RICHBAY CHEMICAL (PTY) LTD

PROPOSED NEW CHEMICAL PLANT: VOSLOORUS, EKURHULENI

FEASIBILITY DOLOMITE STABILITY AND GEOTECHNICAL INVESTIGATION

PREPARED FOR:

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1. INTRODUCTION

Knight Piésold (KP) was appointed by Mr Martin Klopper of Richbay Chemicals (Pty) Ltd (purchase order number 53246) to conduct a feasibility level dolomite stability and geotechnical investigation of a site in Vosloorus in Ekurhuleni, Gauteng. It is understood that the intended use of the site is predominantly for the manufacture, packaging, storage and distribution of chemical products. Large laydown areas for products, storage tanks and parking facilities encompass most of the intended development. Warehouse structures and administration buildings are also anticipated.

As the site is underlain by dolomite of the Chuniespoort Group, Transvaal Supergroup, a dolomite stability investigation is required, in accordance with SAN 1936 Parts 1 to 4. The stability investigation is aimed at determining the potential for sinkholes and subsidence's to develop. The outcome of the stability investigation will determine the type of development that will be allowed as well as the density of development.

The investigation aims to provide a preliminary assessment of the dolomite stability conditions across the site, which has a total area of approximately 8 ha. The objectives of the investigation were to:

- Establish the site stratigraphy and the engineering properties thereof,
- Establish the potential for sinkholes and subsidence's to develop and, on the basis thereof, zone the site and establish the nature of the development that is permissible,
- Identify potential problem soils,
- Establish the potential for in-situ materials to be used in pavement layers, and
- Provide preliminary foundation recommendations for the proposed development.

This report details the work carried out, analyses the results, and gives our preliminary conclusions and recommendations.

2. AVAILABLE INFORMATION

The desk study assessments were based on published geological maps, satellite imagery (Google Earth ®) and published data of geological formations present on site. The data sources included:

- 1:250 000 scale Geological Series sheet 3318 Cape Town Map.
- Engineering Geology of Southern Africa by ABA Brink.
- Google Earth Imagery ®.

No borehole records of a previous dolomite stability investigation on the site are available from the Council for Geoscience (CGS) dolomite databank, however, additional sinkhole events and boreholes are noted nearby.

3. SITE LOCATION AND DESCRIPTION

The site is located approximately 2,5 km east of Vosloorus in Ekurhuleni Metropolitan Municipality (EMM) as indicated in the locality plan (Figure 1), included at the end of this report. The site lies immediately east of the N3 national highway and falls within the bounds of Portion 86 of the farm Vlakplaats 138 IR.

The Weinert Climatic N-value [1][1] for the site is less than five. Chemical weathering is the predominant weathering form within this climatic environment and facilitates the breakdown of primary minerals into secondary minerals and clays.

Waterlands Road defines the eastern boundary of the site, and vacant farmland encompasses the immediate remaining boundaries. The entire site is enclosed by a 4 m high concrete wall which is visible from satellite imagery. Access to the site is gained from the main access gate off Waterlands Road in the north-eastern corner of the site.

The general topography of the site slopes gently towards the N3 highway, with sporadic heaps of dumped material occurring in the southern central portion of the site. Regional surficial drainage generally follows the topography and flows westwards from Waterlands Road to the N3 Road Embankment, which channels the storm water to a concrete line catchpit adjacent to the southwest corner of the site. Available GIS databases indicate that a storm water pipeline cuts north-south through the western half of the site. Refer to site photographs included in Appendix A at the end of this report.

No sinkholes or subsidence's were observed on the site at the time of investigation. CGS records indicate that the nearest occurrences of sinkholes are between 380 m and 470 m east of the site (namely EK_S220 and EK_S221) [2]. Visual inspection of these areas was not undertaken; however, satellite imagery suggest that these two sinkholes were possibly related to leaking stormwater pipes to the west of the R103 regional route.

Vegetation across the site predominantly comprises veldt grasses with scattered trees across the site and one small grove in the central portions of the site. It appears that much of the upper soil profile (<0,5 m below current ground level) has been highly disturbed by historic use as laydown areas over most of the site.

Numerous small access roads, lined with aggregate crosscut the site. These provide access to the limited infrastructure, comprised of a workshop, administration building and change room in the centre of the site. All of which are bound with precast walling.

Remnants of a forecourt and possible buried fuel tank are evident in the centre of the site, directly opposite the workshop. It is unclear whether the fuel tank was in fact above ground or remained buried.

To the west of the change house is a smaller building which houses the borehole pump, used to fill a storage tank which feeds the change house groundwater. Satellite imageries suggest the installation of this borehole predates 2003.

[1] References are indicated thus and are listed at the back of the report.

4. METHODOLOGY

The investigation was carried out by performing a gravity survey of the site on a 20 m grid to provide gravimetrical anomalies highlighting subsurface conditions for investigation. The gravity survey was carried out by GeoFocus Geophysical Services in mid-September 2021. The results of the survey have been used to determine investigation positions and are contained in Appendix D.

Following the results of the gravity survey, the field investigation comprised the excavation of twelve test pits (TP1 to TP12) and drilling of eleven percussion boreholes (PH1 to PH11) on 16 and 17 September 2021 respectively.

The test pits were excavated to maximum reach or refusal conditions of a CAT 428F TLB. The test pits were excavated by V&S Cathire to investigate the shallow soil conditions. The test pits were profiled in-situ by an engineering geologist and representative samples selected for laboratory testing. Test pits were backfilled on the same day as the percussion drilling concluded.

Representative samples were taken from the soil profiles and have been submitted to Specialised Testing (ST) commercial laboratory in Pretoria, South Africa for geotechnical testing. The following laboratory tests have been requested:

- 12x Particle Size Distribution (PSD) and Atterberg Limits,
- 3x Modified AASHTO maximum dry density and optimum moisture content tests,
- 3x California Bearing Ratio (CBR) tests,
- 3x pH and electric conductivity (Ec) tests,
- 1x Collapse potential (CP) test, and
- 1x Consolidation (Oedometer) test.

The percussion boreholes were drilled by Hennie Erwee Drilling using a Super Rock 1000 percussion drilling rig to a maximum depth of 60 m or until 6 m sound bedrock was encountered. Two drilling rigs were established on the same day to complete drilling in one day. The boreholes investigated gravimetrical anomalies to assess the subsurface conditions at the site.

Chip samples were recovered at 1 m intervals from the percussion drilling, and the depths of water strikes, sample and air losses and penetration rates were accurately recorded by the driller during the drilling operation.

The boreholes were logged on site by an engineering geologist in accordance with industry guidelines and standards, which included, but are not limited to the following:

- SANS 1936: 2012: Development of Dolomite Land. Parts 1 to 4.[3].
- SANS 633:2012: Soil profiling and rotary percussion borehole logging on dolomite land in Southern Africa for engineering purposes [4].

Groundwater rest levels were recorded 24 hours after the completion of drilling, after which the boreholes were backfilled and sealed.

The positions of the test pits and boreholes were recorded on site using a hand-held GPS accurate to 3 m. The GPS co-ordinates are provided on the profiles and are presented in WGS84 datum, South African grid, Lo29.

The positions of the test pits and boreholes are shown on Figure 5. The test pit profiles are summarised in TABLE 3 and full profiles are contained in Appendix B. The borehole profiles are summarised in TABLE 4 and the full profiles contained in Appendix C.

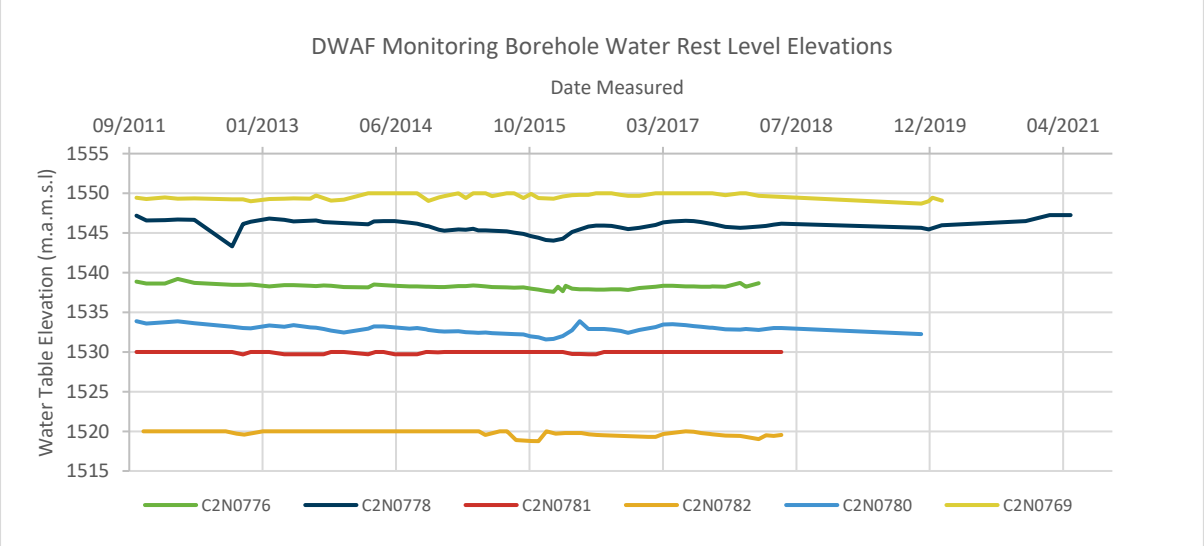
5. REGIONAL GEOLOGY AND GROUNDWATER

According to the published 1:250 000 scale Geological Map, Sheet 2628 East Rand [5], the site is underlain by karstic rocks of the Malmani Subgroup, Chuniespoort Group, Transvaal Supergroup. Regionally, geological contacts with younger dolerite rocks of Post Karoo Intrusive origin, are indicated on the map approximately 760 m east and 1,4 km west of the site. Significant erosion of the dolerite is interpreted given the regional topography and its inferred absence below the site. Locally the dolomite is intensely interfingered with dolerite across most of the site, with the latter being widespread. A complex geological profile is the result of the interrelation of these two dominant lithologies.

The site appears to be located on the eastern bank of a regional drainage feature, draining southwards, sub-parallel to the N3 highway. This feature drains to the Rietspruit River which lies approximately 1,7 km south of the site. An extract of the published geological map of the area is provided in Figure 2.

The Malmani Subgroup consists of chert-rich, alternating with chert-poor dolomite formations. These rocks have a notorious reputation for the development of karst subsurface landscape, associated with highly irregular and voided bedrock profile, as well as heterogenic soil conditions. The soil cover often comprises highly erodible soils, which can readily mobilise downward by means of percolating water to create leached or voided zones, which may result in the formation of sinkholes and subsidences [6].

The site forms part of the Natalspruit East dolomite groundwater compartment with many ground water monitoring boreholes, as indicated in Figure 3. The median groundwater level in the compartment is recorded as 15,2 m with the minimum and maximum ad-hoc measurements varying between 12,3 m and 21,4 m below surface [7]. Water rest elevations from the DWAF monitoring boreholes surrounding the site are indicated below.



Water rest levels recorded in monitoring boreholes operated by the Department of Water Affairs (DWAF), indicate that regional water level for boreholes near the site over the last 10-year period is relatively stable. However, slight fluctuations (<1m) do occur, which can possibly be attributed to seasonal drought and possibly nearby abstraction of water for industrial and/or agricultural use.

The static water level (SWL) for this site has been taken as the regional median of 15 m below surface and used in the stability analysis in Section 8 of this report. The investigation was conducted at the turn of seasons from dry to wet. No significant water sources of consequence or in excess of seasonal rainfall, were noted near the site. A summary of the water rest levels as encountered in the boreholes is presented in TABLE 1 and the descriptive statistics of the water rest levels are shown in TABLE 2.

TABLE 1: Summary of Bedrock and Water Rest Elevations

Hole No.	Hole Depth (m)	Water Strike (m)	Water Rest Level (m)	Dolomite Bedrock depth (m)	Ground Elevation (m.a.m.s.l.)	Water table Elevation (m.a.m.s.l.)	Dolomite Bedrock Elevation (m.a.m.s.l.)
PH1	12	-	Dry	3.0	1546.8		1543.8
PH2	25	8.1	9.6	18.5	1543.9	1534.3	1525.4
PH3	22	13.5	11.6	16.0	1546.1	1534.5	1530.1
PH4	20	-	10.9	13.0	1543.2	1532.3	1530.2
PH5	28	11	10.2	18.0	1546.9	1536.7	1528.9
PH6	24	14	11.2	>24	1545.7	1534.5	<1521.7
PH7	20	11	10.6	11.0	1545.0	1534.4	1534
PH8	23	14.9	10.3	18.0	1541.9	1531.6	1523.9
PH9	21	-	12.2	>21	1540.9	1528.7	<1519.9
PH10	26	14.3	10.8	25.0	1547.4	1536.6	1522.4
PH11	21	-	9.9	14.0	1541.4	1531.5	1527.4

TABLE 2: Descriptive Statistics of Site Water Rest Levels

Zone	Water Rest Level (m)	Dolomite Bedrock depth (m)	Water table Elevation (m.a.m.s.l.)	Dolomite Bedrock Elevation (m.a.m.s.l.)
All data	**10**	**Boreholes drilled within the site**		
Avg	10.7	16.7	1533.5	1527.8
St Dev	2.4	4.0	2.4	3.6
Min	9.6	11.0	1528.7	1522.4
Max	12.2	25.0	1536.7	1534.0
Variance	0.6	16.2	5.5	12.6
No. used	10	8	10	8

In general, the water strikes encountered in boreholes were notably deeper than the final water rest levels in the boreholes. This possibly indicates that the confined conditions may be present due to the down slope orientation of the dolerite dyke relative to the dolomite. The Original Water Level (OWL) is generally deeper than the water rest level recorded from this drilling campaign by roughly 4,5 m. The water rest levels are generally above dolomite bedrock, except for boreholes PH1 (Dry) and PH7, which is 0,5 m above bedrock. The average water rest level for the site is regarded as 11 m below surface for the purpose of stability analysis.

6. INVESTIGATION RESULTS

6.1 TYPICAL PROFILE

The results of the test pit excavations indicate that the site is covered by fill and underlain by transported and residual soils extending to bedrock. TABLE 3 provides a summary of the test pit logs. The summary of the borehole profiles is included in TABLE 4. A geological cross section of the drilling results is presented in Figure 4. The ground profile is described as follows:

- Most of the site is blanketed by a generally thin fill of variable composition. This varies between 0,1 m and 0,8 m thick with the average thickness of 0,29 m. Typical descriptions for the thin occurrences of fill are greyish brown to black silty fine sand combined with coarse (27mm) dolomite and chert aggregate. Instances of fill thicker than 0,2 m are generally highly variable in description and properties. Particularly thick layer of fill was encountered in test pit TP3 which comprises gravelly silty sand with minor cobbles. Additionally, spoil heaps of stockpiled fill materials are visible from surface in the areas between test pit TP3 and TP6 near the southern boundary of the site.
- One instance of topsoil was encountered below the surface to a maximum depth of 0,4m. The topsoil has presumably been stripped in other areas across the site prior to use as laydown areas. This was noted as a dark brown silty fine gravely sand of dense consistency with abundant rootlets.
- The transported soil underlying the topsoil comprises hillwash, which is generally overlain by fill across most of the site. The hillwash is typically encountered to a depth of 1,4 m below surface in all test pits confined to the western half of the site with an average thickness of 0,6 m. In the eastern half of the site, hillwash occurs to a shallower depth of 0,75 m on average with a similar thickness and encountered in test pits TP11 and TP8 only. Hillwash on site is described as red brown to dark red brown, slightly fine gravelly sandy silty clay for the occurrences above residual dolerite profiles. Consistencies vary between firm to stiff in the tactile descriptions. In the eastern portions of the site underlain by dolomite, the profile appears sandier from tactile descriptions and comprises clayey silty fine sands of medium dense consistency.
- A pebble marker horizon varies between 0,3 m and 0,8 m thick and is present to a maximum depth of 2,1 m in test pit TP1. The horizon is described as dark reddish brown stained black speckled white, silty sandy fine to coarse gravel with a medium dense to generally dense consistency. The gravel and cobble-sized fragments comprise highly to completely weathered chert.
- Isolated occurrences of pedogenic soils are encountered in test pits TP2 and TP5. Nodular ferricrete has developed at depth within the reworked residual dolerite in the former and within the transported soils (hillwash) in the latter. Slow excavation was noted at the base of TP2 which is situated in the lowest lying portion of the site, and this was due to the only occurrence of honeycomb ferricrete at its base. This may be indicative of seasonal development of a shallow perched ground water table within the surficial soils.
- The residual dolerite soil profile, which occurs below the transported soils, is often reworked to an average thickness of 0,9 m in its upper portions and situated at an average depth of 1,4 m below surface. This reworked portion is underlain by residual dolerite in all instances except for TP1, TP2 and TP4. Grading of the reworked to partially reworked soils typically correlate with a change in colour from dark red brown mottled black yielding slightly sandy silty clay to clayey silt. The latter being reddish orange slightly sandy clayey silt. Consistencies of the reworked portions are typically in the range of firm to stiff with occasional instances of very stiff. Tactile descriptions of the residual

dolerite vary from orange-brown to yellow brown slightly clayey sandy silt to silty sand. Consistencies vary between stiff to very stiff for the former grading and dense to very dense in the latter.

