DOLomite Stability Investigation:
Witfontein Ext 87
(a portion of the remainder of Portion 8
of the farm Witfontein 16IR
Ekurhuleni Metropolitan Municipality

September 2016

For

M&T Developments,
P.O. Box 39727
FEARIE GLEN, 0043

Report No.: GS0437 REV 00

Prepared by
GeoStable SA cc
Company Registration No. 2009/124785/23

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GeoStable SA cc (*GeoStable SA*) was appointed by M&T Development (Pty) Ltd to evaluate the existing information on the proposed Witfontein Ext 87, a portion of the remainder of Portion 8 of the farm Witfontein 16IR in the Ekurhuleni Metropolitan Municipal district and to conduct infill drilling where deemed necessary. The eastern portion of the site is considered for medium to high density residential development and additional drilling was required to obtain the required borehole density for residential township establishment purposes. The site is located on the south-eastern corner of the intersection between the R21 highway in the west and the R25 (Link Road) in the north. The entire site covers an area of approximately 80 ha but the area focussed on in the east is 39.4ha in extent which includes the main access roads. The site located between 1601m amsl (above mean sea level) in the northwest and 1575m amsl in the southeast and has a general slope of ±1.3° to the southeast towards the small perennial tributary of the Rietvlei River approximately 400m to the south of the site.

The site lies within the Upper-Sterkfontein dolomite groundwater compartment with the expected original groundwater level in the vicinity of 1570m above mean sea level (a.m.s.l). Groundwater levels varied steadily from general depths of 20m to 16m in the northern portion of the site to depths between 15m to 10m in the southern portion of the site. A general groundwater flow from north to south is observed towards the tributary of the Rietvlei River in the south. Dewatering will have a limited negative effect on the site around BH4/9 and BH15/27. It is recommended that a groundwater monitoring borehole is drilled on the site close to BH15/17 and incorporated into the monthly readings by M&T Development and the Ekurhuleni Metropolitan Municipality for the Sterkfontein-East Upper dolomite groundwater compartment to actively manage groundwater on the site.

The site is underlain by dolomite of the Monte Christo and Oaktree Formations with various igneous intrusions of variable age cutting through the regional dolomite rock. The residual gravity map (1991) indicated a well-defined gravity high area in the north with two N-S striking, less prominent gravity high ridges in the southeast and southwest of the site. A very prominent gravity low trough cuts through the centre of the site in an E-W direction with an extension to the south in between the two gravity high ridges and also extending widely to the western portion of the site. Drilling proved this gravity low trough to be associated with a large syenite intrusion and deep “pockets” within the dolomite bedrock where shale, quartzite and diamicrite of the Karoo Supergroup was deposited. The residual gravity contours and drilling results contributed greatly to the demarcation of the dolomite stability zones on the site.
The site was zoned into three inherent hazard zones:

**Zone 1: IHC1/2/1/2** is suitable for all types of free standing residential houses up to 60 dwellings/ha, low rise residential units up to 120 units per hectare as well as high rise residential development with a residential coverage ratio of ≤0.4, no higher than 10 storeys and a population of ≤800 people per hectare all with D3 precautionary measures.

**Zone 2: IHC 3/4//1** is suitable for free standing residential houses up to 25 dwellings/ha, low rise residential units up to 80 units per hectare as well as high rise residential development with a residential coverage ratio of ≤0.4, no higher than 10 storeys and a population of ≤800 people per hectare all with D3 precautionary measures.

**Zone 3: IHC3/6//3/6** is localised areas where the wad-rich material is 4m thick and located within the upper 10m of the profile (BH4/9 in the road reserve and BH15/27). Dewatering will also expose more wad-rich layers in these profiles. Footprint investigations close to these two boreholes might reveal very localised poor conditions and the current zonation should not hamper the township application process for residential development at this stage. No wet services should be allowed to cross this zone and it is recommended that surface landscaping should be used to facilitate proper drainage in this area.

Footprint drilling is required for all residential developments and all foundations should be designed to span a loss of support of 5m in diameter at this stage. D3 precautionary measures should be implemented across the site.

Foundations should be designed to span a loss of support of 5m in diameter for all types of residential development on this site within Zones 1 and 2 unless footprint drilling proved better conditions.

The site should be landscaped to facilitate proper drainage and to avoid the ponding of surface water against any infrastructure on the site. No wet services should be planned across Zone 3. All site services must be tested to zero percent leakage after installation by a certified contractor and proof of these tests must be submitted to the local municipality.

The long-term dolomite stability conditions on the site are based on the vigilance towards surface and piped water control thereon. The onus of proper bulk piped and surface water control in the long term rests with the developers/owners of the individual stands/units.

A general DRMP should be adopted by the owner of the development as well as each individual owner/occupant of the residential units in the development. Site specific DRMP’s can only be drawn up after the site layout plans are finalized and the bulk wet services and stormwater layout plans have been approved.
Dolomite Stability Investigation: Witfontein Ext 87  
(A Portion of the Remainder of Portion 8 of the Farm  
Witfontein 16IR  
Ekurhuleni Metropolitan Municipality)

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1 INTRODUCTION & TERMS OF REFERENCE

GeoStable SA cc (GeoStable SA) was appointed by M&T Development (Pty) Ltd to evaluate the existing information on the proposed Witfontein Ext 87, a portion of the remainder of Portion 8 of the farm Witfontein 16IR in the Ekurhuleni Metropolitan Municipal district and to conduct infill drilling where deemed necessary. The site has previously been investigated for commercial/light industrial development. The eastern portion of the site is now considered for medium to high density residential development and additional drilling was required to obtain the required borehole density for residential township establishment purposes.

2 SITE DESCRIPTION AND PROPOSED DEVELOPMENT

The site is located on the southeastern corner of the intersection between the R21 highway in the west and the R25 (Link Road) in the north with the Serengeti Golf Estate to the south of the as indicated in Figure 1: Locality plan, Appendix A: Figures. The entire site covers an area of approximately 80 ha but the area focussed on in the east covers an area of only 39.4ha.

The site is covered with indigenous grass around the edges with ploughed fields across the major portion of the site. The site located between 1601m amsl (above mean sea level) in the northwest and 1575m amsl in the southeast and has a general slope of ±1.3° to the southeast towards the small perennial tributary of the Rietvlei River approximately 400m to the south of the site. The entire site was previously investigated and approved for light commercial development. With the need for housing in the area the eastern portion of the site is now re-evaluated for medium to high density residential development.

3 AVAILABLE INFORMATION

Maps:
- The 1:50 000 scale geological map 2628AB Benoni
- The 1:50 000 scale topographic map 2628AB Benoni
- Borehole layout plan of existing boreholes supplied by M&T Development.
- Maps as contained in existing reports on the site as listed below.

