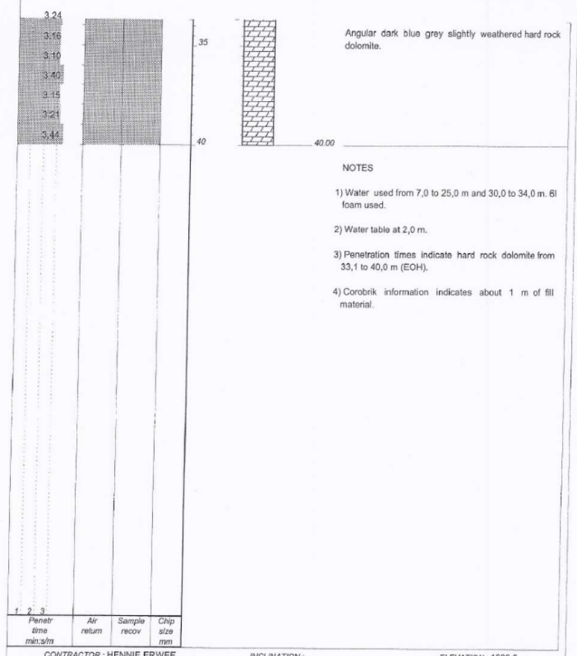
JOB NUMBER: 2011/02



VERREF RIETFONTEIN
Rietfontein Waste Disposal Site

HOLE No: BH 5507
Sheet 2 of 2

JOB NUMBER: 2011/02



CONTRACTOR : HENNIE ERWEE
MACHINE : Super Rock
DRILLED BY : Paulus
PROFILED BY : B Bolitho
TYPE SET BY : K Stewart
SETUP FILE : PERCUSS.SET

INCLINATION :
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DATE : 2011-06-16
DATE : 21/07/11 15:33
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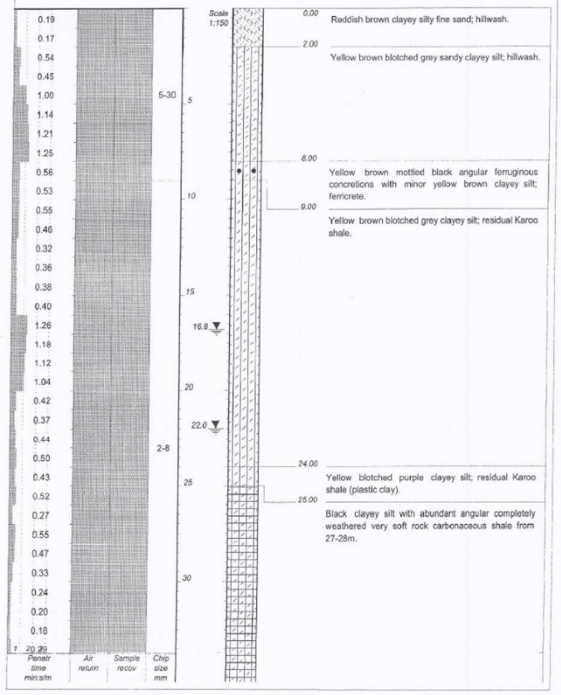
ELEVATION : 1606.0
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Y-COORD : -57 097.3706
HOLE No: BH 5507