- Dolomite residuum, both fines dominated, and chert dominated were encountered in the test pits across the eastern half of the site, viz. TP7 – TP12. Residual dolomite (fines) was encountered in the test pits TP7 – TP9 and identified as reworked in all cases, with an average thickness of 0,6 m. Descriptions for this are typically dark brown mottled or speckled red brown and black, silty sandy clay to fine gravelly clayey silty sand. The coarser fraction within the reworked horizons mainly consisted of chert. The chert residuum (coarse) was encountered in all test pits on the eastern side of the site and has an average thickness of 1,35 m. Typically, this has been described as red brown speckled or blotched white stained orange, clayey sandy fine to coarse gravel with occasional cobbles. Consistencies typically range between medium dense to dense.
- One instance of a mixed transitional zone was encountered in TP12 near the centre of the site. This comprised a mixture of chert dominated residuum and highly weathered fragments of residual dolerite. In total, two test pits had identified the contact zones between the dolomitic profile and the intrusive dolerite profile near surface, namely TP7 and TP12.
- Refusal of the TLB was encountered in test pits TP5 to TP7, TP10 and TP11. This was mainly on very soft rock to soft rock dolerite in TP5 and TP6, on shallow chert boulders/ bedrock in TP7 and TP11 with dolomite bedrock encountered in the base of TP10.
- The borehole profiles show the bedrock to be highly variable with complex interfingering of the dolerite within the dolomite. Negligible dolomite residuum was interpreted to be present within the soil profile where it extends below the maximum depth of the test pits, except for borehole PH5 between 2 m and 9 m. A 3 m thick layer of residual dolomite (wad) was encountered in borehole PH10 at shallow depth. One zone of air and sample loss (<50% return) was encountered in PH1 between 8 m and 11 m. Outside of these identified zones, no air and sample losses were encountered, also no weathered products of dolomite were encountered at the contacts between differing lithologies.

The conditions across the site are uniform with minor variations observed between eastern and western halves. No groundwater seepage was encountered in any of the test pits. Most of the boreholes encountered water strikes and recorded a static water level at least 24 hours after drilling. The water rest level for the site as recorded in the boreholes has been taken as 11 m below surface and used as such in the stability analysis in subsequent sections.

6.2 GEOPHYSICAL SURVEY

The gravity survey was carried out in mid-September 2021. The site characterised by gravity high features in the extreme eastern and central-western portions which grades to gravity low features surrounding it. The latter gravity high straddles the site with a NW-SE trend and the central broad gravity low integrates multiple smaller lows. A peak-to-peak envelope of the results is roughly 0,3 mGal. Refer to Figure 6 detailing the revised residual gravimetric map and borehole positions. The detailed report by the geophysicist is included in Appendix E.

Borehole PH1 intersected bedrock at shallow depth (6 m) and was used to apply corrections to the gravity data. Similarly, the two prominent gravity low features in the central portions of the site were intersected by PH2 and PH3. The remaining boreholes intersected dolerite of varying thicknesses and at differing elevations, aimed at refining the geotechnical model as well as the gravimetric survey results. A revision of the gravity survey results was carried out by the geophysicist, to account for the

bedrock depths encountered in the boreholes. Overall, although the presence of dolerite influenced the gravity readings to a great degree, a fair reflection of the variances in bedrock is represented by the final gravity results.

6.3 LABORATORY TEST RESULTS

Representative samples were collected from the test pits and submitted to Specialised Testing (ST) Laboratory in Pretoria for testing. The results are summarised in TABLE 5 at the end of the report. A condensed version or the results is presented below and discussed. The detailed laboratory results are included in Appendix D.

6.3.1 HILLWASH

Hillwash has been described in the profiles as sandy to silty clay. The results of testing on hillwash samples from the western portion of the site indicate the following:

- The material consists mainly of sand (ranges from 24% to 38%), silt (ranges from 28% to 31%) and clay (ranges from 32% to 37%).
- The average GM is 0,51.
- The Plasticity Index (PI) ranges between 18% and 19% with a low potential expansiveness [8].
- The unified soil class indicates that hillwash classifies as a clay of low plasticity (CL).
- Consolidation tests on the hillwash predict settlements of 10 mm/m, 15 mm/m and 39 mm/m at 100 kPa, 150 kPa and 250 kPa bearing pressures should foundations be placed on top of the hillwash horizon.
- A collapse potential of 0.4 % was achieved in testing, which indicates that “no problem” with respect to collapsible fabric exists within the hillwash horizon [9].

6.3.2 PEDOGENIC SOILS

One instance of nodular ferricrete was tested for its potential use in layerworks. Grading results indicate it comprises a slightly clayey silty sandy gravel with a PI of 16%, a low potential expansiveness, GM of 1,98 and classifies as a clayey gravel (GC) according to the USCS. Compaction results indicate that crushing of the ferricrete nodules occurs under compaction and strength is then lost, such that the material qualifies as poorer than G9 quality material [10] and can only be used as low-grade general fill. This is not suitable for use in layerworks.

6.3.3 REWORKED RESIDUAL DOLERITE

Reworked residual dolerite has been described in the profiles as clayey sandy silts to gravelly clayey sand. The results of testing on topsoil samples indicate the following:

- The material consists mainly of gravel (ranges from 6% to 32%), sand (ranges from 26% to 29%), silt (ranges from 20% to 38%) and clay (ranges from 19% to 30%).
- The average GM is 0,86 with a range between 0,53 and 1,29 depending on degree of pedogenic cementation. Soils with GM<1 is typically dominated by fines particles and do not compact well.
- The Plasticity Index (PI) ranges between 20% and 22% with liquid limits of between 40% and 44%, which results in a low to medium potential expansiveness.

- The unified soil class indicates that the reworked residual dolerite classifies as a clay of low to intermediate plasticity (CL-CI) and occasionally a clayey sand (SC).
- A slightly acidic pH of 5,7 and electric conductivity of 0,022 S/m indicate that the soils will likely be corrosive towards steel [11] and mildly aggressive towards concrete [12].

6.3.4 RESIDUAL DOLERITE

Residual dolerite has been described in the profiles as a silty sand to sandy silt. The results of testing on topsoil samples indicate the following:

- The material consists mainly of sand (ranges from 29% to 67%), silt (ranges from 23% to 44%) and clay (ranges from 5% to 25%).
- The average GM is 0,67 with a range between 0,33 and 0,98. Soils with GM<1 is typically dominated by fines particles and do not compact well.
- The Plasticity Index (PI) ranges between 8% and 24% with liquid limits of between 31% and 54%, which results in a low to medium potential expansiveness.
- The unified soil class indicates that the fines portion of the residual dolerite classifies as a clay of high plasticity (CH) and occasionally a clayey sand (SC).
- A slightly acidic pH of 5,5 and electric conductivity of 0,022 S/m indicate that the soils will likely be corrosive towards steel and mildly aggressive towards concrete.

6.3.5 REWORKED RESIDUAL DOLOMITE

6.3.5.1 Chert Dominated Residuum

The chert dominated residuum has been described in the profiles as a silty sandy fine to course gravel and cobbles. The results of testing on the samples indicate the following:

- The material consists mainly of gravel (ranges from 72% to 73%), sand (ranges from 13% to 15%), silt (ranges from 8% to 9%) and clay (typically 5%).
- The average GM is 2,35.
- The Plasticity Index (PI) ranges between 12% and 15% with a low potential expansiveness.
- The unified soil class indicates that chert residuum classifies as a clayey gravel (GC).
- Compaction results on this material yields an average Maximum Dry Density (MDD) of 2046 kg/m^3 at an Optimum Moisture Content (OMC) of 9%. This horizon qualifies for use as a G6 quality material.
- The above parameters notably include one mixed sample of the pebble marker with the chert residuum below appear to have not significantly influenced the properties.

6.3.5.2 Fines Dominated Residuum

Fines dominated residuum has been described in the profiles as a clayey silty sand to a clayey sandy silt. The results of testing on the samples indicate the following:

- The material consists mainly of gravel (ranges from 17% to 21%), sand (ranges from 36% to 40%), silt (ranges from 17% to 23%) and clay (ranges from 22% to 24%).
- The average GM is 1.0 with a range of 0,95 to 1,06.

- The Plasticity Index (PI) ranges between 13% and 14% with a low potential expansiveness.
- The unified soil class indicates that fines dominated residuum classifies as a clayey sand (SC) and clay of low (CL) plasticity.

7. GEOTECHNICAL ASSESSMENT

7.1 GENERAL

The site has been divided into two main geotechnical zones as indicated in the geotechnical plan (Figure 5) included at the end of this report. This is largely based on the potential for differing soil conditions linked to prevailing lithology of surface soils split east from west.

7.1.1 ZONE A

The typical soil profile encountered within this zone is comprised primarily of transported soils to a depth of 1,5 m on average, which are underlain by reworked and residual dolerite soils to a depth of 3 m below surface. Laboratory results indicate that the reworked residual dolerite soils are likely to pose a medium potential for expansiveness. Therefore, the design of any structure to be founded in this portion of the site will need to cater or mitigate heave in the order of 20 mm to 25 mm. Bearing pressures of the in-situ soil profile can be regarded as follows:

- 50 kPa can be achieved within the hillwash, pebble marker and nodular ferricrete within this zone at an average depth of 0,5 m which will vary in some instances, particularly in the central portions of this zone viz. TP2, TP3 and TP4, where this is achieved slightly deeper.
- 100 kPa can be achieved within the hillwash, pebble marker and nodular ferricrete within this zone at an average depth of 0,8 m which will vary in some instances, particularly in the central portions of this zone viz. TP2, TP3 and TP4, where this is achieved slightly deeper.
- 150 kPa can be achieved within the residual and reworked residual dolerite soils within this zone at an average depth of 1,2 m which will vary in some instances, particularly in the central portions of this zone viz. TP4, where this is achieved at roughly 2 m from surface.

7.1.2 ZONE B

The typical soil profile encountered within this zone is comprised primarily of transported soils to a depth of 0,5 m on average below which chert residuum, reworked and residual dolomite soils are encountered to a depth of 3 m below surface, except for TP10 which encountered shallow dolomite rock. Bearing pressures of the in-situ soil profile can be regarded as follows:

- 50 - 100 kPa can be achieved in the chert residuum and reworked residual dolerite within this zone at an average depth of 0,5 m, which will vary in some instances, particularly in the south-eastern portions of this zone viz. TP8. 100 kPa is achievable at significantly greater depth on account of a thick hillwash layer of lower consistency which extends to 1,6 m depth. Ground improvement may be considered in these areas.
- 150 kPa can be achieved in the chert residuum and reworked residual dolerite within this zone at an average depth of 0,8 m which will vary in some instances, particularly in the central portions of this zone viz. TP8. This bearing pressure is achieved significantly deeper on account of a thick

hillwash layer of lower consistency which extends to 1,6 m depth. Ground improvement may be considered in these areas.

7.2 SEISMICITY

Seismic activity in the vicinity of the site is indicated to be significant to the development. The seismic hazard map of South Africa [13] was consulted in order to obtain the peak ground acceleration of the area of interest. In general, the Gauteng Province ranges are medium to high in terms of seismic activity.

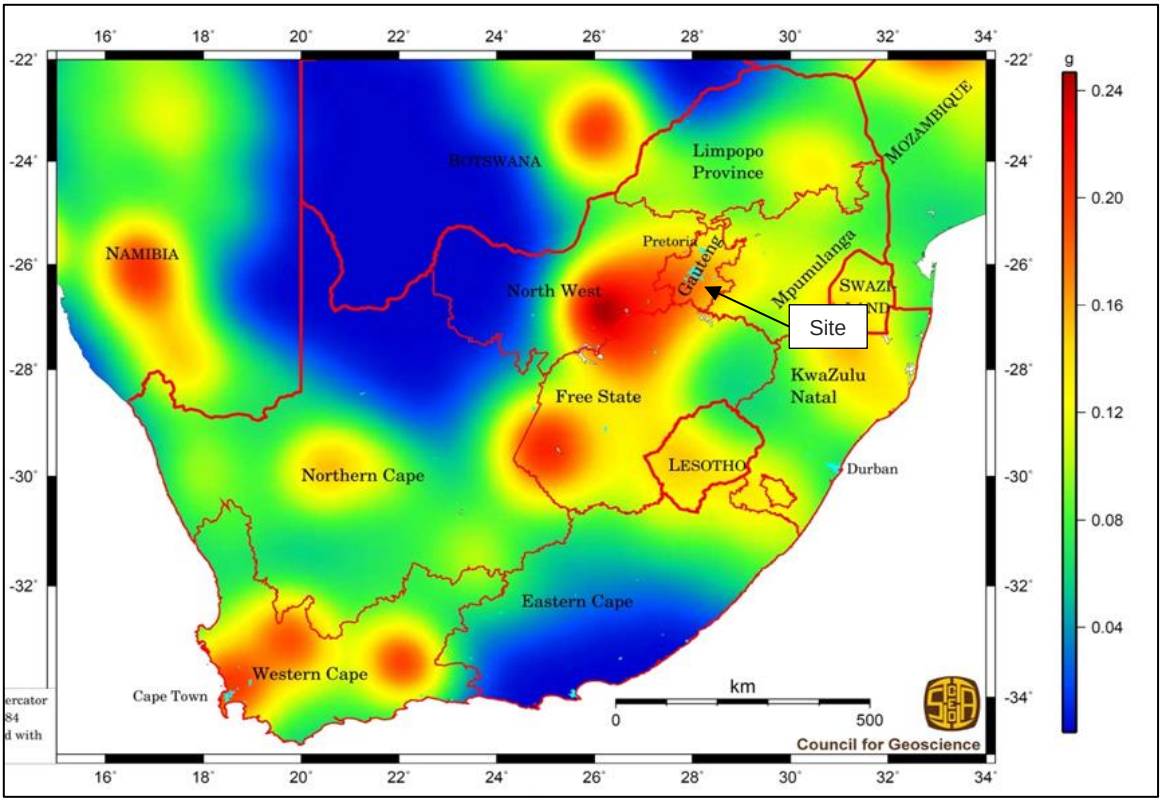


Figure 1: Peak ground acceleration (g) with 10% probability for being exceeded in a 50 year return period.

According to Kijko, the peak ground acceleration for the area is approximately 0,16 m/s2, with a 10% probability of being exceeded in a 50-year period. The seismic activity in the area is therefore considered to be medium to high. Appropriate design considerations may be found in SANS 10160-4 [14].

7.3 AREAS SUBJECT TO FLOODING

Although no evidence of ponding water was encountered during the investigation, special attention should be paid to the areas in which cut to fill operations are envisaged. This to ensure good drainage around newly constructed terraces. Both the 50- and 100-year flood lines must be determined for the site by an appropriately qualified and experienced engineer. This information must then be incorporated in the design.

7.4 SLOPE STABILITY

It is likely that the creation of terraces during construction will result in the creation of slopes, both cut and fill. Special advice should be sought with respect to ensuring that these are stable. No indication of the presence of unstable natural slopes was found during the investigation.

7.5 EXCAVATABILITY

The excavation characteristics of the different soil horizons have been evaluated according to the South African Bureau of Standards standardised excavation classification for earthworks [15] and earthworks (small works – SABS 1200DA). In terms of this classification and the in-situ soil/rock consistencies as profiled, the relationships given below are generally applicable. For specific excavation requirements refer to the soil profiles in Appendix B.

- “soft excavation” - very loose/very soft through to dense or stiff.
- “intermediate excavation” - very dense/very stiff through to very soft rock.
- “hard excavation” - soft rock or better.

Across the site, soils are classified as “soft excavation” to an average depth of 2,8 m, below which “intermediate excavation” is expected, and power tools may be required to excavate further. In some instances, hard excavation may be expected in the areas surrounding test pits TP7, TP10 and TP11, where shallow rock is encountered at depths of 2,7 m, 1,9 m and 2,6 m respectively. Sporadic instances of shallower rock may be encountered, particularly near the north-eastern corner of the site within the weathered dolomite profile.

8. DOLOMITE STABILITY ASSESSMENT

8.1 GENERAL

The results of the boreholes were used during this study to assess the general dolomite stability of the site. The dolomite risk characterisation of the boreholes was done in accordance with the method proposed by Buttrick *et. al* [16]. The risk classification of the borehole profiles is summarised in TABLE 4 at the back of this report.

According to the methodology of scenario supposition, the conditions in each borehole must be evaluated in terms of a non-dewatering as well as a dewatering scenario. The method evaluates the stability of an area by investigating the presence of receptacles in the dolomite profile, depth to potential receptacles, maximum sinkhole development space, the nature and mobilisation potential of the blanket material and the presence of mobilising agents.

The factors influencing the stability of the area are briefly defined as follows:

(a) Blanketing Layer

The blanket layer (dolomitic overburden) comprises all the materials occurring between the ground surface and the dolomitic bedrock surface. The term blanket layer is defined here as the component of the dolomitic overburden that overlies the potential receptacles.