**Reports:**

## 4 Methodology

This report discusses the dolomite stability conditions across the site with special focus on the eastern portion of the site currently considered for residential development. The gravity survey conducted in 1991 as part of the original investigation was used in the zonation of the site and is discussed in Par 6. Ten additional boreholes were planned in the eastern portion of the site to comply with regulations regarding borehole densities for a first phase residential investigation and to make sure that the site is evenly covered with data points. The positions of all the boreholes that were drilled on the site are indicated in **Figure 3: Zonation and borehole position plan.**

## 5 Geohydrology

The site is indicated to lie within the Upper Sterkfontein dolomite groundwater compartment with the expected original groundwater level in the vicinity of 1570m above mean sea level (a.m.s.l). Geophysics and drilling on site revealed the Pretoria syenite dyke to enter the site from the north and join other syenite intrusions in the western portion of the site. Prominent syenite dykes also cross through the centre site in an E-W direction and extend from the central area towards the south resulting in small complex geological sub-compartments which makes a groundwater model for the site extremely difficult (**Figure 2: Geology map**). It is assumed that the general boundary between the two major dolomite groundwater compartments in this area is located slightly more to the east but this site seems to be located mainly on the Sterkfontein-East (Upper) groundwater compartment.
The site has a general elevation of approximately 1590m amsl and the general predicted original groundwater level is in the order of 1570m amsl thus the permanent groundwater table can be expected to lie around 20m below surface.

Groundwater levels varied steadily from general depths of 20m to 16m in the northern portion of the site to depths between 15m to 10m in the southern portion of the site. A general groundwater flow from north to south is observed towards the tributary of the Rietvlei River in the south.

After evaluation of the boreholes it was concluded that dewatering will have a negative influence on the dolomite stability of the site in areas where wad-rich layers occur below the groundwater table i.e. BH4/9 and BH6/28.

6 **GEOPHYSICAL INVESTIGATIONS**

A gravity survey has been conducted across the site as part of the original investigation in 1991 as indicated in the figure above. A total of nine-hundred-and-seventy-six stations were set out on a
30m x 30m grid. The residual gravity map produced indicated a well-defined gravity high area in the north with two N-S striking, less prominent gravity high ridges in the southeast and southwest of the site. A very prominent gravity low trough cuts through the centre of the site in an E-W direction with an extension to the south in between the two gravity high ridges and also extending widely to the western portion of the site. Drilling proved this gravity low trough to be associated with a large syenite intrusion and deep “pockets” within the dolomite bedrock where shale, quartzite and diamictite of the Karoo Supergroup was deposited. The residual gravity contours and drilling results contributed greatly to the demarcation of the dolomite stability zones on the site.

A total of fourteen magnetic traverses were undertaken across the site as indicted in the figure above. The presence of a small power line on the eastern boundary of the site prevented magnetic traverses to be conducted in this area and only one traverse, K-K, could be done which is relevant to the area currently under investigation. The results indicated a magnetic anomaly between BH22/28A&B in the north and BH18/27 coinciding with the position of a prominent syenite dyke. No syenite was encountered in boreholes BH22/28 A&B, BH15/27 and BH06/28.
7 GEOLOGY

The regional geology map indicates that the central and eastern portions of the site is located on the chert-rich dolomite of the Monte Christo Formation and the western portion on the chert-poor dolomite of the Oaktree Formation of the Malmani-subgroup, Chuniespoort Group, Transvaal Supergroup. The area currently under investigation is located entirely on the Monte Christo Formation. The prominent Pretoria syenite dyke is indicated on the regional map by an aeromagnetic anomaly only. Drilling and further geophysical investigations confirmed the position of the syenite dyke as well as other igneous intrusions not indicated on the regional map. The other main intrusion is the E-W striking syenite dyke. The dykes become more sill like near surface and spreads out thinly across the dolomitic country rock as can be seen in BH22/28A&B, BH4/9 and BH10/17.

It is evident from the results of the investigations that there are several intrusive bodies of varying age and rock type. The intrusive igneous rocks are definitely syenitic in places and therefore pre-Karoo age. However, in BH20/16 and BH24/5 the igneous rock is of post-Karoo age since it overlies Karoo diamictites and sediments – Geotechnics (1991)

Small outliers of possible Karoo Supergroup sediments of the Dwyka Group in the form of shale, quartzite and diamictite was observed in some of the boreholes map (i.e. BH20/16, BH24/5 and GS09). These outliers as well as the syenite intrusions are indicated on the geological map at the end of the report (Figure 2: Geology map, Appendix A.)

Dark grey, micaceous quartzite was encountered in borehole GS09 between 41m and 60m (the deepest borehole on this site). The quartzite is believed to be from the Black Reef Formation which outcrops to the west of the site.

8 RESULTS OF THE STABILITY INVESTIGATION

8.1 Percussion Drilling

Altogether thirty-five boreholes were drilled on the site of which twenty-one is located on the proposed Witfontein Ext 87. The boreholes were drilled 6m into solid bedrock or to a maximum depth of 60m whichever came first. The borehole samples were logged by an engineering geologist and evaluated in accordance with the most recent methods of dolomite risk assessment [1] [2] [3]. The borehole positions are indicated in Figure 3: Zonation and borehole position map.

All the borehole results are summarised in Table 1, Appendix B, but only the boreholes relevant to the site currently under investigation are discussed here.
GS01, GS04, GS05, GS08, BH28/28, BH6/28 revealed residual chert and residual wad-poor dolomite on top of weathered to solid dolomite bedrock with no air or sample losses. The soft rock dolomite occurred between 4m and 12m and solid hard rock dolomite between 11m and 32m. No syenite occurred in these boreholes.

BH15/27 and BH4/9 revealed soft wad-rich residual dolomite overlying soft to hard rock dolomite at depth. Penetration rates through the upper wad-rich layers were moderate, but beneath the groundwater table the penetration rates decreased and became less than 30sec/m (1991). No syenite occurred in these boreholes.

BH6/18, BH10/17 and BH22/28A&B encountered colluvium underlain by residual syenite less than 13m thick with a layer of residual dolomite, sometimes with wad before entering dolomite bedrock at depths between 10m and 14m.

BH11/31, BH14/21, GS03, GS07 and GS10 encountered a layer of colluvium underlain by a thick layer of residual syenite to depths between 19 m and 26m before entering directly into dolomite bedrock with the exception of GS03 and GS10 which encountered a 2m thick residual dolomite layer with no wad between the upper residual syenite and dolomite bedrock.