D039 JD GEOTECHNICAL SERVICES CC
dotPLOT 6005 PBp

VERREF RIETFONTEIN
Rietfontein Waste Disposal Site

HOLE No: BH 5818
Sheet 1 of 2

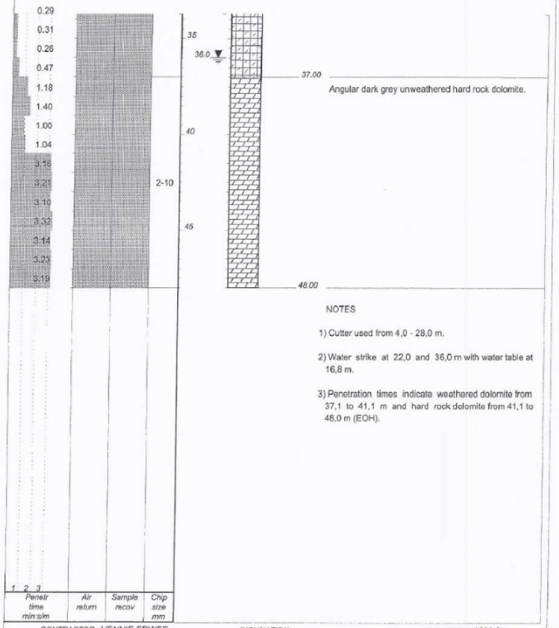
JOB NUMBER: 2011/02



VERREF RIETFONTEIN
Rietfontein Waste Disposal Site

HOLE No: BH 5818
Sheet 2 of 2

JOB NUMBER: 2011/02

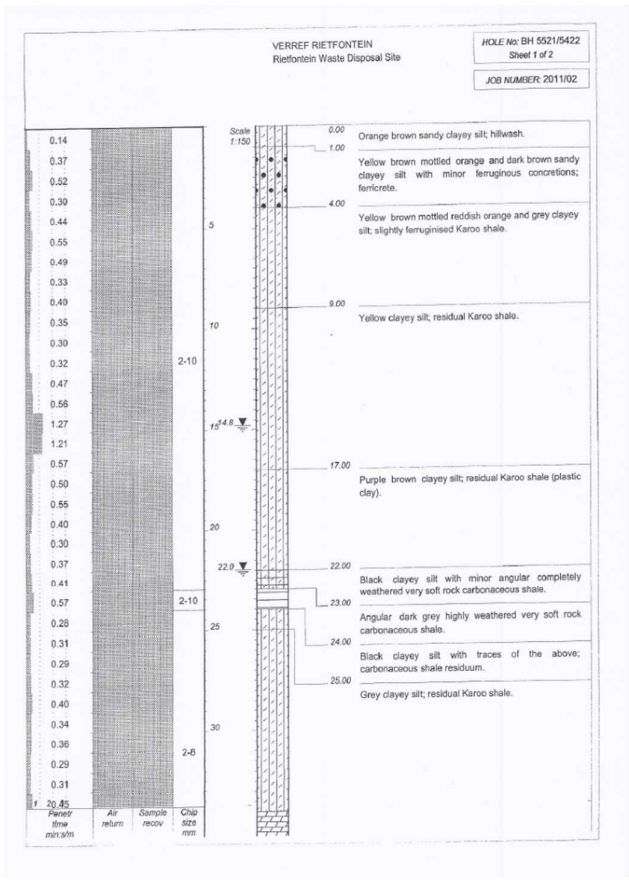


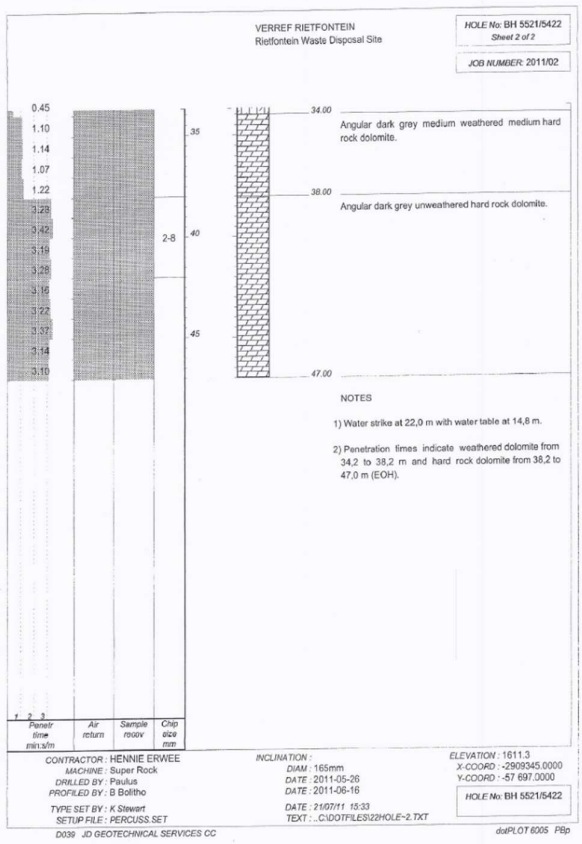
CONTRACTOR : HENNIE ERWEE
MACHINE : Super Rock
DRILLED BY : Paulus
PROFILED BY : B Bolitho
TYPE SET BY : K Stewart
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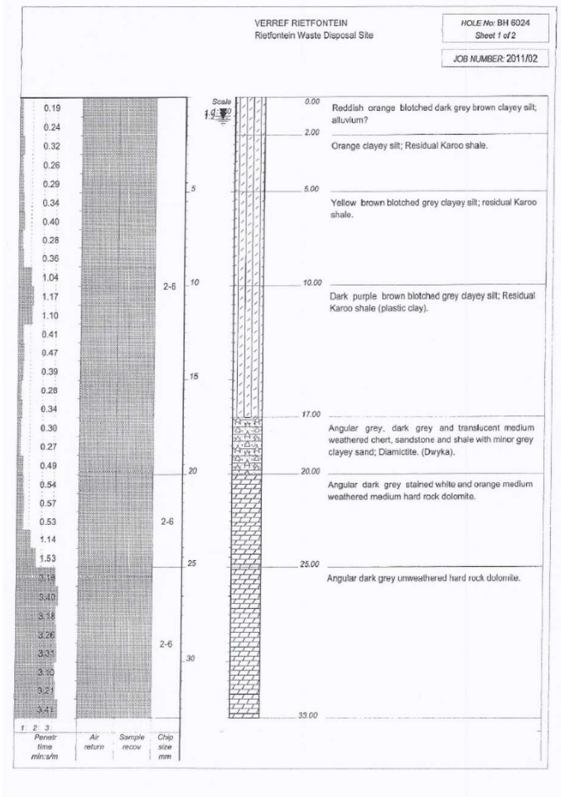
INCLINATION :
DIAM : 165mm
DATE : 2011-05-26
DATE : 2011-06-16
DATE : 21/07/11 15:33
TEXT : ..C:\DOTFILES\22HOLE~2.TXT