(b) Receptacles

Receptacles in the dolomite profile may occur either as small disseminated and interconnected openings in the overburden or as substantial openings (especially where wad is present). Receptacles also occur as substantial openings (cavities) in the bedrock. Both types of opening may be able to receive mobilised (transported) materials from overlying horizons.

(c) Mobilisation and Mobilising Agents

Mobilisation is defined as the movement of dolomite overburden by subsurface erosion. Mobilising agents include ingress of water, ground vibrations, water level drawdown or any process that can include mobilisation of the material in the blanket layer under the force of gravity.

(d) Maximum Potential Development Space

This is a simplified estimation of the maximum size sinkhole that can be expected to develop in a particular profile, provided that the available space is fully exploited by a mobilising agent. The available space depends on the depth below ground surface to the throat of a receptacle or disseminated receptacle and the 'angle of draw' in the various blanket materials.

8.2 HAZARD CLASSIFICATION

(a) Blanketing Layer

The blanketing layer comprises transported soils (viz. fill; hillwash; topsoil; pebble marker), residual dolerite with varying percentages of chert residuum and residual dolomite, dolerite rock and dolomite rock.

The transported soils are confined to the upper 3m, generally not exceeding 2,5 m. Shallow geotechnical investigation test pits provide more detailed information, as described in Section 6.1 above, to include topsoil and hillwash. The penetration rates of the fill/talus horizon are generally between 14 sec/m and 49 sec/m in the medium hard chert fragments and reddish brown clayey sandy silt. This horizon has a high to medium mobilisation potential.

The residual dolerite is encountered in all but two boreholes (namely PH1 and PH10) generally at shallow depths (within 15 m below natural ground level). The residual dolerite often contains friable zones with typical penetration rates of less than 15 sec/m. However, the typical range for the residual dolerite is 26 sec/m to 56 sec/m with medium mobilisation potential. The residual dolerite horizons are described as orange-brown clayey silt/ sandy silt to reddish brown silty clay with varying proportions of very soft to soft rock bands of dolerite, primarily near the base of the olive brown silty sand/sandy silt.

Residual dolomite sporadically also occurs within the residual dolerite and near the dolomite bedrock interface with typical penetration rates of 8sec/m to 18sec/m, with a medium to high mobilisation potential.

Dolerite rock is present in all the boreholes except for PH1 where dolomite was found at shallow depths. The dolerite is in various stages of weathering. The highly weathered dolerite is recorded within 25 m below ground level with typical penetration rates of 23 sec/m to 1 min 24 sec/m but

is most commonly 25 sec/m to 40 sec/m. The highly weathered dolerite is described as light brown to olive brown speckled black, very soft rock to soft rock. The dolerite rock is considered to have a low mobilisation potential.

Slightly weathered hard rock dolerite has penetration rates in excess of 3 min/m with low mobilisation potential. The weathering and interpreted rock strength from the chips do not indicate higher penetration rates, as expected.

Moderately to slightly weathered dolomite rock is encountered in most of the boreholes at varying depths, typically enclosed with dolerite. This dolomite has penetration rates from 34 sec/m to 1 min 54 sec/m, the lower penetration rates are limited to the occurrences of dolomite near the inferred bedrock level. The weathered dolomite rock has low mobilisation potential.

Sound dolomite bedrock is encountered in all but four boreholes, viz. PH4, PH5, PH6 and PH9, described as slightly weathered to unweathered, hard to very hard rock dolomite with penetration rates exceeding 3min/m, with low mobilisation potential.

The two boreholes that were terminated in dolerite and not dolomite bedrock, were terminated with at least 6m of unweathered dolerite rock with penetration rates exceeding 3 min 20 sec/m up to 4 min 20 sec/m. The dolerite rock is described as low mobilisation potential.

The nature of the blanketing layer is predominantly non-dolomitic with extensive dolerite, as residual soils and rock. Dolomite rock is encountered within the profile, with only one occurrence of no dolerite intersected in borehole PH1. Shallow dolomite bedrock was intersected and correlate to a gravity high anomaly in the north-eastern corner where it was drilled.

(b) Receptacles

No receptacles were encountered during the drilling investigation. Only one instance of significant air/sample loss recorded in the shallow portion of the profile.

For the purpose of the risk assessment, it should in any event be assumed that receptacles do occur within the upper portion of the dolomitic bedrock and/or disseminated zones in the residual dolomite, irrespective whether these were encountered by drilling or not.

(c) Mobilisation Agents

In an urbanised/agricultural area it should be assumed that a mobilising agent is always present in the form of leaking wet services, ponding of surface water and ground vibrations. In the area where the water table is deep, a thick portion of the blanketing layer is exposed to mobilisation than the areas with a shallow water table. If the water table is ever allowed to be drawn down substantially, weak and/or erodible horizons in the dolomitic profile could be exposed to erosion and the formation of sinkholes and subsidence's will thus be enhanced.

The site is underlain by dolerite which adds to the protection of any potential weak zones due to its less permeable and erodible nature.

A storm water pipeline has been inferred from public GIS data and may serve as a potential source for concentrated water ingress. This may at times be exacerbated by excessive groundwater abstraction via the long-standing domestic borehole already present on the site.

(d) Maximum Potential Development Space of Sinkhole and Subsidence Formation

Subsidence's usually form where compaction of highly compressible material takes place (often associated with the gradual lowering of the groundwater level), or where the receptacle has limited available space, or where the potential sinkhole formation process is halted due to remedial measures taken in time.

According to the drilling results, the potential for subsidence formation across the site is low due to the relatively thick overlying dolerite profile and absence of weak and erodible zones.

The water table is generally situated within the residual dolerite or dolerite rock horizons and above the bedrock level. The risk potential for sinkhole formation will therefore increase in conjunction with groundwater drawdown. These are indicated for each borehole for water ingress and a groundwater level drawdown scenario in TABLE 4.

(e) Hazard Class

The boreholes drilled were classified in terms of the eight different Inherent Hazard Classification (IHC) classes proposed in the method for dolomite land hazard and risk assessment in South Africa (refer to TABLE 4). Figure 6 shows the Hazard Zonation of the site.

The majority of boreholes that were drilled on site have a low to medium potential for the formation of small to medium sized sinkholes and subsidence's (IHC 2/3). Therefore, an overall zonation of IHC 3 is recommended for the entire site in the drawdown and water ingress scenario, excluding the north-eastern corner of the site. Conditions within north-eastern corner of the site indicate a high potential for small sized sinkholes to develop (IHC 5) for water ingress and the water drawdown scenario. According to SANS 1936-1, the site is classified to have a D3 + FPI area designation when considering C3, C5 or C6 land usage.

9. CONCLUSIONS AND RECOMMENDATIONS

The 8ha site is proposed for commercial development of three blocks, comprising double volume warehouses with a first storey office. Shallow and deep soils investigations were carried out at the site, viz. geotechnical and dolomite stability investigation.

Twelve test pits were excavated, and eleven percussion drilled boreholes were drilled to investigate the site. The site is underlain by dolomite, which has been intruded extensively by dolerite., providing a protective horizon above the dolomite bedrock for the majority of the site.

The test pits indicate thin overlying variable transported soils above the residual dolerite as fill, topsoil, hillwash and a pebble marker horizon.

The following recommendations are made according to the results of the test pit investigation and laboratory testing and it is assumed that these conditions are uniform between the test pits. The following recommendations are provided:

- Special foundation precautionary measures are recommended due to the medium potential for expansiveness and the dolomite classification. Total potential heave for the thick residual dolerite soil profiles encountered varies between 20 mm to 25 mm.

- Founding options for the structures include either stiffened or cellular rafts, or split construction with proper site drainage and plumbing requirements. Since the site must adhere to dolomite requirements in terms of SANS1936-3, drainage and plumbing precautions will in any event be required. Given the dolomite requirement stipulated SANS 1936-3 that 5m loss of support must be accommodated, raft foundation solution is proposed. This will override any small geotechnical problems that might be associated with the site. Structure specific geotechnical conditions are to be confirmed in the design level geotechnical investigation which will include footprint drilling for the relevant structures.
- Old trenches are to be excavated, backfilled and recompacted to limit any differential settlements of foundations at these positions.

As discussed above the site is considered to fall within an IHC3 category, indicating that there is a medium potential for medium subsidence's to occur in the event that concentrated water ingress into the sub-strata takes place after dewatering occurs. The dolomite area designation is thus D3+FPI for this type of development. The FPI portion of the designation requires that design level drilling and test pitting is conducted. D3 measures as outlined in SANS1936-3 should be adopted with respect to the prevention of water ingress into the soil. In this respect care should be taken to landscape the site so that water does not pond and all service trenches must be properly backfilled.

The following measures must be implemented on this site:

- All stormwater should be effectively captured and led off the site.
- A one metre wide concrete apron should be constructed around buildings which is designed to shed stormwater away from the structure.
- No ponding of water should be allowed in this area, both during and after construction.
- All courses in the plinth wall should be reinforced with brickforce. Brickforce should be incorporated in every fourth course thereafter and in at least three courses above all openings such as doors and windows.
- Construction joints, to allow relative movement, should be incorporated at intervals of not more than 5 m in linear walls or at points to be determined by the structural engineer.
- All yard walls, steps and similar structures should be isolated from the main structure.
- Flexibility should be incorporated into wet services where they enter or leave buildings in order to ensure that relative movement does not result in leaking pipes.

It must be borne in mind that the development must fulfil the general precautionary measures prescribed by SANS1936-3 for a D3 site. A Dolomite Risk Management Plan (DRMP) must be created for the development and construction supervision of foundations must be carried out by a competent person (engineer or geo-professional).

Furthermore, it is recommended that a hydrogeologist be approached to determine the sustainable yield of the existing domestic borehole on site, assuming this information does not already exist. This will be required to assess the potential for continued use of the borehole on site, which can later be used in monitoring of the water level below the site.

From a geotechnical perspective, the site is considered to be economically and practically developable provided that the recommendations stated above, are adhered to.

10. REFERENCES

[1] Weinert, H. (1965). A climatic index of weathering. Geotechniques. Vol.24, No.4, pp.475-488.

[2] Council for Geoscience (CGS) Dolomite Databank, accessed via https://maps.geoscience.org.za/portal/apps/sites/?fromEdit=true#/interactivewebmap on 10 November 2021.

[3] South African Bureau of Standards SANS 1936-1 to 4. Development of dolomite land: Part 1: General principles and requirements, Part 2: Geotechnical investigations and determinations, Part 3: Design and construction of buildings, structures and infrastructure, Part 4: Risk management. Pretoria 2012.

[4] South African National Standard 633:2012 Edition 1, Soil profiling and rotary percussion borehole logging on dolomite land in Southern Africa for engineering purposes.

[5] 1:250 000 scale Regional Geological Map, Sheet 2628: East Rand, 1986. Second edition. Compiled by Keyser, N., Botha, G.A. & Groenewald, G.H. from mapping by Anhaeusser, C.R. (EGRU circular 62, 1971), Bredell, J.H. (1973-74, Bulletin 62 1978), McCarthy, T.S. & Cadle, A.B. (Univ. Witwatersrand, unpublished map 1984), Wyatt, B.A. (Univ. Witwatersrand, M.Sc. Thesis 1976), Labuschagne, L.S. (1977), Botha, G.A., Michaluk, E., Groenewald, G.H. & Muntingh, D.J.(1984), Ellis, G.J.(1959), Snyman, A.A. (1955), Leube, A. & Schalk, K.E. (1955-6); & from Geological Survey Sheets 51 - Bethal, 52 - Johannesburg, 62 - Vereeniging, 64 - Ermelo & sheet 2628D Balfour - 2629C Standerton.

[6] Brink, A., 1979. 'Engineering Geology of Southern Africa (Vol. 1)'. South Africa: Building Publications.

[7] Department of Water Affairs (DWS) Published Dolomite Compartment Maps: Klipriver/ Natalspruit Dolomite Compartments Map, accessed via https://www.dws.gov.za/Groundwater/DolomiteP.aspx on 10 November 2021.

[8] Van der Merwe, D.H., 1964. 'The Prediction of Heave from the Plasticity Index and Percentage Clay Fraction of Soils'. Transactions SAICE, Volume 6, No. 6, June 1964.

[9] Jennings, J.E. and Knight, K., 1980. 'A guide to construction on or with materials exhibiting additional settlement due to collapse of grain structure'. Proceedings, 6th Regional Conference for Africa SM and FE. Accra. 1980.

[10] COLTO. 1998. Committee of Land Transport Officials. Standard Specification for Road and Bridge Works for State Authorities.

[11] CSIR Report no. BOU/R9705.

[12] Duligal, E., 1996. Significance of Soil Resistivity on Corrosivity. Unpublished report compiled for Africon.

[13] Kijko, A., Graham, G., Bejaichund, M., Roblin, D. and Brandt, M.B.C. 2003. Probabilistic peak ground acceleration and spectral seismic maps for South Africa. Report 2003-053. Council for Geoscience. 33pp.

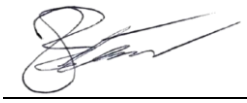
[14] South African National Standard 10160-4:2017, Edition 2, Basis of structural design and actions for buildings and industrial structures Part 4: Seismic actions and general requirements for buildings.

[15] South African Bureau of Standards SANS 1200D. Standardised specification for civil engineering construction Section D: Earthworks. Pretoria 2002 (and amendments).

[16] Buttrick, D.B., van Schalkwyk, A., Kleywegt, R.J., Watermeyer, R.B., 2001. Proposed method for dolomite land hazard and risk assessment in South Africa. Journal of the South African Institution of Civil Engineering, 43(2), 2001, Pages 27-36, Paper 462.

11. CERTIFICATION

This report was prepared and reviewed by the undersigned.

Prepared: 

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Specialist Consultant

Approval that this document adheres to Knight Piésold Quality Systems: EM

TABLE 3:
Summary of Test Pit Profiles

Test Pit No.	Total depth (m)	Refusal	Thickness of Layers m) – (m)												Geotech Zone
			Transported Soil				Pedogenic	Residual Soil					Bedrock		
			Fill	Topsoil	Hillwash	Pebble Marker	Nodular/ *Honeycomb/ **Hardpan Ferricrete	Reworked Residual Dolerite	Reworked Residual Dolomite	Residual Dolerite	Transitional Material	Chert Residuum	Chert/ *Dolomite	Very Soft Rock Dolerite	
TP1	3	-	-	0.0 - 0.4	0.4 - 1.4	1.4 - 2.1	-	2.1 - 3.0+	-	-	-	-	-	-	A
TP2	3	NR	0.0 - 0.5	-	0.5 - 1.4	-	2.7 - 3.0+ NR	1.4 - 2.7	-	-	-	-	-	-	A
TP3	3.1	-	0.0 - 0.8	-	0.8 - 1.3	1.3 - 1.6	-	1.6 - 1.9	-	1.9 - 3.1+	-	-	-	-	A
TP4	3.2	-	-		0.0 - 0.7	0.7 - 1.3	-	1.3 - 3.2+	-	-	-	-	-	-	A
TP5	3.2	R	0.0 - 0.2	-	1.0 - 1.4	-	0.2 - 1.0	1.4 - 1.6	-	1.6 - 2.7	-	-	-	2.7 - 3.2+ R	A
TP6	2.5	R	0.0 - 0.3	-	0.3 - 0.8	-	-	0.8 - 1.5	-	1.5 - 2.5	-	-	-	2.5+ R	A
TP7	2.7	R	0.0 - 0.15	-	-	-	-	0.7 - 1.8	2.2 - 2.7	1.8 - 2.2	-	0.15 - 0.7	2.7+ R	-	A
TP8	3.2	-	0.0 - 0.15	-	0.15 - 0.8	0.8 - 1.6	-	-	2.2 - 3.2+	-	-	1.6 - 2.2	-	-	B
TP9	3.2	-	0.0 - 0.4	-	-	-	-	-	2.8 - 3.2+	-	-	0.4 - 2.8	-	-	B
TP10	1.9	R	0.0 - 0.1	-	-	-	-	-	-	-	-	0.1 - 1.9	*1.9+ R	-	B
TP11	2.6	R	0.0 - 0.1	-	0.1 - 0.7	-	-	-	-	-	-	0.7 - 2.6	2.6+ R	-	B
TP12	3.1	-	0.0 - 0.15	-	-	-	-	2.1 - 2.9	-	2.9 - 3.1+	0.9 - 2.1	0.15 - 0.9	-	-	B