GS02 encountered residual chert and dolomite with no wad from surface to a depth of 13m with soft rock dolomite to 15m, soft rock syenite between 15m and 17m and solid syenite bedrock below 17m.

BH18/27 and GS06 revealed residual syenite from just below surface directly underlain by soft to hard rock syenite with no dolomitic material encountered in the profile.

GS09 was the borehole with a unique profile revealing shale and coarse grained quartzite from surface to 19m most probably of the Dwyka Formation of the Karoo Supergroup. The Dwyka is underlain by a layer of residual chert between 19m and 27m. Residual syenite occurred between 27m and 36m followed by residual dolomite between 36m and 41m. It looks like the syenite has intruded into the dolomitic layer which is situated between 19m and 41m. The dolomite was penetrated and the borehole entered fine grained micaceous quartzite of the Black Reef Formation.

A summary of the drilling results is given in Table 1, Appendix B: Tables. Only the borehole logs pertaining to the site are contained in Appendix C: Percussion Borehole Logs.

### 8.2 Presence of dolomite related instabilities

No known sinkholes have formed on this site. However, a sinkhole has formed on the site to the north of the R25 road on Witfontein Ext 81. A small cavernous layer was recorded by the driller in BH6/28 between 10.4 and 11.3m but penetration rates does not suggest an open cavity rather a disseminated/jointed zone just above dolomite rock.
9 EVALUATION OF DOLOMITE STABILITY CONDITIONS

9.1 General conditions and nature of materials

The site is underlain by dolomite of the Malmani Subgroup which has been intruded by igneous material at different intervals resulting in complex geological model. Sedimentary deposits occurred on top of the dolomite in deeper lying areas/pockets on top of the dolomitic profile which formed the Dwyka and Ecca Group sediments as encountered in GS09 on the site. The presence of Dwyka sediments were also recorded in BH20/16 and BH24/5 to the west of the site.

The residual dolomitic material contains minor to abundant chert gravel with a possibility of wad-rich layers as encountered in two of the boreholes drilled on the site (BH15/17 and BH4/9) and three boreholes to the west of the site (BH16/14, BH27/16 and BH28/22). The general nature of the blanketing layer is stable with limited highly erodible layers as described above. Bedrock varies between mostly dolomite and occasionally syenite in/near the centre of the dykes.

9.2 Receptacle development

Cavernous conditions were encountered in a 1m thick layer in BH6/28 just above bedrock. It is interpreted as an open structured joint zone which is described as a rock-filled disseminated cavity rather than an open cavity. A sinkhole has formed on the area to the north of the site, therefore it can be assumed that sinkholes can also occur on this site under poor drainage conditions.

9.3 Mobilisation potential of the blanketing layer

The blanketing layer is the material covering a potential receptacle. It is all the residual material on top of the bedrock head or material above an existing open or disseminated cavity. Mobilisation potential is the potential of the material to be mobilised under the influence of a mobilisation agent i.e. ingress water, groundwater level draw down, earth tremors etc.

The wad-free residual chert and dolomite has a medium mobilisation potential. Where residual layers contain minor (less than 30%) wad the mobilisation potential of those layers are considered to be medium. Where layers contain abundant (>30%) to more than 50% wad the mobilisation potential is high. The residual shale, quartzite and residual syenite have a medium (<15m thick) to low (>15m thick) mobilisation potential. The top of the weathered/soft dolomite/syenite rock is taken as the bottom of the blanketing layer.
9.4 Mobilisation agent

Leaking wet services and ponding of surface run-off will act as a mobilizing agent, causing the material to migrate down towards cavernous horizons. The lowering of the groundwater table will not influence the general inherent dolomite stability of this site except at BH4/9 and BH15/27 where wad-rich material will be exposed with groundwater drawdown between 3m and 6m.

9.5 Potential development space

The potential development space (surface manifestation of a sinkhole) on the site varies between medium and large (>2m to 5m and >5m in diameter). The following assumptions were made during the evaluation of the potential development space (SAICE, 2001):

1. Receptacle development is present, and the receptacles are large enough to accommodate all the mobilized material from the potential development space.

2. All the materials within the blanketing layer can be mobilized.

3. An adequate and sustained mobilizing agency is present.

10 Risk Zonation and Development Potential

A risk assessment was carried out using the method proposed by Buttrick et al [2] as well as the most recent SANS1936 (2012) documents [4], [5] and [6]. The Inherent Hazard Classification (IHC) of a site is given for a non-dewatering and ingress of water, and a dewatering scenario, IHC Non-dewatering and ingress of water//Dewatering.

The site was zoned into three different zones namely:

**Zone 1: IHC1/2//1/2** is located on thick residual to hard rock syenite or thick syenite directly underlain by dolomite rock. Also incorporated into this zone is thick Karoo sediments and syenite with limited dolomitic material as encountered in GS09. This zone has a low to no inherent hazard for sinkhole formation. For residential development foundations to span a loss of support of 5m in diameter is still required unless footprint investigations prove continuous syenite profiles. D3 measures must be implemented as the nature of the entire site will be influenced by the development and boundaries between various zones can change abruptly.
This zone is suitable for all types of free standing residential houses up to 60 dwellings/ha (RN1 – RN3/DH1-DH3),1 low rise residential units up to 120 units per hectare (RL1 and RL2/AHL1-AHL2)2 as well as high rise residential development with a residential coverage ratio of ≤0.4, no higher than 10 storeys and a population of ≤800 people per hectare (RH3/AHH3)3 all with D3 precautionary measures.

Zone 2: IHC 3/4//3/4 located on dolomite with very thin to no syenite within the profile and residual chert and dolomite with no or very little wad within the profile and no air or sample losses and moderate penetration rates. Bedrock is dolomite at various depths. This zone has a medium inherent hazard for the formation of medium to large size sinkholes. Footprint investigations will be required for all types of residential development confirming suitable conditions. D3 precautionary measures for wet services must be implemented. Foundations should be designed to span a loss of support of at least 5m in diameter.

This zone is suitable for free standing residential houses up to 25 dwellings/ha (RN2, RN3/DH2, DH3), low rise residential units up to 80 units per hectare (RL2/AHL2) as well as high rise residential development with a residential coverage ratio of ≤0.4, no higher than 10 storeys and a population of ≤800 people per hectare (RH3/AHH3).

Zone 3: IHC3/6//3/6 is localised areas where the wad-rich material is 4m thick and located within the upper 10m of the profile (BH4/9 in the road reserve and BH15/27). Dewatering will also expose more wad-rich layers in these profiles. It has a medium to high inherent hazard for the formation of medium sinkholes and is not suitable for residential development. Footprint investigations close to these two boreholes might reveal very localised poor conditions and the current zonation should not hamper the township application process for residential development at this stage. No wet services should be allowed to cross this zone and it is recommended that surface landscaping should be used to facilitate proper drainage in this area.