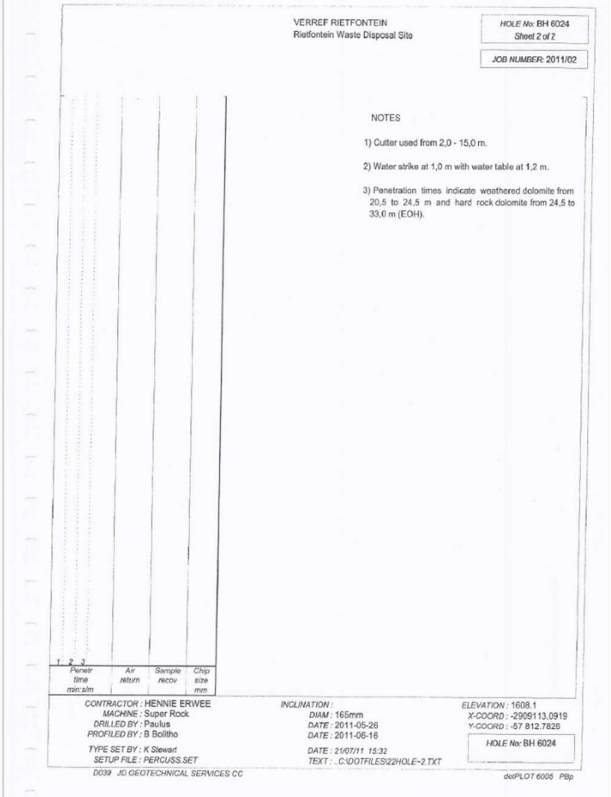
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HOLE No: BH 5818

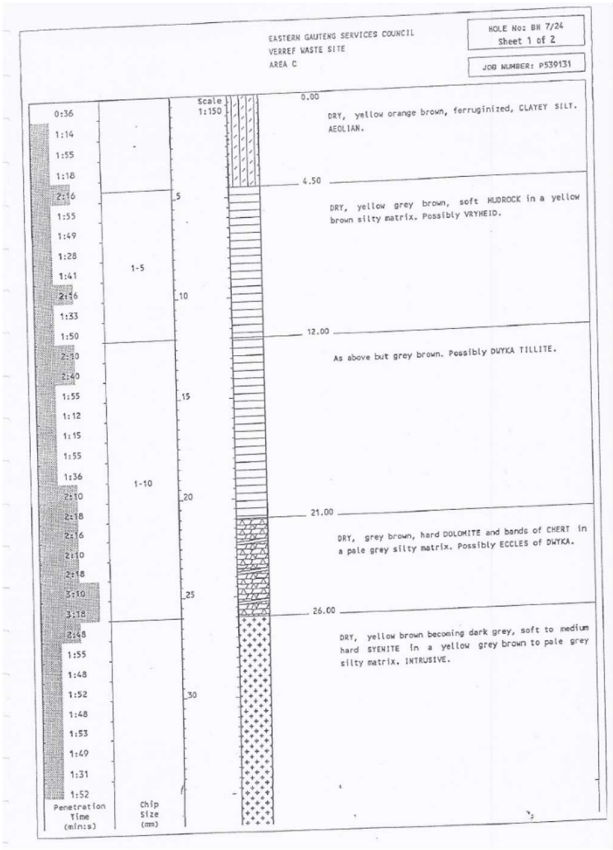
D039 JD GEOTECHNICAL SERVICES CC
dotPLOT 6005 PBp