Notes: NR - Near Refusal
R - Refusal
T- Terminated by geologist

TABLE 4:
Summary of Percussion Borehole Profiles

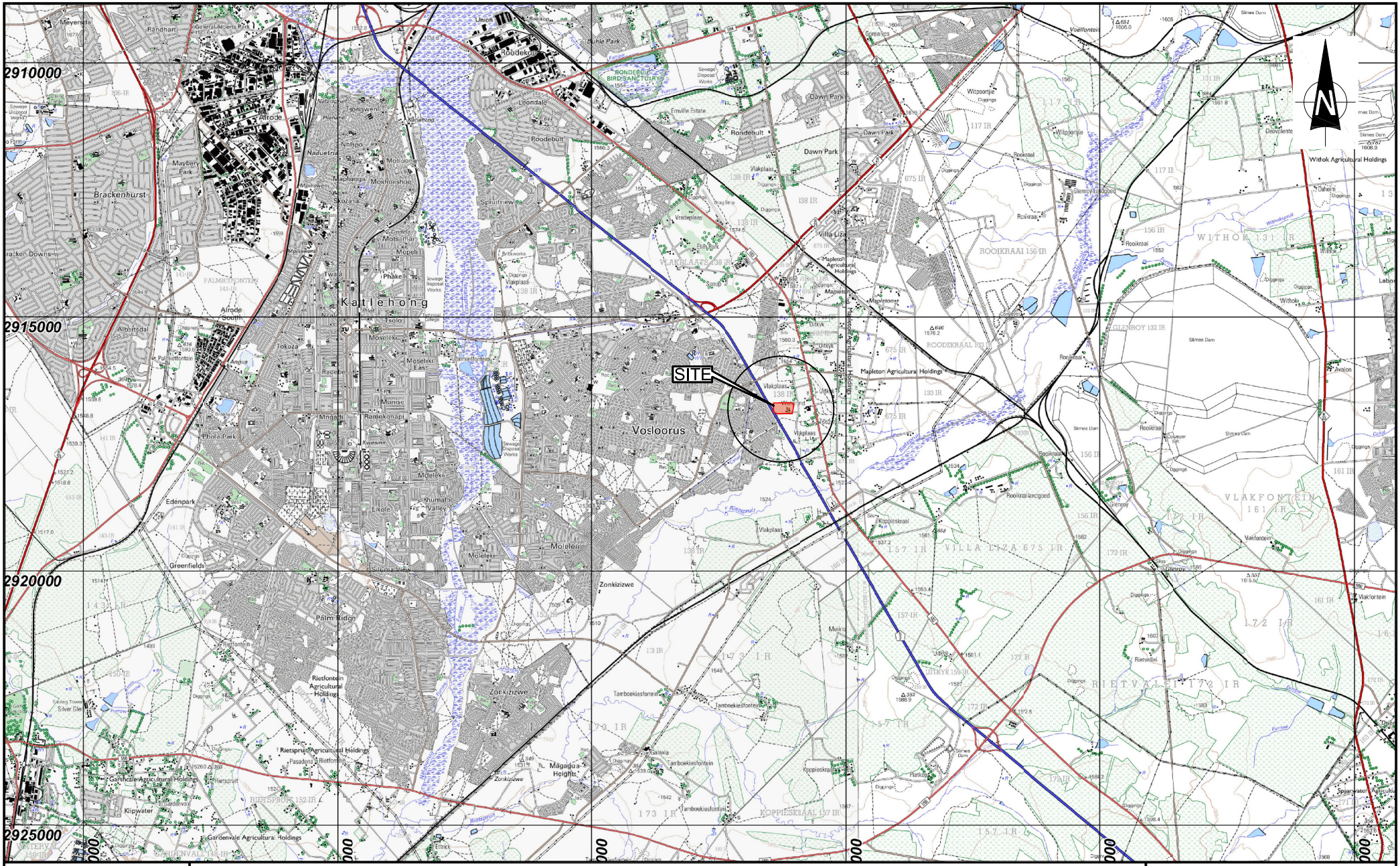
BH No.	Coordinates (WGS84 Lo29)		Collar Elevation (masl)	Inclination	Borehole Depth (m)	SWL (masl)	BLANKET LAYER DEPTH (m) - (m)							Bedrock		Air and/or Sample Loss	Depth to Dolomite Bedrock	Water Strike	Water Rest Level Depth (m)	Hazard Assessment for Sinkhole and Subsidence Development							Hazard Zone
							Transported Soils		Residual Soils											Sinkholes				Subsidence Formation	Inherent Hazard Class (IHC)		
																				Max Size		Hazard					
	Y	X					Fill	Hillwash	Residual Dolerite	Residual Shale	Chert dominated residuum	Fines dominated residuum	Wad	Dolerite	Weathered dolomite or dolomite					Water Ingress	Groundwater Drawdown	Water Ingress	Groundwater Drawdown		Water Ingress	Groundwater Drawdown	
PH1	76095.86	2916707.48	1546.8	Vertical	12	1535.2	0.0 - 0.5					0.5 - 3.0			3.0 - 12.0	8.0 - 11.0	3	-	Dry	Small	Small	High	High	Medium	5	5	A
PH2	76279.25	2916772.05	1543.9	Vertical	25	1535	0.0 - 1.0	1.0 - 2.0	2.0 - 7.5			7.5 - 11.0		11.0 - 18.5 23.0 - 25.0	18.5 - 23.0		18.5	8.1	9.6	Medium	Medium	Medium	Medium	Medium	3	3	B
PH3	76190.88	2916811.75	1546.1	Vertical	22	1534.8			0.0 - 11.0			15.5 - 16.0		11.0 - 15.0	16.0 - 22.0		16	13.5	11.6	Small	Medium	Medium	Medium	Low	2	3	B
PH4	76273.02	2916880.06	1543.2	Vertical	20	1534.6	0.0 - 1.0		3.0 - 8.0		1.0 - 3.0			8.0 - 9.0 10.0 - 13.0 14.0 - 20.0	9.0 - 10.0 13.0 - 14.0		13	-	10.9	Small	Small	Medium	Medium	Medium	2	2	B
PH5	76116	2916797.02	1546.9	Vertical	28	1534.9			9.0 - 16.0		1.0 - 2.0	0.0 - 1.0 2.0 - 9.0		16.0 - 18.0 21.5 - 28.0	18.0 - 21.5		18	11	10.2	Small	Medium	Medium	Low to Medium	Medium	2	2/3	B
PH6	76206.66	2916709.25	1545.7	Vertical	24	1535.2	0.0 - 1.0		3.5 - 11.0 14.0 - 15.0	15.0 - 18.0	1.0 - 3.5			11.0 - 14.0 18.0 - 24.0			>24	14	11.2	Small	Small	Low	Low to Medium	Medium	1	1/2	B
PH7	76222.32	2916845.85	1545	Vertical	20	1534.7	0.0 - 0.5	0.5 - 1.0	2.0 - 8.0			1.0 - 2.0		8.0 - 11.0 13.0 - 20.0	11.0 - 13.0		11	11	10.6	Small	Small	Medium	Medium	Low	2	2	B
PH8	76370.48	2916706.89	1541.9	Vertical	23	1535.2	0.0 - 0.3	0.3 - 1.0	1.0 - 16.5					16.5 - 18.0	18.0 - 23.0		18	14.9	10.3	Small	Medium	Medium	Medium	Low	2	3	B
PH9	76377.64	2916861.72	1540.9	Vertical	21	1534.6		0.0 - 1.0	1.0 - 15.0					15.0 - 21.0			>21	-	12.2	Small	Small	Low	Low	Low	1	1	B
PH10	76109.91	2916881.86	1547.4	Vertical	26	1534.6	0.0 - 2.0					2.0 - 4.0 14.0 - 16.0	4.0 - 7.0	7.0 - 14.0 16.0 - 25.0	25.0 - 26.0		25	14.3	10.8	Medium	Medium	Medium	Medium	Medium	3	3	B
PH11	76352.87	2916780.35	1541.4	Vertical	21	1534.9	0.0 - 0.5	0.5 - 2.5	2.5 - 13.5					13.5 - 14.0 16.0 - 18.0	14.0 - 16.0 18.0 - 21.0		14	-	9.9	Small	Medium	Low to Medium	Medium	Low	2	3	B

Notes:
SWL – Static Water Level
Masl – Meters above sea level

TABLE 5:
Summary of Laboratory Test Results

Sample		Grading %				Atterberg Limits %			GM	PE	USC	pH	Ec (S/m)	CBR (Modified AASHTO) TMH1 A7							Maximum Dry Density (kg/m^3) @ OMC (%)	COLTO Classification	Material Description
No.	Depth (m-m)	Gravel	Sand	Silt	Clay	LL	PI	LS						% Swell	90%	93%	95%	97%	98%	100%			
TP1/1	2.1 - 3.0	15	28	38	19	42	22	11	0.75	Medium	CL	5.7	0.022										Reworked Residual Dolerite
TP1/2	1.0 - 1.4	2	38	28	32	35	18	9.5	0.51	Low	CL												Hillwash
TP2/1	1.0 - 1.4	8	24	31	37	41	19	9.5	0.51	Low	CL												Hillwash
TP2/2	1.4 - 2.7	58	18	10	14	38	16	8.5	1.98	Low	GC			0.1	13	16	19	21	22	24	1805 @ 14.9	<G9	Nodular Ferricrete
TP3/1	1.9 - 3.1	5	67	23	5	31	8	4	0.98	Low	SC	5.5	0.022										Residual Dolerite
TP4/1	1.3 - 3.2	32	26	20	22	40	20	10	1.29	Low	SC												Reworked Residual Dolerite
TP5/1	1.6 - 2.7	2	29	44	25	54	24	11	0.33	Medium	CH												Residual Dolerite
TP6/1	0.85 - 1.5	6	29	35	30	44	20	11	0.53	Medium	CI												Reworked Residual Dolerite
TP8/1	2.2 - 3.2	17	36	23	24	29	14	7	0.95	Low	CL												Reworked Residual Dolomite
TP8/2	0.8 - 2.2	72	15	8	5	27	12	6	2.35	Low	GC			0	20	24	26	30	31	35	2079 @ 8.6	G6	Reworked Residual Dolomite
TP9/1	2.8 - 3.2	21	40	17	22	31	13	6.5	1.06	Low	SC												Reworked Residual Dolomite
TP11/1	0.7 - 2.6	73	13	9	5	31	15	7.5	2.34	Low	GC	5.8	0.011	0.1	14	21	27	33	36	42	2012 @ 9.6	G6	Reworked Residual Dolomite

Notes:
LL – Liquid Limit
PI – Plasticity Index
LS – Linear Shrinkage
GM – Grading Modulus
PE – Potential Expansiveness
USC – Unified Soil Classification
MDD – Maximum Dry Density
OMC – Optimum Moisture Content
Ec – Electric Conductivity
CBR – California Bearing Ratio



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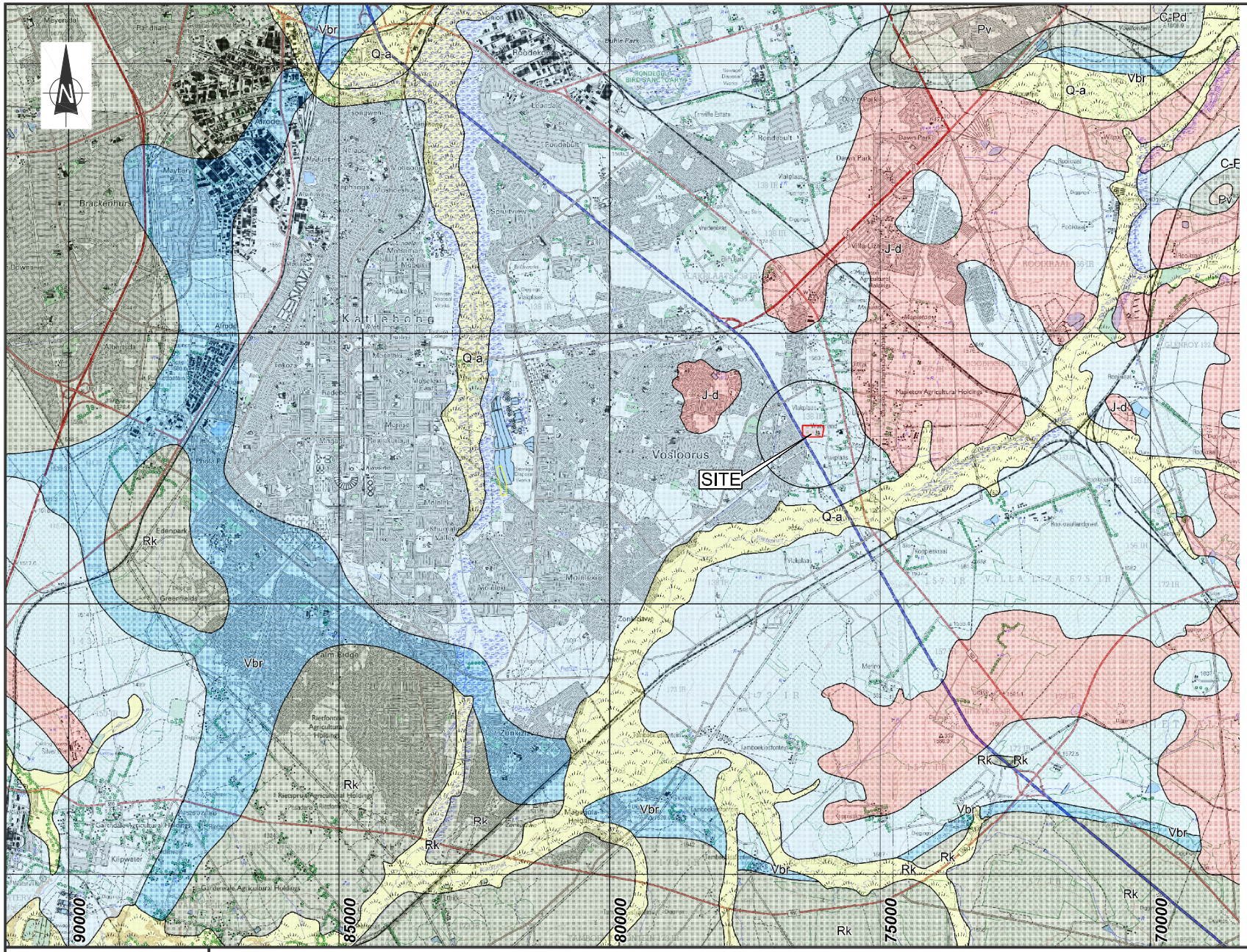
RICHBAY CHEMICALS NEW PLANT, VOSLOORUS
GEOTECHNICAL INVESTIGATION

LOCALITY MAP

PROJECT NO: 31100288/72

FIGURE NO 1

SCALE N.T.S.



Legend

- Site Boundary

Regional Geology

- River Sand (Q25)
- Alluvium (Q-a)
- Mokolian Syenite (M4)
- 9005 Diabase (V-di)
- 0891 Karoo Dolerite Suite (J-d)
- 0694 Klapperkop Quartzite Member (Vkp)
- 0571 Vryheid Formation (Pv)
- 0284 Hekpoort Formation (Vh)
- 0282 Timeball Hill Formation (Vti)
- 0281 Rooihoogte Formation Chert (Vrh)
- 0273 Black Reef Formation (Vbr)
- 0236 Alberton Formation (Ral)
- 0235 Westonaria Formation (Rwe)
- 0226 Booysens Formation (Rbo)
- 0095 Malmani Dolomite (Vma)
- 0075 Dwyka Group Tillite
- 0030 Klipriviersberg Lava (Rk)

REFERENCE MAPS
1:250 000 SCALE
GEOLOGICAL SERIES
SHEETS:2628 EAST RAND

NOT TO ORIGINAL SCALE

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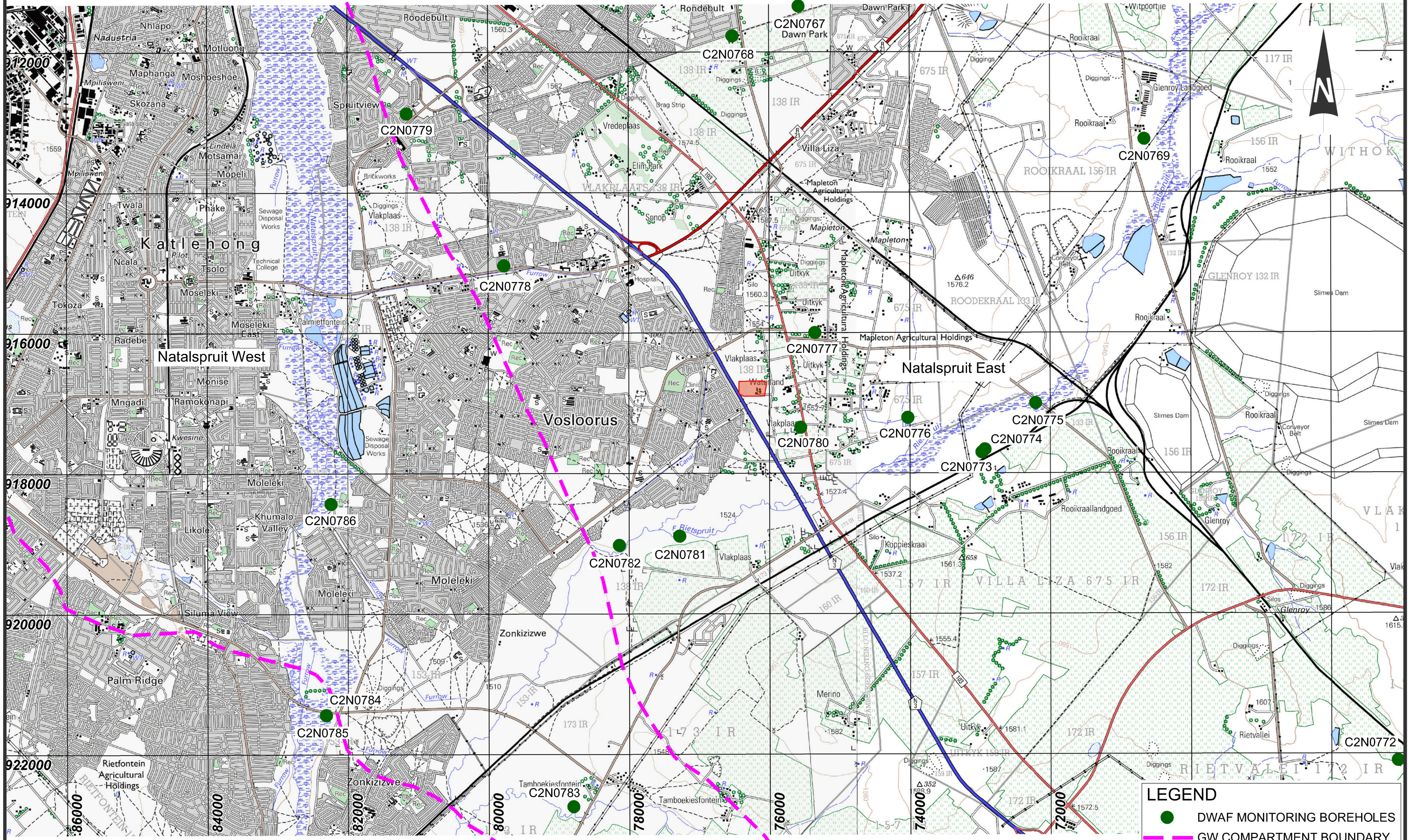
RICHBAY CHEMICALS NEW PLANT, VOSLOORUS
GEOTECHNICAL INVESTIGATION

GEOLOGY MAP

PROJECT NO: 31100288/72

FIGURE NO 2

SCALE N.T.S.