11 CONCLUSIONS AND RECOMMENDATIONS

• An infill dolomite stability investigation was carried out on the eastern portion of the remainder of Portion 8, Witfontein 16 IR to be known as Witfontein X87. The site is characterised by variable conditions with dolomite intruded by igneous material at various intervals and depths. The prominent Pretoria syenite dyke is located just north-west of the site and crosses the R25 just west of the site.

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2 RL/AHL: Low rise residential units ≤3 storeys high, attached homes (SANS 1936 (2012))/NHBRC (2015)
The site was zoned into three inherent hazard zones as discussed in Par 10:

**Zone 1: IHC1/2/1/2** is suitable for all types of free standing residential houses up to 60 dwellings/ha, low rise residential units up to 120 units per hectare as well as high rise residential development with a residential coverage ratio of ≤0.4, no higher than 10 storeys and a population of ≤800 people per hectare all with D3 precautionary measures.

**Zone 2: IHC 3/4/1** is suitable for free standing residential houses up to 25 dwellings/ha, low rise residential units up to 80 units per hectare as well as high rise residential development with a residential coverage ratio of ≤0.4, no higher than 10 storeys and a population of ≤800 people per hectare all with D3 precautionary measures.

**Zone 3: IHC3/6//3/6** is localised areas where the wad-rich material is 4m thick and located within the upper 10m of the profile (BH4/9 in the road reserve and BH15/27). Dewatering will also expose more wad-rich layers in these profiles. Footprint investigations close to these two boreholes might reveal very localised poor conditions and the current zonation should not hamper the township application process for residential development at this stage. No wet services should be allowed to cross this zone and it is recommended that surface landscaping should be used to facilitate proper drainage in this area.

D3 type precautionary measures apply across the entire site.

**D3:** Precautionary measures in addition to those pertaining to the prevention of concentrated ingress of water into the ground are required to support development in accordance with the relevant requirements of SANS 1936-1,3 (2012)

These precautions are designed to minimize the effect that development may have on this area and ensuring that no accumulations of surface water occur as a result of inadequate drainage. Poor water control can lead to subsidence related problems.

- Foundations should be designed to span a loss of support of 5m in diameter for all types of residential development on this site within Zones 1 and 2.

- The site should be landscaped to facilitate proper drainage and to avoid the ponding of surface water against any infrastructure on the site.

- No wet services should be planned across Zone 3.

- All site services must be tested to zero percent leakage after installation by a certified contractor and proof of these tests must be submitted to the local municipality.
Dewatering will have a limited negative effect on the site around BH4/9 and BH15/27. It is recommended that a groundwater monitoring borehole is drilled on the site close to BH15/17 and incorporated into the monthly readings by M&T Development and the Ekurhuleni Metropolitan Municipality for the Sterkfontein-East Upper dolomite groundwater compartment to actively manage groundwater on the site.

The inherent dolomite stability conditions are variable but mostly suitable for residential development as discussed above except for Zone 3. Footprint drilling is required for all residential developments and all foundations should be designed to span a loss of support of 5m in diameter at this stage. D3 precautionary measures should be implemented across the site.

The long-term dolomite stability conditions on the site are based on the vigilance towards surface and piped water control thereon. The onus of proper bulk piped and surface water control in the long term rests with the developers/owners of the individual stands/units.

A general DRMP should be adopted by the owner of the development as well as each individual owner/occupant of the residential units in the development. Site specific DRMP’s can only be drawn up after the site layout plans are finalized and the bulk wet services and stormwater layout plans have been approved.

B Keyter. (Pr Sci Nat)
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GeoStable SA
REFERENCES


APPENDIX A – FIGURES
Figure 1: Locality of Site: Witfontein X87 (Part of Rem of Ptn 8 of the farm Witfontein 16-IR)

Project No.: GS0437
Date: September 2016
Figure 2: Geology map

DATE: Sept 2016
PROJECT NO: GS0437 Rev 00

Geostable SA cc Reg. No. 2009/124785/23

Witfontein X87
(A part of the remainder of the farm Witffontein 16-IR)
# TABLE 1: Summary of the results of the boreholes drilled at the Remainder of Portion 8, Witfontein 16IR.

<table>
<thead>
<tr>
<th>BH no.</th>
<th>Upper colluvium/Residual chert</th>
<th>Residual dolomite (% wad)</th>
<th>Residual shale/quartzite (KAROO)</th>
<th>Residual intrusive</th>
<th>Weathered/soft rock</th>
<th>Bedrock – EOH (m) – (m)</th>
<th>Ground-water strike/table (m)</th>
<th>Air loss (m) – (m)</th>
<th>Sample loss (m) – (m)</th>
<th>Penetration ≤ 30sec/m (1991)</th>
<th>Penetration ≤ 15sec/m (2016)</th>
<th>Mobilisation potential</th>
<th>Potential development space</th>
<th>Inherent Hazard</th>
<th>IHC NDS // DS</th>
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</thead>
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<tr>
<td>4/9</td>
<td>0 – 4</td>
<td>6 – 9 (90) 9 – 14 (+30) 14 – 18 (70)</td>
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<td>4 – 6</td>
<td>-</td>
<td>18 – 23</td>
<td>13.6/ 9.6</td>
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<td>-</td>
<td>1 – 2 14 – 18</td>
<td>Medium to high</td>
<td>Medium to high</td>
<td>Medium to high</td>
<td>3/6(7)</td>
<td></td>
</tr>
<tr>
<td>4/21</td>
<td>0 – 1</td>
<td>-</td>
<td>-</td>
<td>1 – 18</td>
<td>-</td>
<td>18 – 25 (I)</td>
<td>14.9/ 9.6</td>
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<td>-</td>
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<td>Large</td>
<td>Low</td>
<td>None/ Low</td>
<td>1/1</td>
</tr>
<tr>
<td>6-7/4</td>
<td>0 – 1</td>
<td>-</td>
<td>-</td>
<td>1 – 30</td>
<td>-</td>
<td>No hard rock drilled</td>
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<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>2/2</td>
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<td>6/18</td>
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<td>13 – 14 (60)</td>
<td>-</td>
<td>1 – 13</td>
<td>-</td>
<td>14 – 21</td>
<td>12.4/ 10.5</td>
<td>-</td>
<td>-</td>
<td>None</td>
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Geotechnics Africa cc (1991)
### TABLE 1: Summary of the results of the boreholes drilled at the Remainder of Portion 8, Witfontein 16IR.