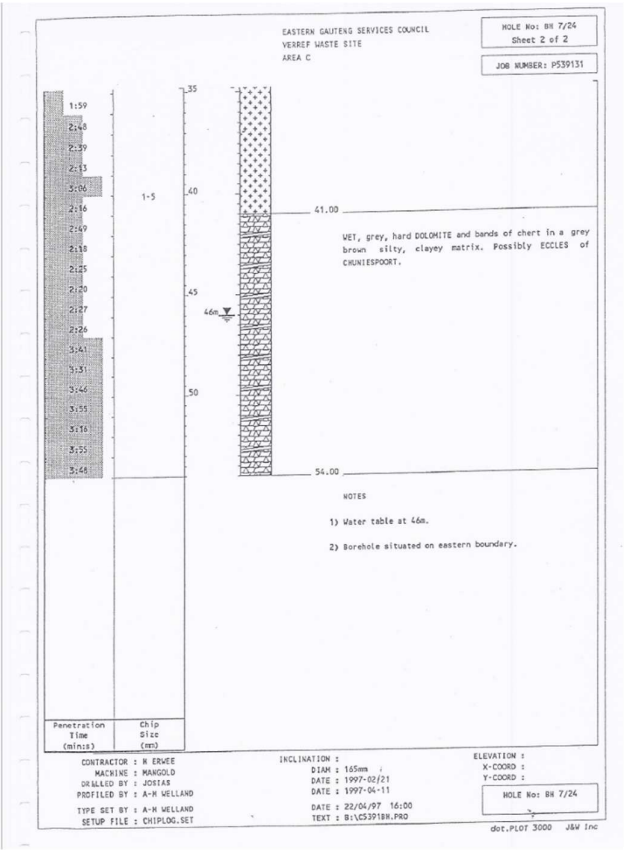

VERREF RIETFONTEIN
Rietfontein Waste Disposal Site
HOLE No: BH 5521/5422
Sheet 1 of 2
JOB NUMBER: 2011/02
Scale 1:150
0.00 Orange brown sandy clayey silt; hillwash.
1.00 Yellow brown mottled orange and dark brown sandy clayey silt with minor ferruginous concretions; ferricrete.
4.00 Yellow brown mottled reddish orange and grey clayey silt; slightly ferruginised Karoo shale.
9.00 Yellow clayey silt; residual Karoo shale.
14.8
17.00 Purple brown clayey silt; residual Karoo shale (plastic clay).
22.0
22.00 Black clayey silt with minor angular completely weathered very soft rock carbonaceous shale.
23.00 Angular dark grey highly weathered very soft rock carbonaceous shale.
24.00 Black clayey silt with traces of the above; carbonaceous shale residuum.
25.00 Grey clayey silt; residual Karoo shale.
2-10
2-10
2-6
Penetr time min:s/m
Air return
Sample recov
Chip size mm

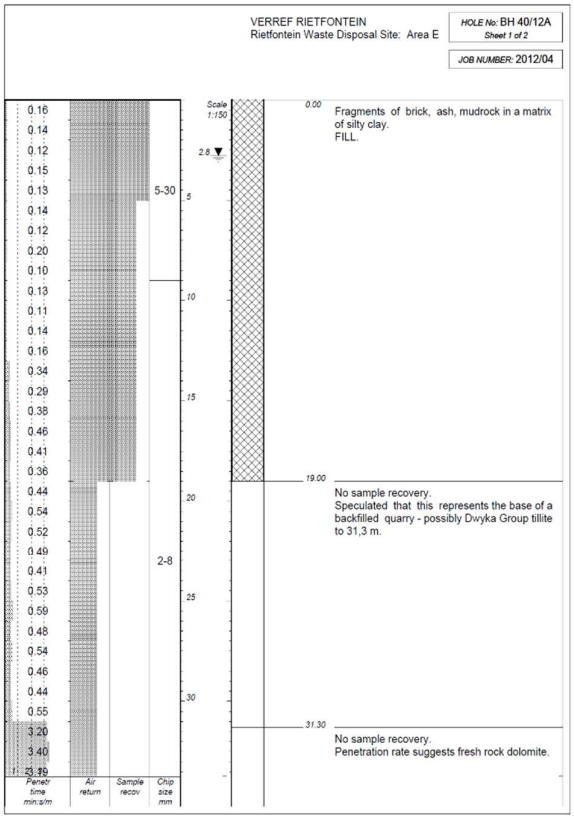

VERREF RIETFONTEIN
Rietfontein Waste Disposal Site
HOLE No: BH 5521/5422
Sheet 2 of 2
JOB NUMBER: 2011/02
34.00 Angular dark grey medium weathered medium hard rock dolomite.
38.00 Angular dark grey unweathered hard rock dolomite.
47.00
2-8
NOTES
1) Water strike at 22,0 m with water table at 14,8 m.
2) Penetration times indicate weathered dolomite from 34,2 to 38,2 m and hard rock dolomite from 38,2 to 47,0 m (EOH).
CONTRACTOR : HENNIE ERWEE
MACHINE : Super Rock
DRILLED BY : Paulus
PROFILED BY : B Bolitho
TYPE SET BY : K Stewart
SETUP FILE : PERCUSS.SET
INCLINATION :
DIAM : 165mm
DATE : 2011-05-26
DATE : 2011-06-16
DATE : 21/07/11 15:33
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ELEVATION : 1611.3
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Y-COORD : -57 697.0000
HOLE No: BH 5521/5422
D039 JD GEOTECHNICAL SERVICES CC
dotPLOT 6005 PBp