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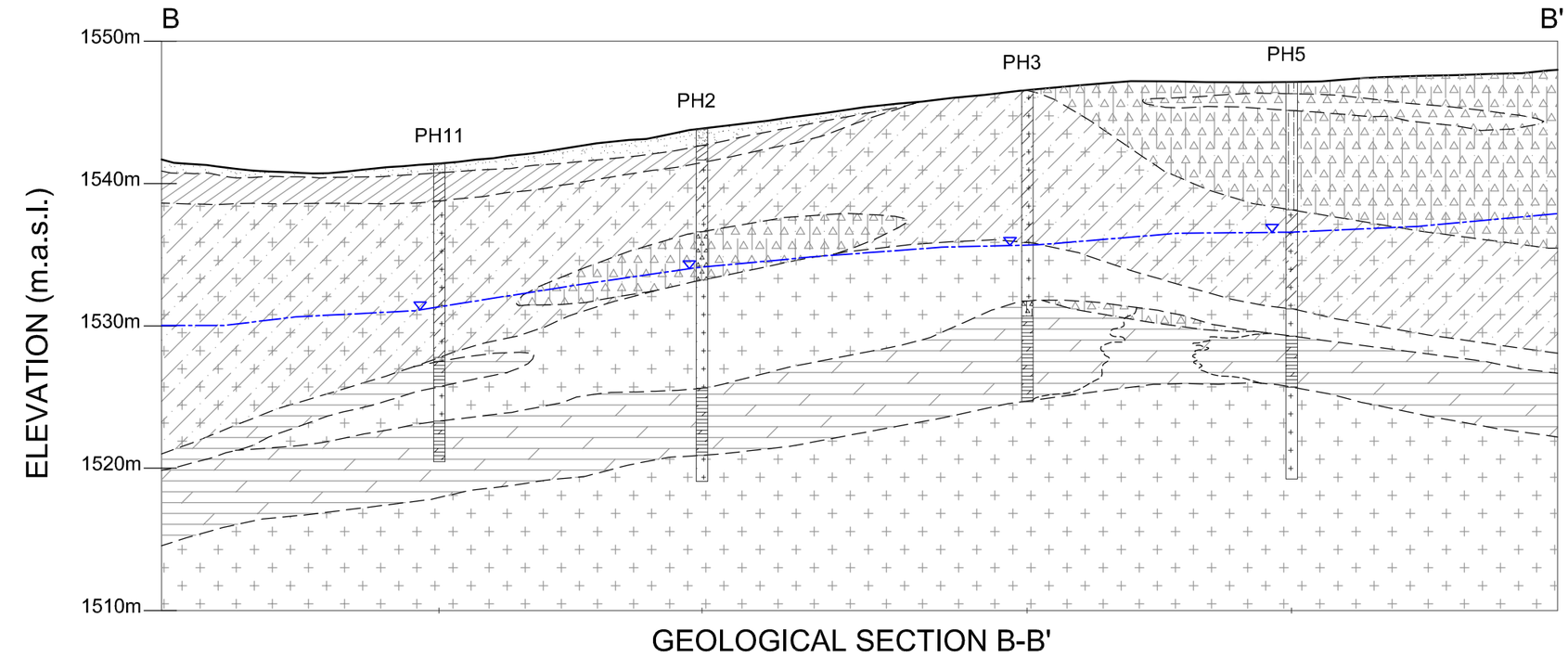
RICHBAY CHEMICALS NEW PLANT, VOSLOORUS
GEOTECHNICAL INVESTIGATION

REGIONAL GROUNDWATER MAP

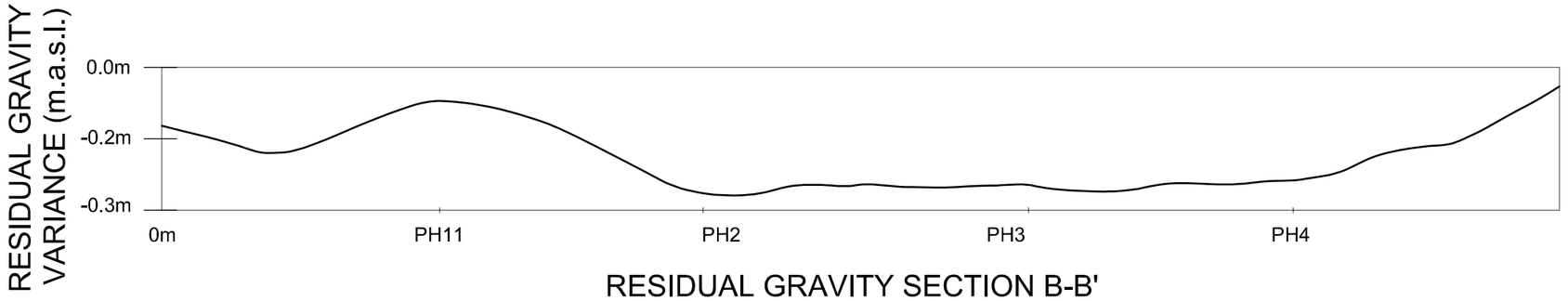
PROJECT NO: 31100288/72

FIGURE NO 3

SCALE 1:50000



GEOLOGICAL SECTION B-B'



RESIDUAL GRAVITY SECTION B-B'

LEGEND:

- GEOLOGICAL BOUNDARY
- WATER REST LEVEL
- TOPSOIL
- HILLWASH
  RESIDUAL DOLERITE
- DOLERITE
- DOLOMITE
- FINES DOMINATED RESIDUUM
- CHERT RESIDUUM

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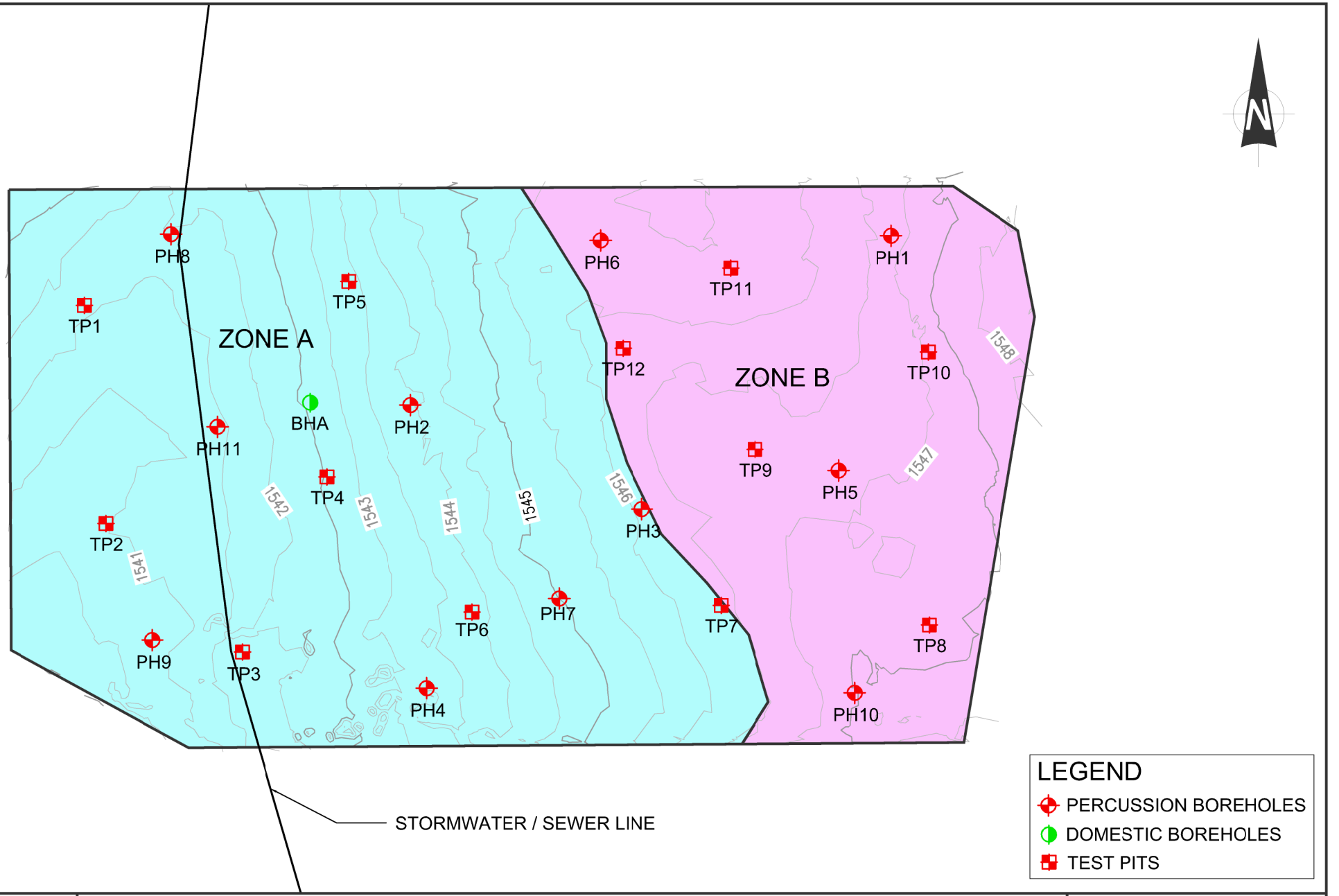
RICHBAY CHEMICALS NEW PLANT, VOSLOORUS
GEOTECHNICAL INVESTIGATION

SECTION B - B'

PROJECT NO: 31100288/72

FIGURE NO 4

SCALE AS SHOWN (A3)



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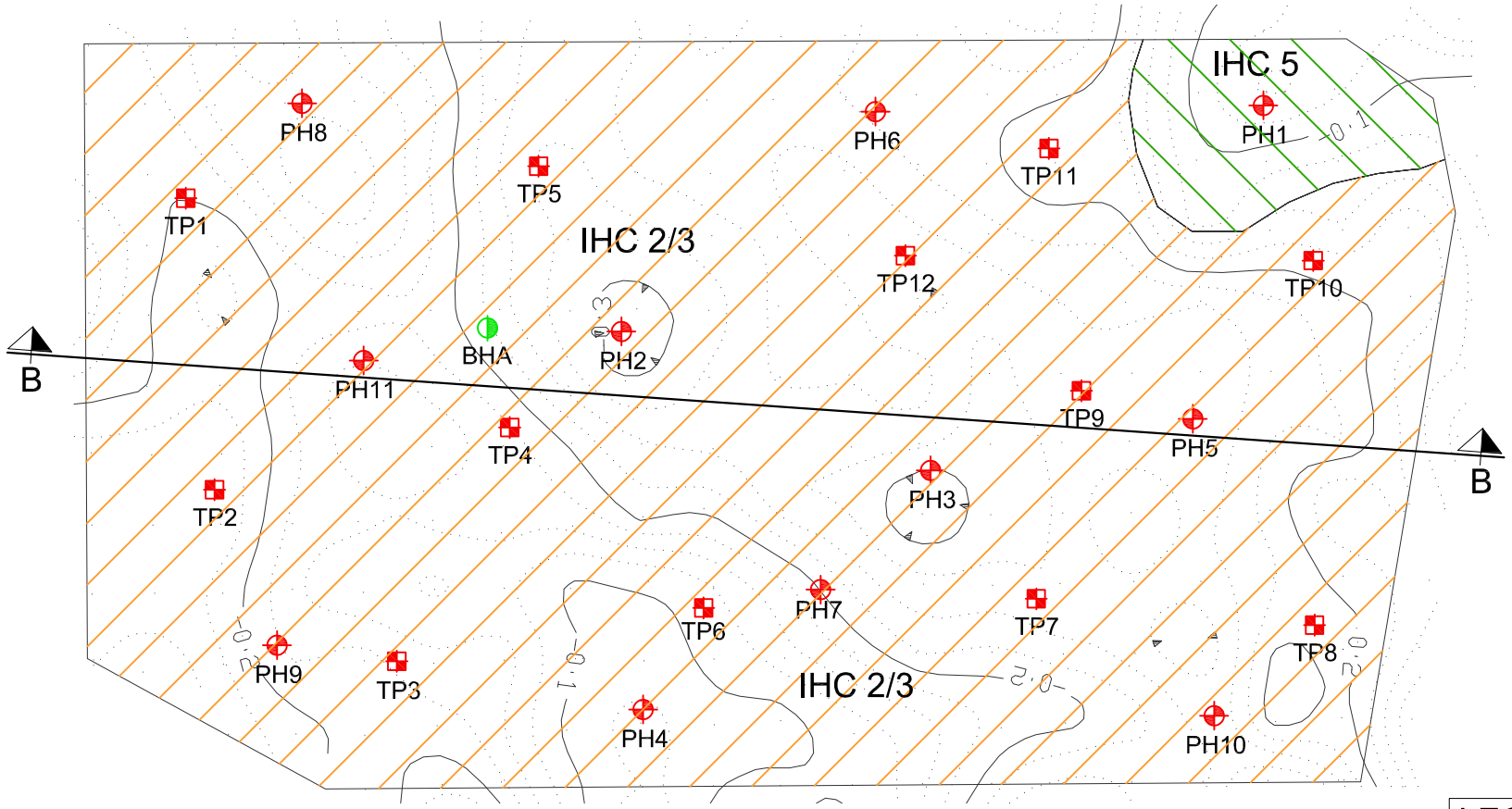
RICHBAY CHEMICALS NEW PLANT, VOSLOORUS
GEOTECHNICAL INVESTIGATION

SITE PLAN SHOWING TEST PIT AND BOREHOLE POSITIONS

PROJECT NO: 31100288/72

FIGURE NO 5

SCALE 1:2000



LEGEND

- PERCUSSION BOREHOLES
- DOMESTIC BOREHOLES
- TEST PITS

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RICHBAY CHEMICALS NEW PLANT, VOSLOORUS
GEOTECHNICAL INVESTIGATION

SITE PLAN SHOWING IHC

PROJECT NO: 31100288/72

FIGURE NO 6

SCALE 1:2000

APPENDIX A

Site Photographs

SITE PHOTOGRAPHS

PHOTO 1 – View of TLB equipment used for excavation of test pits.

PHOTO 2 – Typical residual dolerite profile encountered on site.

PHOTO 3 – Typical transition between reworked residual (top) and residual dolerite (bottom).

PHOTO 4 – View of typical Dolomitic profile with upper transported soils and lower chert dominated residuum.

PHOTO 5 – Transition between residual dolerite (upper reddish brown and yellow brown) soils and reworked residual (lower dark brown) dolomite soils

PHOTO 6 – View of western portion of site, looking south from borehole PH8.