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<th>BH no.</th>
<th>Upper colluvium/Residual dolomite (%)</th>
<th>Residual dolomite (wad)</th>
<th>Residual shale/quartzite (KAROO)</th>
<th>Residual intrusive</th>
<th>Weathered/soft rock</th>
<th>Blanket Layer Depth (m) – (m)</th>
<th>Bedrock – EOH (m) – (m)</th>
<th>Ground-water strike/table</th>
<th>Air loss (m) – (m)</th>
<th>Sample loss (m) – (m)</th>
<th>Penetration ≤ 30sec/m (1991)</th>
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<th>Inherent Hazard</th>
<th>IHC NDS // DS</th>
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GeoStable SA (2016)

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IHC: Inherent Hazard Classification  NDS: Non-dewatering scenario  DS: Dewatering scenario  (I): Intrusive  
4/8 Boreholes outside proposed residential area
APPENDIX C – PERCUSSION BOREHOLE LOGS
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<td>2.18</td>
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<tr>
<td>3.50</td>
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<tr>
<td>3.31</td>
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</tr>
<tr>
<td>3.28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Light grey with orange stains and few white highly weathered chert GRAVEL with abundant to minor red brown silty SAND.**
- **RESIDUAL CHERT.**
- **Dark grey with few brown stains, highly weathered chert GRAVEL with minor red brown sandy CLAY.**
- **RESIDUAL CHERT.**
- **Grey with few black flecks, slightly weathered to unweathered dolomite fragments with traces of grey sand.**
- **SOFT ROCK DOLOMITE.**
- **Grey, with traces of white flecks, unweathered DOLOMITE fragments.**
- **MEDIUM HARD TO HARD ROCK DOLOMITE.**
<table>
<thead>
<tr>
<th>Panor</th>
<th>Air return</th>
<th>Sample</th>
<th>Chip size</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.32</td>
<td></td>
<td></td>
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<tr>
<td>3.17</td>
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<tr>
<td>3.25</td>
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</tr>
<tr>
<td>3.21</td>
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</table>

EOH

NOTES
1) Groundwater table at 8.6 m.
<table>
<thead>
<tr>
<th>Penetr time</th>
<th>Air return</th>
<th>Sample recov</th>
<th>Chip size</th>
</tr>
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<tbody>
<tr>
<td>0.22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.31</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>0.25</td>
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<tr>
<td>0.19</td>
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<td></td>
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<tr>
<td>0.31</td>
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<tr>
<td>0.28</td>
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<tr>
<td>0.32</td>
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<td>0.41</td>
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<td>0.32</td>
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<tr>
<td>0.19</td>
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<tr>
<td>1.22</td>
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<tr>
<td>1.28</td>
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<td></td>
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<tr>
<td>1.32</td>
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<tr>
<td>1.39</td>
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<td>2.53</td>
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<td>3.62</td>
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<td>3.39</td>
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<td>3.48</td>
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<td>3.34</td>
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<td>3.58</td>
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<tr>
<td>3.69</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Light grey and white with orange stains, highly weathered chert GRAVEL with abundant brown silty SAND. RESIDUAL CHERT.

Orange brown and brown with few grey flecks, CLAY with traces of dark grey chert gravel. RESIDUAL CHERT.

Grey slightly weathered dolomite GRAVEL with minor brown clayey SAND. DOLOMITE RESIDUUM.

Grey, unweathered DOLOMITE fragments. SOT ROCK DOLOMITE.

Greenish grey with fine light grey and few pink speckles, syenite GRAVEL. SOFT ROCK SYENITE.

As above but SOLID SYENITE ROCK.

EOH.

NOTES
1) Groundwater table at 10.3 m.
M&T DEVELOPMENT
WITFONTEIN X87
(A Part of the Remainder of Portion 8
of the farm Witfontein 16-IR)

HOLE No. BH GS03
Sheet 1 of 2

JOB NUMBER: GS0437

0.00
Scale
1:150

Light yellow brown sandy SILT,
RESIDUAL SYENITE.

Grey with white flecks and few
orange stains, moderately
weathered DOLOMITE fragments
with traces of brown silt.
DOLOMITE RESIDUUM.

Grey with few black flecks,
unweathered DOLOMITE
fragments.
MEDIUM HARD to HARD ROCK
DOLOMITE.

NOTES
M&T DEVELOPMENT
WITFONTEIN X87
(A Part of the Remainder of Portion B
of the farm Witfontein 16-IR)

EOH,

NOTES
1) Groundwater table at 12.8 m.
2) Water strike at 23.2 m.

CONTRACTOR: M&T DEVELOPMENT
MACHINE: Thor
DRILLED BY: STANLEY
PROFILED BY: B KEYTER Pr.Sci.Nat
TYPE SET BY: K Stewart
SETUP FILE: BH1PG-A4.SET

DOB1 M&T Development

INCLINATION: DIAM: 144mm
DATE: 2016-08-22
DATE: 2016-08-26
DATE: 07/09/2016 16:03

ELEVATION: X-COORD: -2880905
Y-COORD: -72489
HOLE No: BH GS03

P8pH67
Reddish brown sandy SILT with minor fine grey and white highly weathered gravel.
RESIDUAL CHERT.

Light and dark grey with few white and orange highly weathered chert GRAVEL with minor brown sandy SILT.
RESIDUAL CHERT.

Equal amounts of grey slightly weathered dolomite GRAVEL and brown sandy SILT.
RESIDUAL DOLOMITE.

Grey with few black flecks unweathered DOLOMITE fragments.
DOLOMITE ROCK.

EOH.

NOTES

1) No groundwater encountered.
Light grey with few orange stains and few white highly weathered chert GRAVEL with minor red brown silty SAND. RESIDUAL ChERT.

Red brown sandy CLAY with minor grey stained orange moderately weathered chert and few dolomite gravel. RESIDUAL ChERT AND DOLOMITE.

Grey, slightly weathered to unweathered DOLOMITE fragments. SOFT ROCK DOLOMITE.

Grey, slightly weathered on joint surfaces to unweathered DOLOMITE fragments. MODERATELY HARD TO HARD ROCK DOLOMITE.

EOH.

NOTES
1) No groundwater encountered.
Equal amounts of yellow brown to red brown sandy SILT and greyish yellow and fe orange highly weathered chert GRAVEL.
RESIDUAL CHERT.

Red SILT.
RESIDUAL SYENITE.

Yellow with orange patches slightly sandy SILT.
RESIDUAL SYENITE.