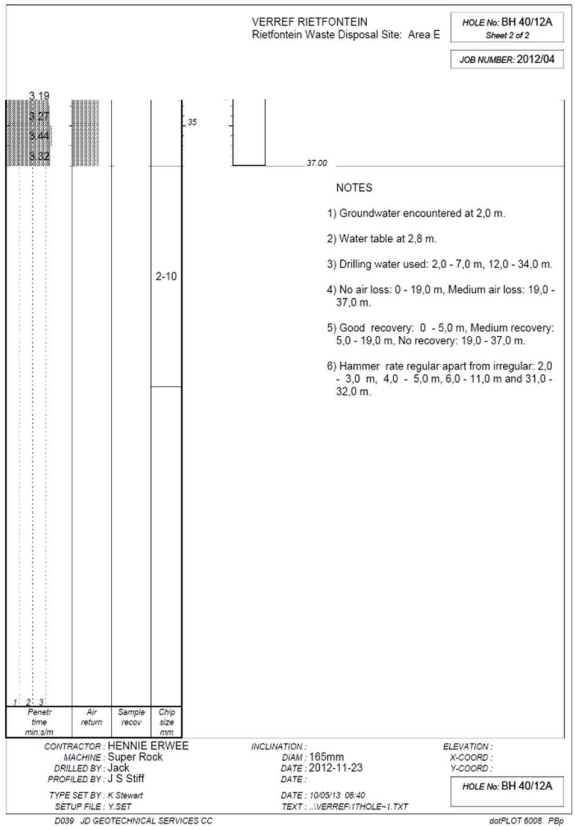

VERREF RIETFONTEIN
Rietfontein Waste Disposal Site
HOLE No: BH 6024
Sheet 1 of 2
JOB NUMBER: 2011/02
Scale 1:150
0.00 Reddish orange blotched dark grey brown clayey silt; alluvium?
2.00 Orange clayey silt; Residual Karoo shale.
5.00 Yellow brown blotched grey clayey silt; residual Karoo shale.
10.00 Dark purple brown blotched grey clayey silt; Residual Karoo shale (plastic clay).
17.00 Angular grey, dark grey and translucent medium weathered chert, sandstone and shale with minor grey clayey sand; Diamictite. (Dwyka).
20.00 Angular dark grey stained white and orange medium weathered medium hard rock dolomite.
25.00 Angular dark grey unweathered hard rock dolomite.
33.00
2-6
2-6
2-6
Penetr time min:s/m
Air return
Sample recov
Chip size mm


VERREF RIETFONTEIN
Rietfontein Waste Disposal Site
HOLE No: BH 6024
Sheet 2 of 2
JOB NUMBER: 2011/02
NOTES
1) Cutter used from 2,0 - 15,0 m.
2) Water strike at 1,0 m with water table at 1,2 m.
3) Penetration times indicate weathered dolomite from 20,5 to 24,5 m and hard rock dolomite from 24,5 to 33,0 m (EOH).
CONTRACTOR : HENNIE ERWEE
MACHINE : Super Rock
DRILLED BY : Paulus
PROFILED BY : B Bolitho
TYPE SET BY : K Stewart
SETUP FILE : PERCUSS.SET
INCLINATION :
DIAM : 165mm
DATE : 2011-05-26
DATE : 2011-06-16
DATE : 21/07/11 15:32
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ELEVATION : 1608.1
X-COORD : -2909113.0919
Y-COORD : -57 812.7826
HOLE No: BH 6024
D039 JD GEOTECHNICAL SERVICES CC
dotPLOT 6006 PBp


EASTERN GAUTENG SERVICES COUNCIL
VERREF WASTE SITE
AREA C
HOLE No: BH 7/24
Sheet 1 of 2
JOB NUMBER: P539131
Scale 1:150
0.00
DRY, yellow orange brown, ferruginized, CLAYEY SILT. AEOLIAN.
4.50
DRY, yellow grey brown, soft MUDROCK in a yellow brown silty matrix. Possibly VRYHEID.
12.00
As above but grey brown. Possibly DWYKA TILLITE.
21.00
DRY, grey brown, hard DOLOMITE and bands of CHERT in a pale grey silty matrix. Possibly ECCLES of DWYKA.
26.00
DRY, yellow brown becoming dark grey, soft to medium hard SYENITE in a yellow grey brown to pale grey silty matrix. INTRUSIVE.
1-5
1-10
Penetration Time (mins)
Chip Size (mm)