APPENDIX B

Test Pit Profiles

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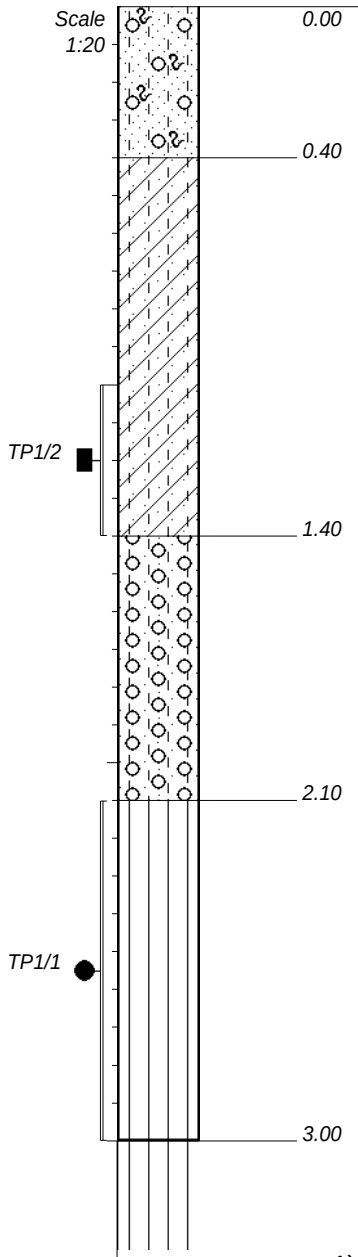
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT: VOSLOORUS

FEASIBILITY GEOTECHNICAL AND DOLOMITE STABILITY INVESTIGATION

HOLE No: TP1
Sheet 1 of 1

JOB: 3110028872



0.00

Slightly moist, dark brown, dense, blocky, slightly fine gravelly silty SAND, with abundant rootlets. **TOPSOIL**.

0.40

Moist, reddish brown, stiff, root voided and pinholed, slightly clayey fine sandy silty CLAY. **HILLWASH**.
Note:
Minor fine-grained highly weathered andesite and ferricrete nodules at base.

1.40

Moist, dark reddish brown stained light orange and black, dense, matrix supported, silty sandy fine to coarse GRAVEL, comprising rounded ferricrete nodules and minor to traces of sub-angular quartz and highly weathered andesite. Ferruginous **PEBBLE MARKER**.

2.10

Moist, orange brown mottled black becoming light yellow stained black below 2.8m, stiff, intact, with relict jointed pockets below 2.8m, slightly gravelly clayey sandy SILT, with minor soft ferricrete nodules between 2.1m and 2.5m. Reworked **RESIDUAL DOLERITE**.
Note:
Appears reworked to base, with runnels of clayey sandy silty between sandy silt relict jointed pockets.

3.00

EOH: Not to refusal of TLB.

NOTES

1) No groundwater seepage encountered.

2) Disturbed sample TP1/1 taken between 2.1m--3.0m.

3) Undisturbed sample TP1/2 taken between 1.0m--1.4m.

CONTRACTOR : ÿV&S Cathire
MACHINE : CAT428F
DRILLED BY : Amos & Johannes
PROFILED BY : D. Bester (114260)

INCLINATION : Vertical
DIAM : 700mm
DATE : ÿ16/09/2021
DATE : 16 Sep 2021

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916734.01
Y-COORD : 76403.66

HOLE No: TP1

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

DATE : 19/11/2021 12:15
TEXT : C\WP51\PROFILES\PEITP.TXT

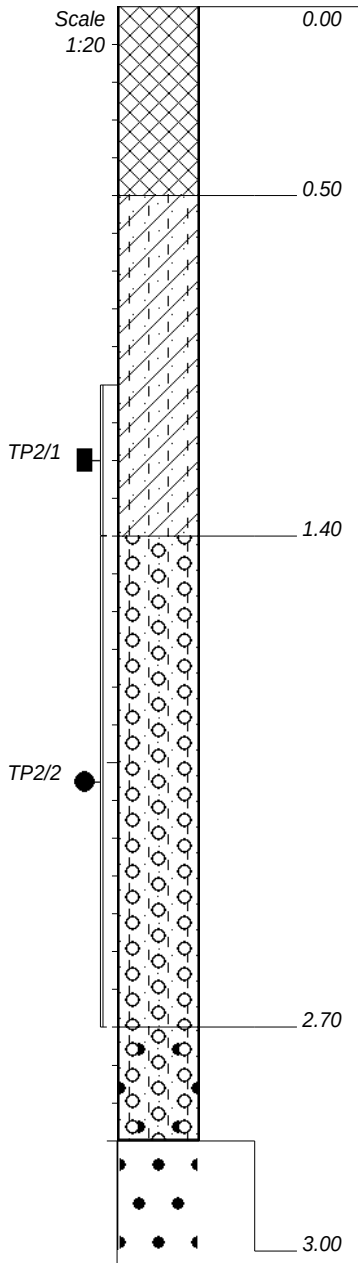
Knight Piésold CONSULTING

RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT: VOSLOORUS

FEASIBILITY GEOTECHNICAL AND DOLOMITE STABILITY INVESTIGATION

HOLE No: TP2
Sheet 1 of 1

JOB: 3110028872



0.00 – 0.50: Slightly moist, dark grey and black speckled orange brown, very loose, intact, silty fine SAND, with thin layer (<100mm) of silty sandy gravel at base. **FILL**, comprising ash/graphite waste.

0.50 – 1.40: Moist, reddish brown, firm to stiff, root voided, fine sandy silty CLAY, with traces of rootlets. **HILLWASH**.

1.40 – 2.70: Moist, reddish brown blotched black, medium dense with dense pockets, matrix supported, silty sandy coarse GRAVEL, comprising angular ferricrete nodules of soft rock strength. Ferruginous reworked **RESIDUAL DOLERITE**

Note:
Becomes yellow brown stained orange mottled black, with highly to completely weathered dolerite fragments of coarse gravel-size below 2.4m.

2.70 – 3.00: Moist, light yellowish brown stained orange and mottled black, dense, matrix supported, sandy silty fine to coarse GRAVEL, comprising ferricrete nodules with minor highly weathered quartzite. **NODULAR FERRICRETE**.
Note:
Borders on Honeycomb Ferricrete in places.

3.00: EOH: Near refusal of TLB on very dense HONEYCOMB FERRICRETE.

NOTES

1) No groundwater seepage encountered.

2) Undisturbed sample TP2/1 taken between 1.0m--1.4m.

3) Bulk disturbed sample TP2/2 taken between 1.4m--2.7m.

CONTRACTOR : ÿV&S Cathire
MACHINE : CAT428F
DRILLED BY : Amos & Johannes
PROFILED BY : D. Bester (114260)

INCLINATION : Vertical
DIAM : 700mm
DATE : ÿ16/09/2021
DATE : 16 Sep 2021

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916817.28
Y-COORD : 76395.48

HOLE No: TP2

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

DATE : 19/11/2021 12:15
TEXT : C\WP51\PROFILES\PEITP.TXT

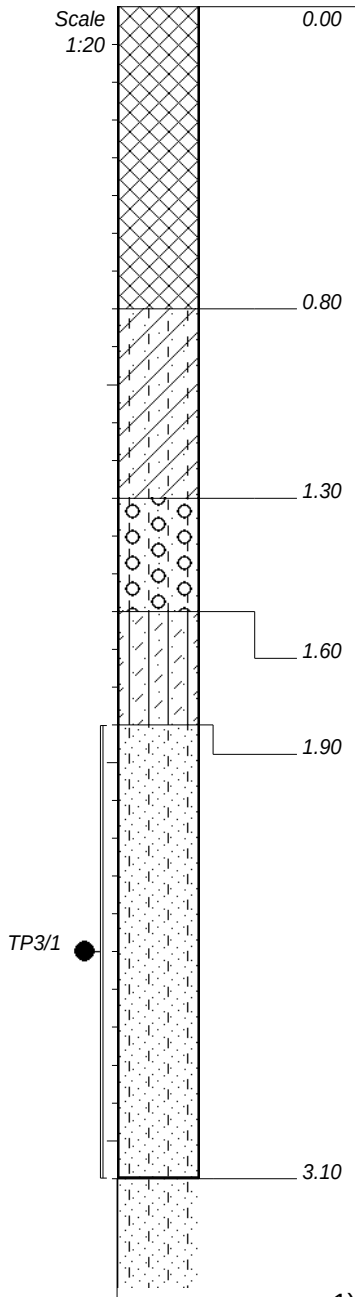
Knight Piésold CONSULTING

RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT: VOSLOORUS

FEASIBILITY GEOTECHNICAL AND DOLOMITE STABILITY INVESTIGATION

HOLE No: TP3
Sheet 1 of 1

JOB: 3110028872



0.00	Slightly moist, light greyish brown, loose, intact, gravelly silty SAND, with minor cobbles. **FILL**
0.80	Moist, dark reddish brown, stiff, intact, fine sandy silty CLAY. **HILLWASH**.
1.30	Moist, dark reddish brown mottled black and white, dense, matrix supported, silty sandy fine to coarse GRAVEL, comprising ferricrete nodules and completely to highly weathered chert gravel. **PEBBLE MARKER**.
1.60	Moist, dark reddish brown mottled black, firm, intact, clayey sandy SILT. Reworked **RESIDUAL DOLERITE**.
1.90	Moist, light olive brown stained black on relict joints, dense , relict jointed, slightly clayey silty SAND. **RESIDUAL DOLERITE**. Note: Partially reworked in upper 0.5m of horizon.
3.10	EOH: Not to refusal of TLB.

NOTES

1) No groundwater seepage encountered.

2) Disturbed sample TP3/1 taken between 1.9m--3.1m.

CONTRACTOR : ÿV&S Cathire
MACHINE : CAT428F
DRILLED BY : Amos & Johannes
PROFILED BY : D. Bester (114260)

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

INCLINATION : Vertical
DIAM : 700mm
DATE : ÿ16/09/2021
DATE : 16 Sep 2021

DATE : 19/11/2021 12:15
TEXT : C\WP51\PROFILES\PEITP.TXT

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916866.29
Y-COORD : 76343.38

HOLE No: TP3

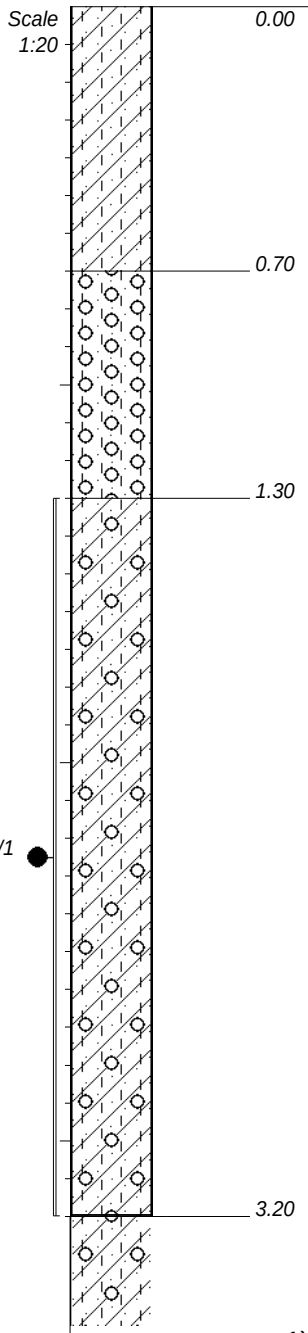
Knight Piésold CONSULTING

RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT: VOSLOORUS

FEASIBILITY GEOTECHNICAL AND DOLOMITE STABILITY INVESTIGATION

HOLE No: TP4
Sheet 1 of 1

JOB: 3110028872



0.00	Slightly moist becoming moist below 0.2m, red brown, firm, root voided, fine sandy silty CLAY. **HILLWASH**.
0.70	Moist, dark red brown stained black speckled white, medium dense, matrix supported silty sandy fine to coarse GRAVEL, comprising completely to highly weathered, subrounded chert and ferricrete nodules. Ferruginous **PEBBLE MARKER**.
1.30	Moist, reddish orange mottled black, firm becoming stiff below 2m, intact, fine gravelly sandy silty CLAY. Reworked **RESIDUAL DOLERITE**. Note: Scattered highly weathered and subrounded chert gravel and cobbles and abundant small soft ferricrete nodules.
3.20	EOH: Not to refusal of TLB.

NOTES

1) No groundwater seepage encountered.

2) Bulk disturbed sample TP4/1 taken between 1.3m--3.2m.

CONTRACTOR : ÿV&S Cathire
MACHINE : CAT428F
DRILLED BY : Amos & Johannes
PROFILED BY : D. Bester (114260)

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

INCLINATION : Vertical
DIAM : 700mm
DATE : ÿ16/09/2021
DATE : 16 Sep 2021

DATE : 19/11/2021 12:15
TEXT : C\WP51\PROFILES\PEITP.TXT

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916799.5
Y-COORD : 76311.14

HOLE No: TP4

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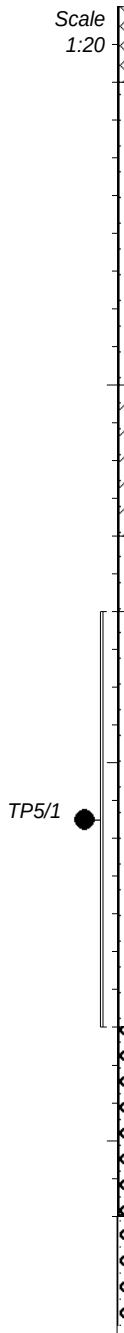
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT: VOSLOORUS

FEASIBILITY GEOTECHNICAL AND DOLOMITE STABILITY INVESTIGATION

HOLE No: TP5
Sheet 1 of 1

JOB: 3110028872



0.00	Slightly moist, greyish brown, medium dense, matrix supported, silty sandy GRAVEL, comprising subrounded highly weathered quartz and chert, with abundant rootlets. **FILL**.
0.20	Moist, reddish brown speckled white stained black, dense with very dense pockets, silty sandy fine to coarse, subrounded GRAVEL, comprising ferricrete nodules, quartzite and chert. Minor strongly cemented honeycomb ferricrete, cobbles and small boulders. **NODULAR FERRICRETE**.
1.00	Moist, dark reddish brown, stiff, intact, fine sandy silty CLAY, with minor rounded quartz gravel and ferricrete nodules. **HILLWASH**.
1.40	Moist, medium brown mottled light brown stained black, firm to stiff, intact, slightly clayey sandy SILT. Reworked **RESIDUAL DOLERITE**.
1.60	Moist, light yellowish brown stained reddish orange and black, stiff, intensely relict jointed, sandy SILT. **RESIDUAL DOLERITE**. Note: Infill of light grey silty clay along relict joints, which are very closely to closely spaced.
2.70	As above, but closely relict jointed and of very stiff to very soft rock consistency. Interpreted as very soft rock completely weathered DOLERITE.
3.20	EOH: Refusal of TLB in material as above.

NOTES

1) No groundwater seepage encountered.

2) Disturbed sample TP5/1 taken between 1.6m--2.7m.

CONTRACTOR : ÿV&S Cathire
MACHINE : CAT428F
DRILLED BY : Amos & Johannes
PROFILED BY : D. Bester (114260)

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

INCLINATION : Vertical
DIAM : 700mm
DATE : ÿ16/09/2021
DATE : 16 Sep 2021

DATE : 19/11/2021 12:15
TEXT : C\WP51\PROFILES\PEITP.TXT

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916724.88
Y-COORD : 76302.89

HOLE No: TP5

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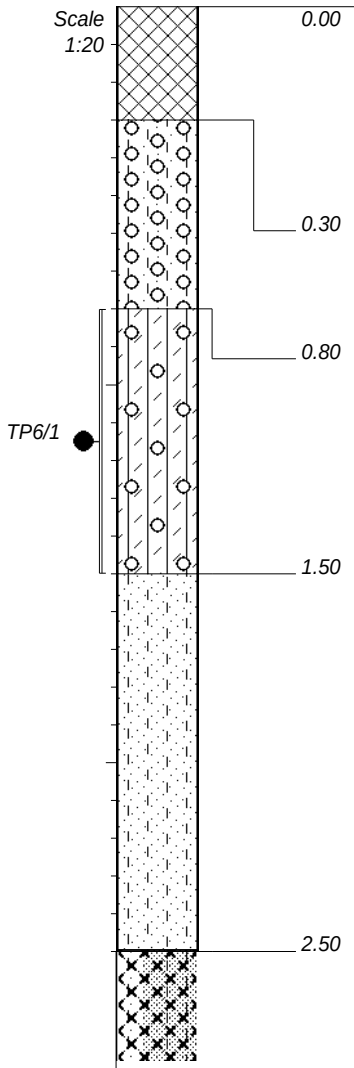
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT: VOSLOORUS

FEASIBILITY GEOTECHNICAL AND DOLOMITE STABILITY INVESTIGATION

HOLE No: TP6
Sheet 1 of 1

JOB: 3110028872



0.00 – 0.30: Slightly moist, dark brown speckled orange and white, dense, matrix supported, silty sandy fine to coarse GRAVEL, comprising highly to completely weathered chert and quartz with iron oxide staining, and ferricrete nodules. **FILL**.
Note:
Possibly compacted by traffic.

0.30 – 0.80: Moist, reddish brown speckled white and orange, dense, matrix supported, silty sandy fine to coarse GRAVEL, comprising highly weathered chert with iron staining. **HILLWASH**.

0.80 – 1.50: Moist, reddish orange mottled black, stiff, intact, fine gravelly slightly sandy clayey SILT. Reworked **RESIDUAL DOLERITE**. Traces of ferricrete nodules.