Yellow brown silty SAND with minor to abundant fine and very fine, brown and black highly weathered syenite gravel.
RESIDUAL SYENITE.

Back and dark grey slightly weathered to unweathered SYENITE fragments.
SOFT ROCK SYENITE.

Dark grey with fine black speckles, unweathered SYENITE fragments.
SOLID SYENITE ROCK.

EOH.

NOTES
1) Groundwater not measured.
2) Hole collapsed at 8.9 m.
Red clayey SILT. 
RESIDUAL SYENITE.

Yellow clayey SILT. 
RESIDUAL SYENITE.

Khaki silty SAND to sandy SILT with traces of fine brown highly weathered syenite gravel. 
RESIDUAL SYENITE.

Black and dark grey with few brown moderately weathered SYENITE gravel with minor khaki brown sandy SILT. 
SYENITE RESIDUUM.

Brown and purple, highly weathered DOLOMITE fragments with traces of brown SILT. 
ALTERED SOFT ROCK DOLOMITE.

Grey and light purple slightly weathered to unweathered DOLOMITE fragments. 
ALTERED DOLOMITE BEDROCK.

NOTES
1) Groundwater table at 20.8 m.
**M&T DEVELOPMENT**
**WITFONTEIN X87**
*(A Part of the Remainder of Portion 8 of the farm Witfontein 16-IR)*

<table>
<thead>
<tr>
<th>Penetr</th>
<th>Air</th>
<th>Sample</th>
<th>Chip</th>
</tr>
</thead>
<tbody>
<tr>
<td>time</td>
<td>return</td>
<td>recv</td>
<td>size</td>
</tr>
</tbody>
</table>

- 0.23
- 0.19
- 0.22
- 0.31
- 0.19
- 0.21
- 1.26
- 1.49
- 2.11
- 2.28
- 2.39
- 3.21
- 3.09
- 3.23
- 3.11
- 3.28
- 3.16

**Scale** 1:150

- 0.00
- 2.00
- 6.00
- 8.00
- 10.00
- 15.00

White and light grey highly weathered chert GRAVEL with abundant red brown silty SAND. **RESIDUAL CHERT.**

Grey with few orange stains highly weathered to moderately weathered CHERT with subordinate dolomite GRAVEL and minor to abundant brown silty SAND. **RESIDUAL CHERT & DOLOMITE.**

Light grey with brown stains, moderately weathered DOLOMITE fragments with traces of brown silt. **DOLOMITE RESIDUUM.**

Grey, unweathered DOLOMITE fragments. **MEDIUM HARD TO HARD ROCK DOLOMITE.**

- 17.00

**EOH.**

**NOTES**
1) No groundwater encountered.
Red brown sandy CLAY with traces of highly weathered gravel. **COLLUVIUM.**

Pale red silty SAND with traces of white highly weathered coarse grained quartzite gravel. Grey quartzite band between 5.0 m - 6.0 m. **RESIDUAL QUARTZITE. KAROO SUPERGROUP.**

Grey with few light pink, coarse grained highly weathered quartzite GRAVEL and light grey highly weathered shale GRAVEL with minor light brownish grey sandy SILT. **SHALE AND QUARTZITE RESIDUUM. KAROO SUPERGROUP.**

Brownish grey SILT with minor to abundant below 18.0 m, brownish light grey, shale gravel. **SHALE RESIDUUM.**

Grey and few white, stained orange and brown highly weathered chert gravel with abundant grey brown to yellow brown sandy SILT. **RESIDUAL CHERT**

Yellow to kahki yellow sandy SILT. **RESIDUAL SYENITE.**
Grey and light grey to white highly weathered to moderately weathered dolomite and quartzite fragments and few calcrete crystals with minor grey silt. **Dolomite and Quartzite Bands.**

Grey, micaceous in places with thin copper precipitation slightly weathered to unweathered fine grained Quartzite - Possibly **Black Reef Formation?**

EOH

**NOTES**

1) Groundwater table at 18.8 m.

2) Water strikes at 40.3 m and 48.1 m.
M&T DEVELOPMENT
WITFONTEIN X87
(A Part of the Remainder of Portion 8
of the farm Witfontein 16-IR)

HOLE No: BH GS10
Sheet 1 of 1
JOB NUMBER: GS0437

Yellow brown with red brown patches SILT.
RESIDUAL SYENITE.

As above with traces of fine brown highly weathered syenite gravel.
RESIDUAL SYENITE.

Brown and grey highly weathered DOLOMITE gravel with minor to abundant brown sandy SILT.
DOLOMITE RESIDUUM.

Grey slightly weathered to unweathered DOLOMITE fragments.
SOFT ROCK DOLOMITE.

Grey, unweathered DOLOMITE fragments.
MODERATELY HARD TO HARD ROCK DOLOMITE.

EOH.

NOTES
1) Groundwater table at 19.2 m.

CONTRACTOR: M&T DEVELOPMENT
MACHINE: Thor
DRILLED BY: STANLEY
PROFILED BY: B KEYTER Pr.Sci.Nat
TYPE SET BY: K Stewart
SETUP FILE: BH1PG-A4.SET

INCLINATION:
DIAM: 144mm
DATE: 2016-08-19

ELEVATION:
X-COORD: -2880348
Y-COORD: -72508
HOLE No: BH GS10

D081 M&T Development
<table>
<thead>
<tr>
<th>Depth</th>
<th>Legend</th>
<th>Strata Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Orange-brown CLAYEY SAND. Hillwash.</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Yellowish-orange CLAY-SILT. Residual Igneous Rock.</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Dark brown CLAYEY SILT (wad), with traces of weathered chert. Dolomite Residuum.</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>White, pale brown and pale grey highly weathered/slightly weathered CHERT, with minor wad. (Chips up to 10mm diameter)</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>Dark brown CLAYEY SILT (wad) with minor white weathered chert and yellow-brown highly weathered igneous rock.</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td>See sheet 2 for description.</td>
</tr>
</tbody>
</table>

### Penetration rate (mins/metre)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

**Project Name**

PORTION 8: WITFONTEIN 16 IR

**Project Engineer**

JPR

**Date Profiled**

19/9/91

**GEOTECHNICS AFRICA CC**

Reg No CK 88/08625/23

ROTAŽÝ PERCUSSION BOREHOLE LOG

Project No 91/046

Borehole No 4/9

Sheet 1 of 2
<table>
<thead>
<tr>
<th>Depth</th>
<th>Legend</th>
<th>Strata Description</th>
<th>Air/Sample Return</th>
<th>Penetration rate (mins/metre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td></td>
<td>Dark and pale grey slightly weathered DOLOMITE. Samples contaminated from above.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES:
1) Water intersected during drilling at a depth of 13.6m.
2) Water rest level 9.6m below surface at least 24 hours after completion of drilling.