EASTERN GAUTENG SERVICES COUNCIL
VERREF WASTE SITE
AREA C
HOLE No: BH 7/24
Sheet 2 of 2
JOB NUMBER: P539131
41.00
WET, grey, hard DOLOMITE and bands of chert in a grey brown silty, clayey matrix. Possibly ECCLES of CHUNIESPOORT.
46m
54.00
NOTES
1) Water table at 46m.
2) Borehole situated on eastern boundary.
1-5
Penetration Time (mins)
Chip Size (mm)
CONTRACTOR : H ERWEE
MACHINE : MANGOLD
DRILLED BY : JOHAN
PROFILED BY : A-H WELLAND
TYPE SET BY : A-H WELLAND
SETUP FILE : CHIPLOG.SET
INCLINATION :
DIAM : 165mm
DATE : 1997-02/21
DATE : 1997-04-11
DATE : 22/04/97 16:00
TEXT : B:\C53918H.PRO
ELEVATION :
X-COORD :
Y-COORD :
HOLE No: BH 7/24
dot.PLOT 3000 J&W Inc


VERREF RIETFONTEIN
Rietfontein Waste Disposal Site: Area E
HOLE No: BH 40/12A
Sheet 1 of 2
JOB NUMBER: 2012/04
Scale 1:150
0.00
Fragments of brick, ash, mudrock in a matrix of silty clay.
FILL.
2.8
19.00
No sample recovery.
Speculated that this represents the base of a backfilled quarry - possibly Dwyka Group tillite to 31,3 m.
31.30
No sample recovery.
Penetration rate suggests fresh rock dolomite.
5-30
2-8
Penetr time min:s/m
Air return
Sample recov
Chip size mm


VERREF RIETFONTEIN
Rietfontein Waste Disposal Site: Area E
HOLE No: BH 40/12A
Sheet 2 of 2
JOB NUMBER: 2012/04
37.00
NOTES
1) Groundwater encountered at 2,0 m.
2) Water table at 2,8 m.
3) Drilling water used: 2,0 - 7,0 m, 12,0 - 34,0 m.
4) No air loss: 0 - 19,0 m, Medium air loss: 19,0 - 37,0 m.
5) Good recovery: 0 - 5,0 m, Medium recovery: 5,0 - 19,0 m, No recovery: 19,0 - 37,0 m.
6) Hammer rate regular apart from irregular: 2,0 - 3,0 m, 4,0 - 5,0 m, 6,0 - 11,0 m and 31,0 - 32,0 m.
2-10
Penetr time min:s/m
Air return
Sample recov
Chip size mm
CONTRACTOR : HENNIE ERWEE
MACHINE : Super Rock
DRILLED BY : Jack
PROFILED BY : J S Stiff
TYPE SET BY : K Stewart
SETUP FILE : Y.SET
INCLINATION :
DIAM : 165mm
DATE : 2012-11-23
DATE :
DATE : 10/05/13 08:40
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ELEVATION :
X-COORD :
Y-COORD :
HOLE No: BH 40/12A
D039 JD GEOTECHNICAL SERVICES CC
dotPLOT 6008 PBp

H. WEBER & ASSOCIATES INC.
CONSULTING GEOTECHNICAL ENGINEERS

PERCUSSION BOREHOLE LOG

Client: RAND SCRAP IRON & METAL COMPANY

Borehole Number: F

Project: VLAKFONTEIN (GIFGAT) SOLID WASTE SITE.

Project Number:

Depth Metres	Legend	Description	Penetration Rate (Minutes) 2 4 6 8	Air/ Sample Return
		Yellow, becoming grey, silty fine SAND. Mine slimes.		
3,0		Yellow brown, clayey SILT with ferruginised concretions. Hillwash.		
5,0		Yellowish orange, mottled yellow, CLAY-SILT Residual Karoo shale.		
▽6,0		As above, but brown, mottled yellow.		
7,0		Light brown, blotched grey, CLAY-SILT. Residual Karoo shale.		
13,0		Grey, blotched yellow, CLAY-SILT. Karoo shale.		
15,0		Pale pink, blotched dark brown, CLAY-SILT Karoo shale.		
19,0		Hole stopped - not requested. Not cased.		