1.50 – 2.50: Moist, light brown stained orange and black, very dense, relict jointed, silty SAND. **RESIDUAL DOLERITE**. Interpreted as completely weathered very soft rock DOLERITE.

2.50: EOH: Refusal of TLB on completely to highly weathered, very soft to soft rock DOLERITE.

NOTES

1) No groundwater seepage encountered.

2) Disturbed sample TP6/1 taken between 0.8m--1.5m.

CONTRACTOR : ÿV&S Cathire
MACHINE : CAT428F
DRILLED BY : Amos & Johannes
PROFILED BY : D. Bester (114260)

INCLINATION : Vertical
DIAM : 700mm
DATE : ÿ16/09/2021
DATE : 16 Sep 2021

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916851.03
Y-COORD : 76255.73

HOLE No: TP6

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

DATE : 19/11/2021 12:15
TEXT : C\WP51\PROFILES\PEITP.TXT

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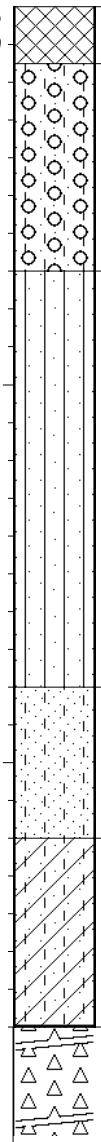
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT: VOSLOORUS

FEASIBILITY GEOTECHNICAL AND DOLOMITE STABILITY INVESTIGATION

HOLE No: TP7
Sheet 1 of 1

JOB: 3110028872

Scale 1:20



0.00	Slightly moist, dark grey, loose, clast supported, silty fine sandy GRAVEL, comprising dolomite and chert aggregate (27mm). **FILL**.
0.15	Slightly moist to moist, dark red brown, dense, matrix supported, silty sandy fine to coarse GRAVEL, comprising sub-angular to subrounded highly weathered chert, strongly cemented by iron oxide in places. **CHERT RESIDUUM**
0.70	Moist, reddish orange gradually becoming light orange brown stained black, stiff with very stiff bands, relict jointed, slightly clayey sandy SILT. Partially reworked **RESIDUAL DOLERITE**.
1.80	Moist, light yellow brown stained orange and black, very dense, relict jointed, silty SAND. **RESIDUAL DOLERITE**. Note: Breaks out to cobbles along relict joints.
2.20	Moist, dark brown mottled reddish brown and black, stiff, intact, silty sandy CLAY, with minor thin chert bands (<100mm thick). Reworked **RESIDUAL DOLOMITE**. Note: Traces of wad.
2.70	EOH: Refusal of TLB on medium hard rock CHERT BAND.

NOTES

1) No groundwater seepage encountered.

CONTRACTOR : ÿV&S Cathire
MACHINE : CAT428F
DRILLED BY : Amos & Johannes
PROFILED BY : D. Bester (114260)

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

INCLINATION : Vertical
DIAM : 700mm
DATE : ÿ16/09/2021
DATE : 16 Sep 2021

DATE : 19/11/2021 12:15
TEXT : C\WP51\PROFILES\PEITP.TXT

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916848.47
Y-COORD : 76160.72

HOLE No: TP7

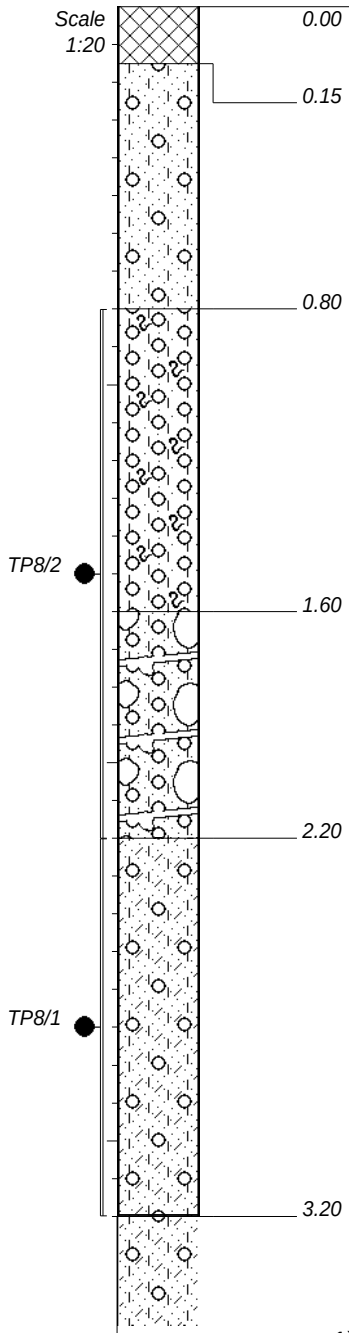
Knight Piésold CONSULTING

RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT: VOSLOORUS

FEASIBILITY GEOTECHNICAL AND DOLOMITE STABILITY INVESTIGATION

HOLE No: TP8
Sheet 1 of 1

JOB: 3110028872



0.00	Slightly moist, dark grey, loose, clast supported, silty fine sandy GRAVEL, comprising dolomite and chert aggregate (27mm). **FILL**.
0.15	Moist, dark reddish brown, medium dense, pinholed, fine gravelly silty fine SAND, with minor roots. **HILLWASH**.
0.80	Moist, dark reddish brown, loose to medium dense, matrix supported, silty sandy fine to medium GRAVEL, comprising sub-rounded highly weathered chert with abundant roots. **PEBBLE MARKER**. Minor highly weathered cobbles.
1.60	Moist, dark reddish brown blotched white and stained orange, dense, matrix supported, slightly clayey silty SAND, angular to sub-angular, highly weathered chert GRAVEL and COBBLES, with minor small boulders. Interpreted as chert band, roughly 15 degrees north dipping. **CHERT RESIDUUM**.
2.20	Moist, medium brown to reddish brown speckled black, loose to medium dense, intact, fine gravelly clayey silty SAND, with minor soft manganiferous nodules. Reworked **RESIDUAL DOLOMITE**.
3.20	EOH: Not to refusal of TLB.

NOTES

1) No groundwater seepage encountered.
2) Disturbed sample TP8/1 taken between 2.2m--3.2m.
3) Bulk disturbed sample TP8/2 taken between 0.8m--2.2m.

CONTRACTOR : ÿV&S Cathire
MACHINE : CAT428F
DRILLED BY : Amos & Johannes
PROFILED BY : D. Bester (114260)

INCLINATION : Vertical
DIAM : 700mm
DATE : ÿ16/09/2021
DATE : 16 Sep 2021

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916855.98
Y-COORD : 76081.22

HOLE No: TP8

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

DATE : 19/11/2021 12:15
TEXT : C\WP51\PROFILES\PEITP.TXT

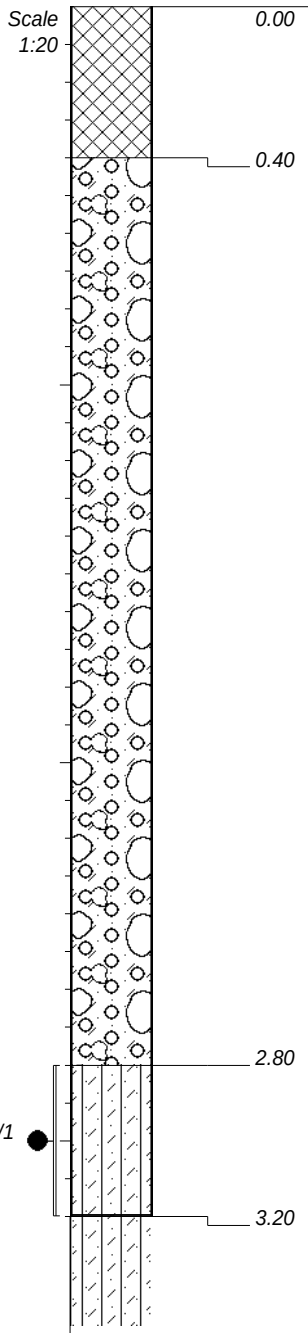
Knight Piésold CONSULTING

RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT: VOSLOORUS

FEASIBILITY GEOTECHNICAL AND DOLOMITE STABILITY INVESTIGATION

HOLE No: TP9
Sheet 1 of 1

JOB: 3110028872



0.00 – 0.40: Slightly moist, dark greyish brown speckled orange stained black, medium dense, matrix supported, silty sandy fine to coarse GRAVEL, COBBLES and small BRICKS, comprising completely to highly weathered iron oxide content chert and manganese nodules. **FILL**.

0.40 – 2.80: Moist, reddish brown, dense with medium dense pockets, matrix supported, clayey sandy fine to coarse GRAVEL and COBBLES, comprising completely to highly weathered sub-angular chert. **CHERT RESIDUUM**.

2.80 – 3.20: Moist, dark brown mottled black, firm, clayey sandy SILT, with minor highly weathered chert gravel. Reworked **RESIDUAL DOLOMITE**.
Note:
Traces of wad.

EOH: Maximum reach of TLB, not to refusal.

NOTES

1) No groundwater seepage encountered.

2) Disturbed sample TP9/1 taken between 2.8m--3.2m.

CONTRACTOR : ÿV&S Cathire
MACHINE : CAT428F
DRILLED BY : Amos & Johannes
PROFILED BY : D. Bester (114260)

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

INCLINATION : Vertical
DIAM : 700mm
DATE : ÿ16/09/2021
DATE : 16 Sep 2021

DATE : 19/11/2021 12:15
TEXT : C\WP51\PROFILES\PEITP.TXT

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916789
Y-COORD : 76147.79

HOLE No: TP9

Knight Piésold CONSULTING

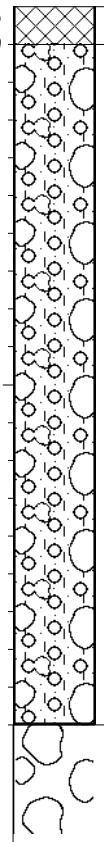
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT: VOSLOORUS

FEASIBILITY GEOTECHNICAL AND DOLOMITE STABILITY INVESTIGATION

HOLE No: TP10
Sheet 1 of 1

JOB: 3110028872

Scale 1:20



0.00	Slightly moist, dark grey, loose, clast supported, silty fine sandy GRAVEL, comprising dolomite and chert aggregate (27mm). **FILL**.
0.10	Moist, reddish brown speckled white stained orange, medium dense with dense pockets, matrix supported, silty sandy fine to coarse GRAVEL and COBBLES, with minor small boulders, comprising completely to highly weathered chert. **CHERT RESIDUUM**. Note: Minor fine and medium manganese nodules.
1.90	EOH: Refusal of TLB due to difficult excavation from large hard rock dolomite and chert BOULDER at 1.4m depth.

NOTES

1) No groundwater seepage encountered.

CONTRACTOR : ÿV&S Cathire
MACHINE : CAT428F
DRILLED BY : Amos & Johannes
PROFILED BY : D. Bester (114260)

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

INCLINATION : Vertical
DIAM : 700mm
DATE : ÿ16/09/2021
DATE : 16 Sep 2021

DATE : 19/11/2021 12:15
TEXT : C\WP51\PROFILES\PEITP.TXT

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916751.82
Y-COORD : 76081.63

HOLE No: TP10

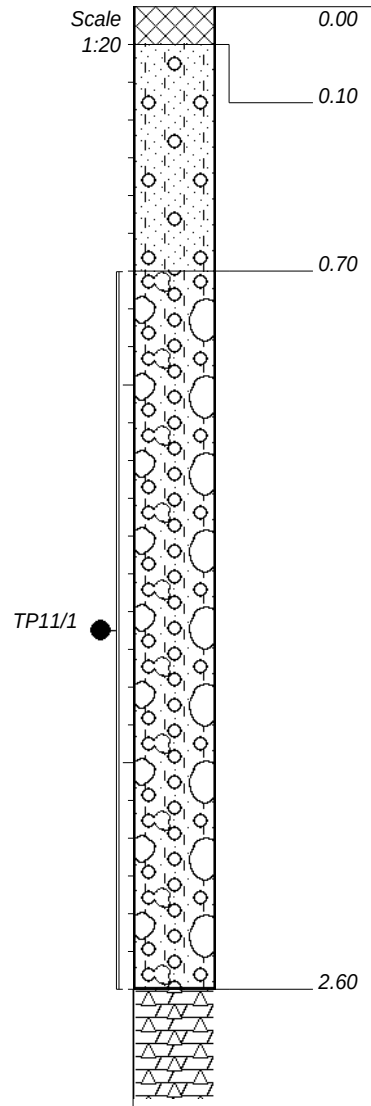
Knight Piésold CONSULTING

RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT: VOSLOORUS

FEASIBILITY GEOTECHNICAL AND DOLOMITE STABILITY INVESTIGATION

HOLE No: TP11
Sheet 1 of 1

JOB: 3110028872



0.00 Slightly moist, dark grey, loose, clast supported, silty fine sandy GRAVEL, comprising dolomite and chert aggregate (27mm). **FILL**.

0.10 Moist, dark reddish brown, medium dense, pinholed and root voided, fine gravelly silty fine SAND, with minor roots. **HILLWASH**.

0.70 Moist, reddish brown, medium dense, matrix supported, silty sandy fine to coarse GRAVEL and COBBLES, with minor small boulders, comprising completely to highly weathered chert. **CHERT RESIDUUM**.

2.60 EOH: Refusal of TLB on highly weathered, grey stained reddish brown and black, thinly bedded, closely jointed, soft to medium hard rock DOLOMITE, interbedded with CHERT.

NOTES

1) No groundwater seepage encountered.

2) Bulk disturbed sample TP11/1 taken between 0.7m--2.6m.

CONTRACTOR : ÿV&S Cathire
MACHINE : CAT428F
DRILLED BY : Amos & Johannes
PROFILED BY : D. Bester (114260)

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

INCLINATION : Vertical
DIAM : 700mm
DATE : ÿ16/09/2021
DATE : 16 Sep 2021

DATE : 19/11/2021 12:15
TEXT : C\WP51\PROFILES\PEITP.TXT

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916719.81
Y-COORD : 76157.09

HOLE No: TP11

Knight Piésold CONSULTING

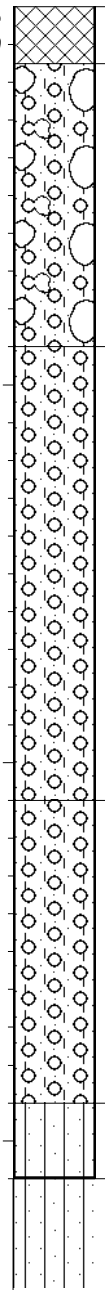
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT: VOSLOORUS

FEASIBILITY GEOTECHNICAL AND DOLOMITE STABILITY INVESTIGATION

HOLE No: TP12
Sheet 1 of 1

JOB: 3110028872

Scale 1:20



0.00	Slightly moist, dark grey, loose, clast supported, silty fine sandy GRAVEL, comprising dolomite and chert aggregate (27mm). **FILL**.
0.15	Moist, reddish brown, medium dense, matrix supported, silty sandy fine to coarse GRAVEL and COBBLES, with minor small boulders, comprising completely to highly weathered chert. **CHERT RESIDUUM**.
0.90	Moist, reddish brown mottled black, medium dense, matrix supported, silty sandy fine to coarse GRAVEL and COBBLES, comprising highly weathered dolerite, ferricrete nodules and sub-angular chert. Interpreted as completely weathered contact zone between DOLERITE and DOLOMITE. Note: Minor roots.
2.10	Moist, reddish brown mottled black, medium dense, matrix supported, silty sandy fine to coarse GRAVEL, comprising highly weathered dolerite and ferricrete nodules. Reworked **RESIDUAL DOLERITE**.
2.90	Moist, light yellowish brown stained black, stiff, relict jointed, sandy SILT. **RESIDUAL DOLERITE**. Note: Breaks out to gravel.
3.10	EOH: Maximum reach of TLB, not to refusal.

NOTES

1) No groundwater seepage encountered.