GEOTECHNICS AFRICA CC
Reg No CK 88/08625/23
ROTARY PERCUSSION BOREHOLE LOG
Project No
Borehole No 4/9

Sheet 2 of 2
Red-brown SANDY CLAY, with traces of weathered chert. Hillwash. (Chip size up to 5mm)

Orange-brown speckled white, fine CLAYEY SAND. Residual Igneous Rock.

Pale yellow-brown fine SANDY SILT - Residual Igneous Rock.

Pale yellow-brown fine SILTY SAND. Residual Igneous Rock.

Dark brown CLAYEY SILT (wad), with abundant white, pale grey and dark grey chert.

Dolomite Residuum.
(Chip size 2-15mm)

Pale grey (becoming dark grey at depth), unweathered DOLOMITE, with minor chert.
(Chip size 1 - 10mm).

Notes: 1) Water intersected during drilling at a depth of 12.4m
2) Water rest level 10.5m below surface at least 24 hrs after completion of drilling.

Project Name
PORTION B WITFONTEIN 16 I.R.

Project Engineer	Profiled By	Date Profiled
J.E.R.	6/8/91
Red-brown sandy clay. Hillwash.

Red-brown mottled black SANDY CLAY, with minor weathered chert. Probably Manganese Cemented Dolomite and Chert Residuum.

(Chip size 1 - 5mm)

Dark brown and red-brown sandy CLAY-SILT (wad and ferrugan soil) with minor yellow, white and grey slightly weathered chert. Dolomite and Chert Residuum.

(Chip size up to 5mm)

Dark grey stained white and yellow, slightly weathered CHERT with traces of dark brown clay-silt (wad).

From 10-11m traces of dark brown speckled white highly leached Dolomite.

(Chip size up to 20mm)

Dark brown speckled white, highly leached DOLOMITE, with minor dark brown clay-silt (wad)

(Chips friable and from 5-10mm)

Dark grey and pale grey unweathered DOLOMITE.

(Chip size 1 - 10mm)

Notes: 1) Driller reported presence of cavity from 10,4 - 11,3m.
2) Water encountered during drilling at a depth of 10,4m.

GEOTECHNICS AFRICA CC
Reg No CK 88/08625/23
ROTARY PERCUSSION BOREHOLE LOG
Project No 91/046
Borehole No 6/28
Sheet 1 of 1

PORTION 8 WITFONTEIN ; 16 I.R.

Project Engineer
Profiled By
J.F.R.
Date Profiled
8/8/91
Red-brown SANDY CLAY, with minor ferruginous concretions at base. Hillwash.

3

Pale yellowish-orange CLAY-SILT. Residual Igneous Rock.

5

Pale and dark grey, unweathered CHERT, with minor dark brown sandy CLAY-SILT (wd).
(Chips up to 20mm diameter)

9

Dark grey and white fractured (stained yellow-brown) CHERT, with abundant dark brown clayey silt (wd) and minor leached dolomite. (Chips up to 10mm diameter)

11

Dark grey and white, weathered and slightly weathered DOLOMITE. (Chips up to 5mm diameter)

12

Dark grey and pale grey slightly weathered DOLOMITE.
(Chips up to 5mm diameter)

No sample return below 15m.
Moderate air loss below 15m.
<table>
<thead>
<tr>
<th>Depth</th>
<th>Legend</th>
<th>Strata Description</th>
<th>Air/Sample Return</th>
<th>Penetration rate (MIN/METRE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td></td>
<td>Dark grey and pale grey, slightly weathered DOLOMITE. (Chips up to 5mm diameter)</td>
<td></td>
<td>1 2 3 4 5 6 7 8</td>
</tr>
</tbody>
</table>

NOTES:
1) Water intersected during drilling at a depth of 14.7m.
2) Water rest level at 12.4m below surface at least 24 hours after completion of drilling.
<table>
<thead>
<tr>
<th>Depth</th>
<th>Legend</th>
<th>Strata Description</th>
<th>Air</th>
<th>Sample Return</th>
<th>Penetration rate (MIN/METRE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td></td>
<td>Dark grey and pale grey, slightly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>weathered DOLOMITE.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(Chips up to 5mm diameter)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

1) Water intersected during drilling at a depth of 14.7m.

2) Water rest level at 12.4m below surface at least 24 hours after completion of drilling.
<table>
<thead>
<tr>
<th>Depth</th>
<th>Legend</th>
<th>Strata Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td></td>
<td>Red-brown SANDY CLAY, with abundant white weathered chert CRAVELS. Hillwash. Only traces of chert below 1m. (Chips up to 5mm diameter)</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Red-brown sandy CLAY-SILT with traces of ferruginous concretions. Weakly Ferruginised Hillwash. (Chips less than 2mm diameter)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reddish-purple speckled yellow-brown CLAY-SILT. Residual Igneous Rock</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Yellow-brown speckled orange-brown and olive, CLAYEY SILT. Residual Igneous Rock</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>Red-brown speckled yellow-brown CLAY-SILT, with traces of olive highly weathered rock. Residual Igneous Rock</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Penetration Rate (MIN/METRE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

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**Project Name**: PORTION 8 WITFONTEIN 16 IR

**Project Engineer**: JFR

**Date Profiled**: 6/9/91

**Reg No**: CK 88/08625/23

**Project No**: 91/046

**Borehole No**: 11/31

**Sheet**: 1 of 2

---

**GEOTECHNICS AFRICA CC**

**ROUNDFERROCK PERCUSSION BOREHOLE LOG**
<table>
<thead>
<tr>
<th>Depth</th>
<th>Legend</th>
<th>Strata Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td></td>
<td>Red-brown speckled yellow-brown CLAY-SILT, with traces of olive highly weathered rock. Residual Igneous Rock</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>Dark and pale grey, probably slightly weathered DOLOMITE. (Chips 2-10mm diameter)</td>
</tr>
</tbody>
</table>

**NOTES:**
1. No water intersected during drilling.
2. Water rest level 15.7m below surface at least 24 hours after completion of drilling.
Depth | Legend | Strata Description | Air Sample Return | Penetration rate (MIN/METRE)
--- | --- | --- | --- | ---
1 | | Red-brown SANDY CLAY, with abundant dark and pale grey unweathered chert GRAVELS. Hillwash. | | 1
2 | | (Chips up to 15mm diameter) | | 2
3 | | Red-brown weakly ferruginised SANDY CLAY, with minor ferruginous concretions. Ferruginised Hillwash. Red-brown speckled orange-brown sandy CLAY-SILT. Reworked Residual Igneous Rock. | | 3
10 | | Yellow-brown speckled white SILTY fine SAND. Residual Igneous Rock. | | 10
20 | | Khaki speckled white SILTY medium and fine SAND. Residual Igneous Rock. | | 20

See sheet 2 for description.