Contractor: JACK BENNETT	Ground Level: /
Machine and Hammer: ROCK GIANT/150mm	Logged By: B BOLITHO
Date Drilled: 3-9-94	Date Logged: 3-9-94

Remarks
Air/Sample Return: G - Good, M — Moderate, P — Poor, N — No

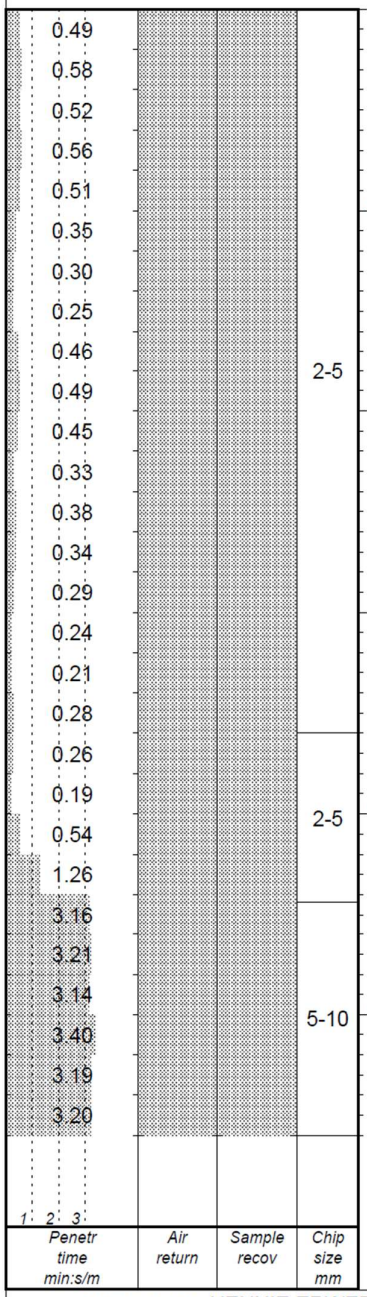
Compression 17 Bar Pressure
(1700 kPa)

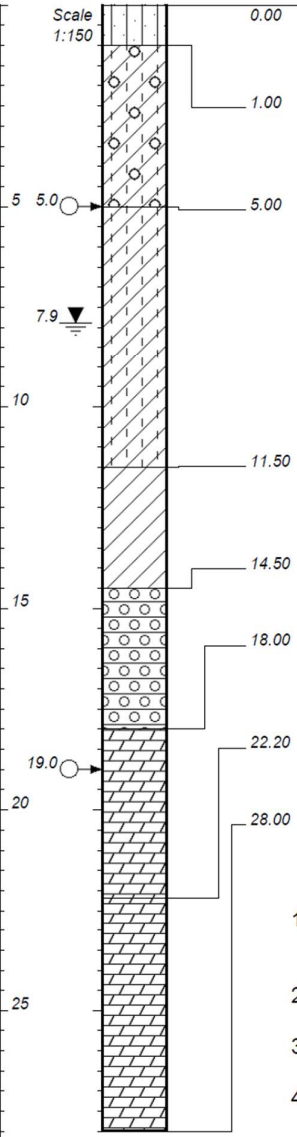
ater level at 6,0m on 5-9-94 and 15-9-94

VERREF RIETFONTEIN
Rietfontein Waste Disposal Site: Area G

HOLE No: BH 61/21
Sheet 1 of 1

JOB NUMBER: 2012/04





0.00	Moist, yellow orange, sandy SILT. Topsoil and Aeolian. Transported.
1.00	Moist, orange brown and black, gravelly silty CLAY with ferricrete fragments. Ferrugenised residual Ecca mudrock.
5.00	Moist, yellow and light grey, silty CLAY. Completely to highly weathered Ecca Group shale.
11.50	Moist, purple and yellow brown CLAY. Completely weathered Ecca Group mudrock (plastic clay).
14.50	Grey, medium weathered rock diamictite. Dwyka Group tillite.
18.00	Grey and light grey, fresh dolomite fragments with discolouration on some joint surfaces. Slightly weathered possibly fractured dolomite.
22.20	Dark blue grey fresh rock DOLOMITE. Malmani Subgroup.
28.00	

NOTES

1) Minor water strike (encountered) at 5,0 m. Strong water strike (encountered) at 19,0 m.

2) Water table at 7,9 m.

3) No drilling water used.

4) No air or sample loss.

5) Hammer rate regular apart from irregular: 19,0 - 20,0 m, 22,0 - 23,0 m, Cutter used: 5,0 m - 14,0 m.