---

Project Name
PORTION 8 WITFONTEIN 16 IR

Project Engineer | Profiled By | Date Profiled
--- | --- | ---
JFR | | 6/9/91

GEOTECHNICS AFRICA CC
Reg No CK 88/08625/23
ROTARY PERCUSSION BOREHOLE LOG
Project No
Borehole No 14/21
Sheet 1 of 2
Pale grey and white mottled dark brown, low density highly leached DOLOMITE, with minor dark brown clayey silt (wad). (Chips up to 20mm diameter)

Equal quantities of dark brown clayey silt (wad) and pale grey to white highly leached dolomite with minor unweathered chert. (Chips up to 10mm)

Pale and dark grey unweathered CHERT, with minor leached dolomite and dark brown clayey silt (wad).

NOTES:
1) Water intersected during drilling at a depth of 23.2m.
2) Water rest level 14.5m below surface at least 24 hours after completion of drilling.
Red-brown SANDY CLAY.
Hillwash.

Red-brown manganese cemented SANDY CLAY, with minor weathered chert gravels and manganese concretions. Dolomite Residuum.

Equal amounts of pale grey and white CHERT and dark brown sandy CLAY-SILT (Wad).
Dolomite and Chert Residuum.

Pale grey stained white and yellow-brown, weathered DOLOMITE, with minor chert.
(Chips up to 5mm diameter)

Dark and pale grey slightly weathered DOLOMITE.
(Chips 5mm diameter)

Pale grey stained brown and yellow-brown, weathered DOLOMITE.
(Chips up to 15mm diameter)

See sheet 2 for description.
Depth | Legend | Strata Description | Air/Sample Return | Penetration Rate
---|---|---|---|---
26 | | Dark brown CLAYEY SILT (Wad), with minor leached dolomite. Strong inflow of water at 17m samples contaminated. Dolomite appears to increase in quantity with depth as penetration rates decrease. | | 22
27 | | Driller reports solid dolomite owing to low penetration rates. No samples recovered owing to high inflow of water and collapse of hole sides at 23m. | | 23
28 | | | | 24
29 | | | | 25
30 | | | | 26

NOTES:
1) Water intersected at a depth of 16.3m during drilling.
2) Water rest level 15.1m below surface at least 24 hours after completion of drilling.
<table>
<thead>
<tr>
<th>Depth</th>
<th>Legend</th>
<th>Stratigraphic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>Red-brown SANDY CLAY, with minor weathered chert. Hillwash and Pebble Marker.</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Red-brown sandy CLAY-SILT. Reworked Residual Igneous Rock.</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Yellow-brown CLAYEY medium and fine SAND. Residual Igneous Rock.</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>Dark brown speckled yellow-brown and greyish-green highly weathered, probably very soft rock Igneous Rock. (Chip size 1 - 10mm)</td>
</tr>
</tbody>
</table>

**Penetration rate (min/metre)**

---

**Project Name**
PORTION 8 WITFONTEIN 16 I.R.

**Project Engineer**
J.F.R.

**Date Profiled**
8/8/91

**GEOTECHNICS AFRICA CC**
Reg No CK 88/08625/23
ROTARY PERCUSSION BOREHOLE LOG

**Project No**
Borehole No 18/27

91/046

Sheet 1 of 2
Greyish-green mottled dark brown, highly weathered, fractured, probably hard rock Igneous Rock. (Chip size up to 10mm).

Dark greyish-green slightly weathered, fractured, probably very hard rock Igneous Rock. (Chip size up to 15mm).

Notes: 1) No water intersected during drilling.
2) Water rest level 16m below surface at least 24 hours after completion of drilling
Red-brown SANDY CLAY. Hillwash

Dark red-brown SANDY CLAY, with minor manganese concretions and weathered chert gravels. Hillwash.

Reddish-orange CLAY-SILT. Residual Igneous Rock.

Pale yellow-brown and pale grey indurated shaley material. (Chips up to 15mm diameter)

Dark brown and red-brown CLAYEY SILT (wad and ferroan soil), with minor weathered chert. Dolomite Residuum. (Chips up to 5mm diameter)

Pale grey stained brown and yellow-brown, moderately weathered DOLOMITE, with minor chert. (Chips up to 15mm diameter)

Dark brown and red-brown CLAYEY SILT (wad and ferroan soil) with minor chert.

NOTES:
1) Water intersected at a depth of 18m.
2) Hole abandoned at a depth of 18m as hole collapsing and no further progress possible.
<table>
<thead>
<tr>
<th>Depth</th>
<th>Legend</th>
<th>Strat Description</th>
<th>Air/ Sample Return</th>
<th>Penetration Rate (MIN/METRE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Red-brown SANDY CLAY: Hillwash.</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minor weathered-chert gravels from 3 - 4m.</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Reddish-purple speckled yellow-brown CLAY-SILT. Residual Igneous Rock.</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Pinkish-purple speckled white SANDY SILT. Residual Igneous Rock.</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Dark brown CLAYEY SILT (Wad), with abundant pale grey and white chert. (Chips up to 15mm diameter)</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Pale grey stained yellow-brown and brown, moderately weathered DOLOMITE. (Chips up to 20mm)</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Bluish-grey unweathered DOLOMITE.</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td><strong>NOTES:</strong></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1). Hole drilled 5m west of 22/28B.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2). No water intersected during drilling.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3). Hole dry to a depth of 19m when plumbed at least 24 hours after completion.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth</td>
<td>Legend</td>
<td>Strata Description</td>
<td>Air/ Sample Return</td>
<td>Penetration rate (min/metre)</td>
</tr>
<tr>
<td>-------</td>
<td>--------</td>
<td>--------------------</td>
<td>--------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td>Red-brown SANDY CLAY.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Hillwash.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Dark brown and red-brown CLAYEY SILT (wad and ferroan soil), with abundant weathered chert. Dolomite and Chert Residuum. (Chip size 2 - 20mm).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Bluish-grey unweathered DOLOMITE. (Chip size 1-10mm)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: 1) No water intersected during drilling.

2) Hole dry to a depth of 11m when plumbed at least 24 hours after completion of drilling.
Dolomite stability on Witfontein Ext 87

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<td>1</td>
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<td>1</td>
<td>Sep 2016</td>
<td>B Keyter</td>
</tr>
</tbody>
</table>

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