CONTRACTOR : HENNIE ERWEE
MACHINE : Super Rock
DRILLED BY : Jack
PROFILED BY : J S Stiff
TYPE SET BY : K Stewart
SETUP FILE : Y.SET

INCLINATION :
DIAM : 165mm
DATE : 2012-11-23
DATE :
DATE : 10/05/13 08:40
TEXT : ..\VERREF\17HOLE~1.TXT

ELEVATION :
X-COORD :
Y-COORD :

HOLE No: BH 61/21

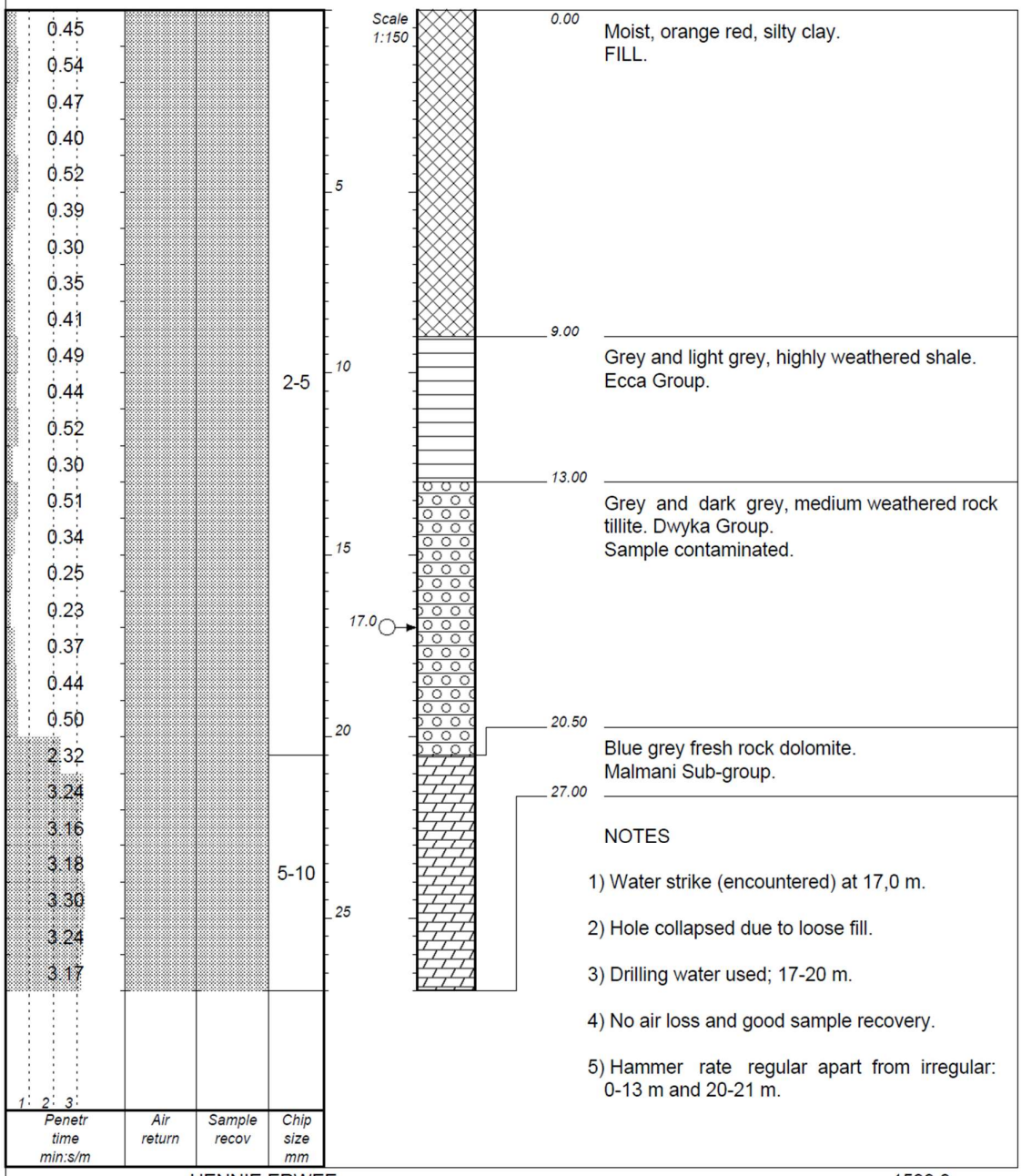
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VERREF RIETFONTEIN
Rietfontein - Area E

HOLE No: BH V10
Sheet 1 of 1

JOB NUMBER: 2013/03



CONTRACTOR : HENNIE ERWEE
MACHINE : Super Rock
DRILLED BY : Jack
PROFILED BY : JS Stiff
TYPE SET BY : K Stewart
SETUP FILE : Y.SET

INCLINATION :
DIAM : 165mm
DATE : 2013-03-19
DATE : 2013-04-30
DATE : 10/05/13 08:31
TEXT : ..\VERREF\V1-V10~1.TXT

ELEVATION : 1599.9
X-COORD : 2909410.1
Y-COORD : 57503.7

HOLE No: BH V10

D039 JD GEOTECHNICAL SERVICES CC

dotPLOT 6008 PBp