CONTRACTOR : ÿV&S Cathire
MACHINE : CAT428F
DRILLED BY : Amos & Johannes
PROFILED BY : D. Bester (114260)

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

INCLINATION : Vertical
DIAM : 700mm
DATE : ÿ16/09/2021
DATE : 16 Sep 2021

DATE : 19/11/2021 12:15
TEXT : C\WP51\PROFILES\PEITP.TXT

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916750.41
Y-COORD : 76198.13

HOLE No: TP12

APPENDIX C

Percussion Borehole Profiles

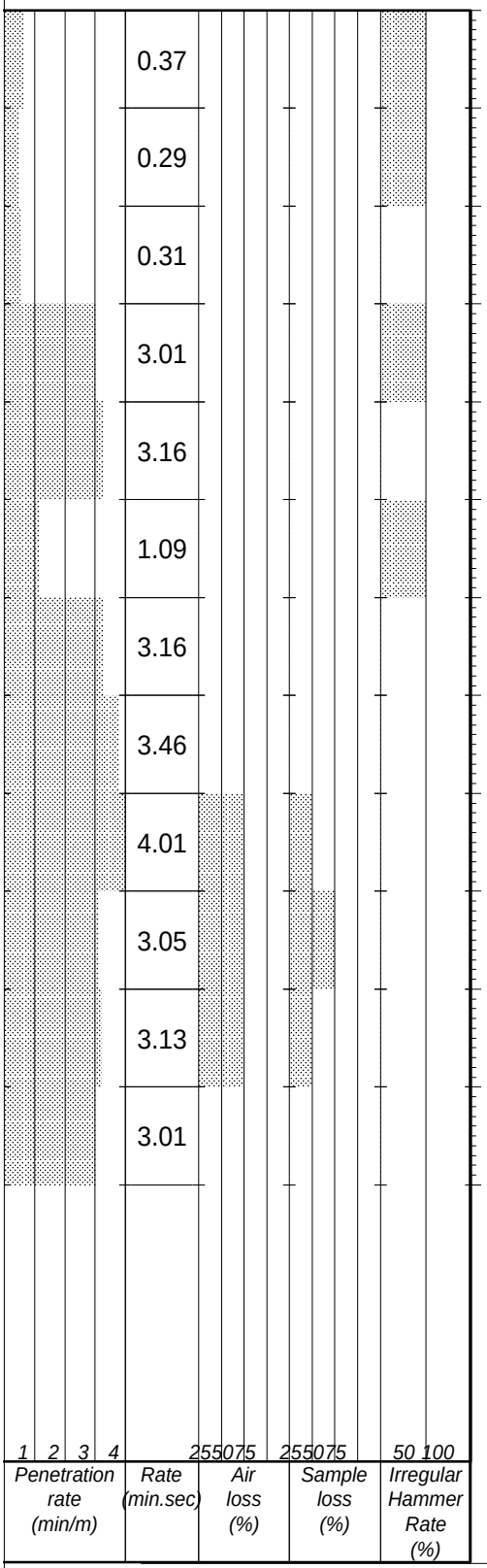
Knight Piésold CONSULTING

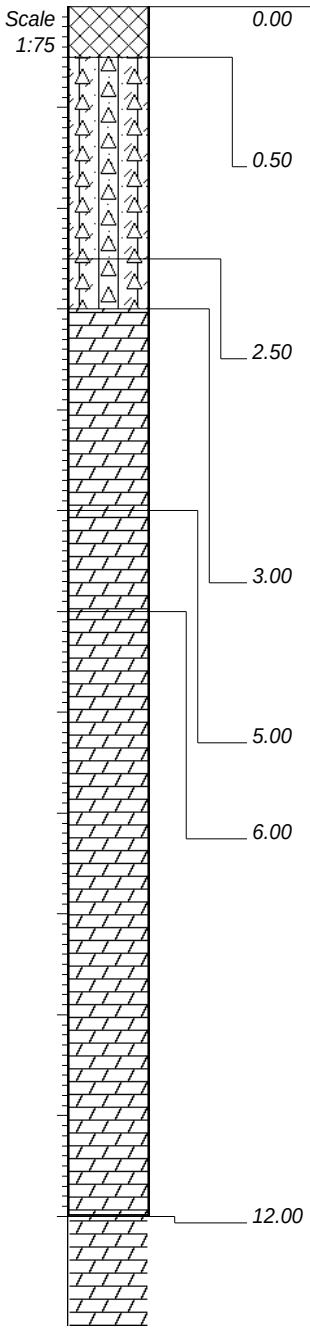
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH1
Sheet 1 of 1

JOB: 3110028872





Medium brown, silty SAND, with abundant white stained orange and black, highly weathered CHERT. **FILL**.

Dark reddish brown, clayey sandy SILT, with abundant white stained orange and black, highly weathered CHERT. Reworked **RESIDUAL DOLOMITE**.

Dark brown, slightly sandy clayey SILT, with minor white stained orange, highly weathered CHERT, with moderately weathered, translucent chert and traces of wad. **RESIDUAL DOLOMITE**.

Dark grey and grey, moderately to slightly weathered, <u>hard</u> rock DOLOMITE, with minor dark grey chert (interbedded).

Dark grey, slightly weathered DOLOMITE.

Dark grey becoming light grey below 9m, slightly weathered, <u>hard</u> rock DOLOMITE, with minor dark grey chert (interbedded) between 6m and 8m.

<u>Note</u>:
1. Evidence of stained orange joint faces from 3m to 5m.
2. Dark pulverised material between 9m and 12m.

EOH: Assumed that profile continues as above.

NOTES

1) No water strikes noticed.

2) Borehole dry when dipped on 17/09/2021.

3) Collar elevation at time of investigation: 1546.8 m.

CONTRACTOR : Hennie Erwee Drilling
MACHINE : Super Rock 1000
DRILLED BY : Japhta
PROFILED BY : Deon Bester (114260)

INCLINATION : Vertical
DIAM : 165mm
DATE : 17 Sep 2021
DATE : 17 Sep 2021

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916707.48
Y-COORD : 76095.86

HOLE No: PH1

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

DATE : 22/11/2021 09:34
TEXT : ..1\PROFILES\PEHPERCBH.TXT

D079 E Mouton

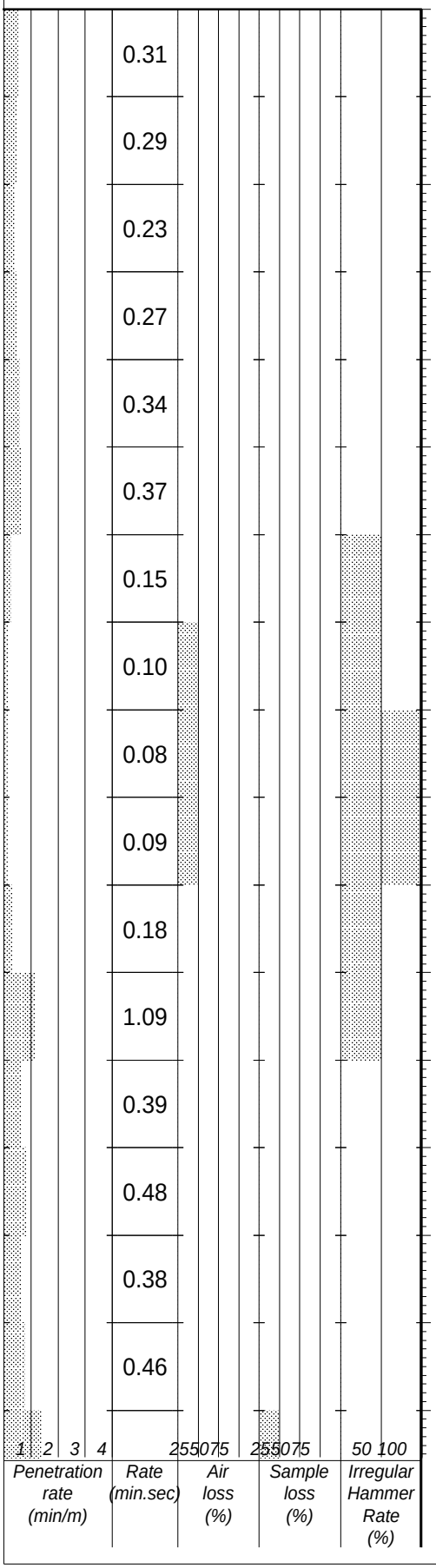
dotPLOT 7022 PBpH7

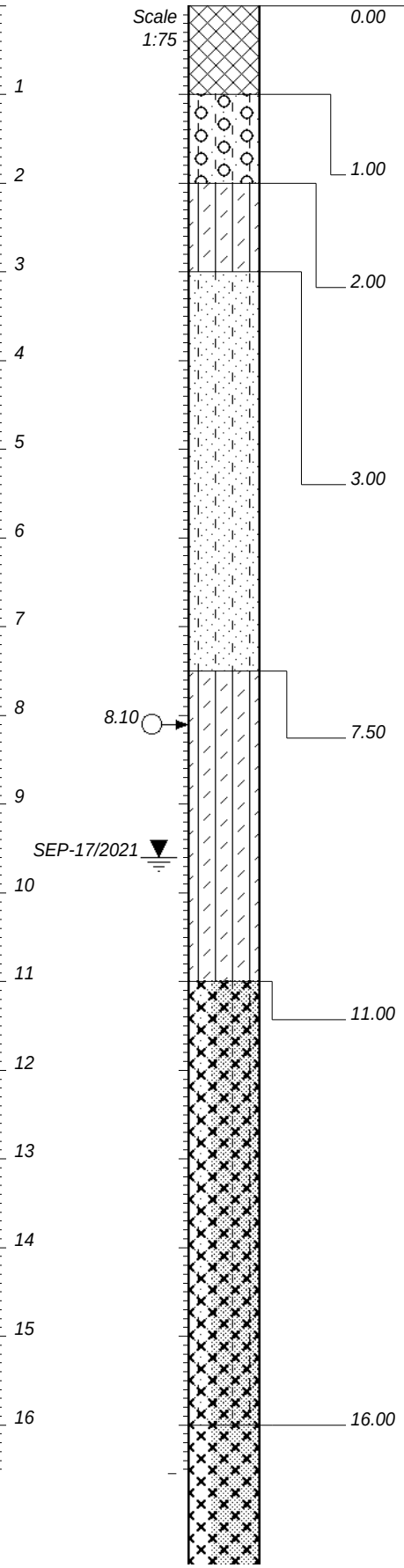
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH2
Sheet 1 of 2

JOB: 3110028872





White stained orange brown and red brown, highly weathered CHERT, with builders rubble and minor slightly weathered dolomite. **FILL**.

Dark reddish brown, silty sandy GRAVEL, comprising highly weathered chert. **HILLWASH**.

Red brown, slightly sandy clayey SILT, with minor ferricrete nodules and highly weathered chert (possibly contamination from above). Reworked **RESIDUAL DOLERITE**.

Light yellow brown becoming olive brown near base, slightly clayey silty SAND, with traces of highly weathered dolerite. **RESIDUAL DOLERITE**.
Note:
Minor to abundant highly weathered dolerite between 5m and 6.5m.

Dark brown, clayey SILT, with minor wad and traces to minor off-white highly weathered (altered) chert, with talcose appearance. **RESIDUAL DOLOMITE**.
Note:
Traces of highly weathered, intensive, possibly contamination from above.

Light olive brown speckled black, silty SAND, with abundant highly weathered dolerite. Interpreted as pulverised highly weathered (friable) DOLERITE of possibly very soft to soft rock strength.

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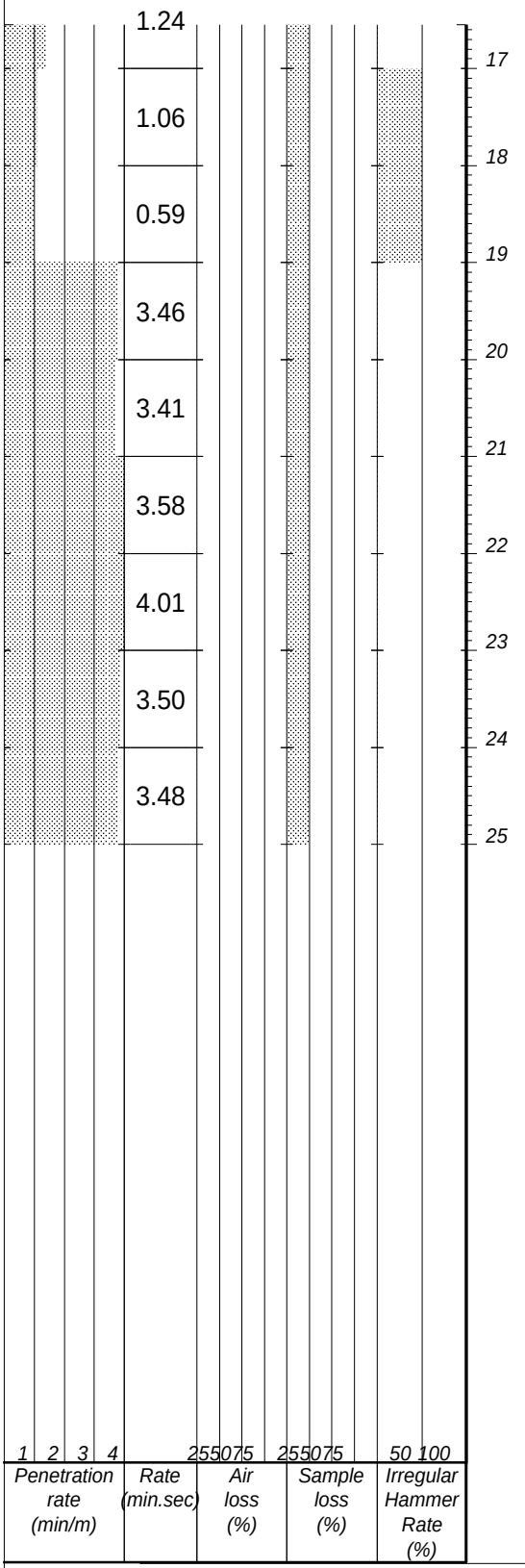
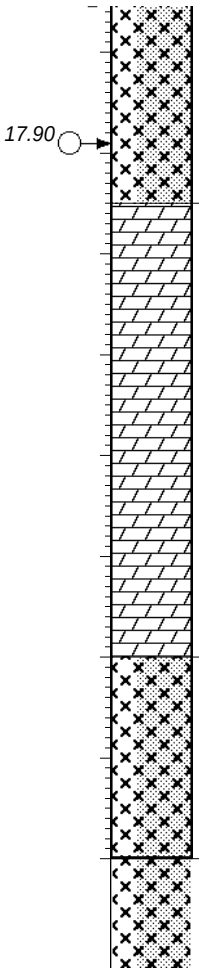
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH2
Sheet 2 of 2

JOB: 3110028872





Dark olive brown speckled black, highly weathered DOLERITE.

18.50

Dark grey and grey, slightly weathered, hard rock DOLOMITE, with traces of chert, quartz veins and joint faces stained orange.

23.00

Dark greenish grey speckled black, slightly weathered, hard rock DOLERITE, with minor moderately weathered dolerite at base (possibly contamination).

25.00

EOH: Assumed that profile continues as above.

NOTES

1) Water strike at 8.10 m and 17.90 m.

2) Water table level measured on SEP-17/2021 at 9.60 m.

3) Collar elevation at time of investigation: 1543.9 m.

4) Steel pipe (30mm) for borehole water supply intersected near surface (bent) but not broken.

CONTRACTOR : Hennie Erwee Drilling
MACHINE : Super Rock 1000
DRILLED BY : Japhta
PROFILED BY : Deon Bester (114260)

INCLINATION : Vertical
DIAM : 165mm
DATE : 20 Sep 2021
DATE : 20 Sep 2021

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916772.05
Y-COORD : 76279.25

HOLE No: PH2

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

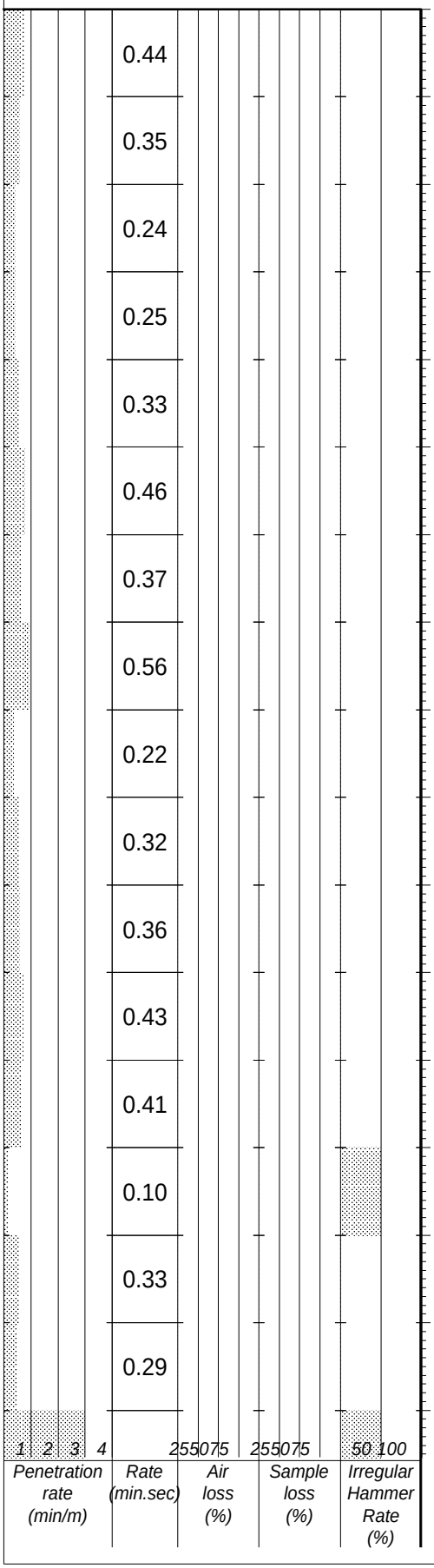
DATE : 22/11/2021 09:34
TEXT : ..1\PROFILES\PEHPERCBH.TXT

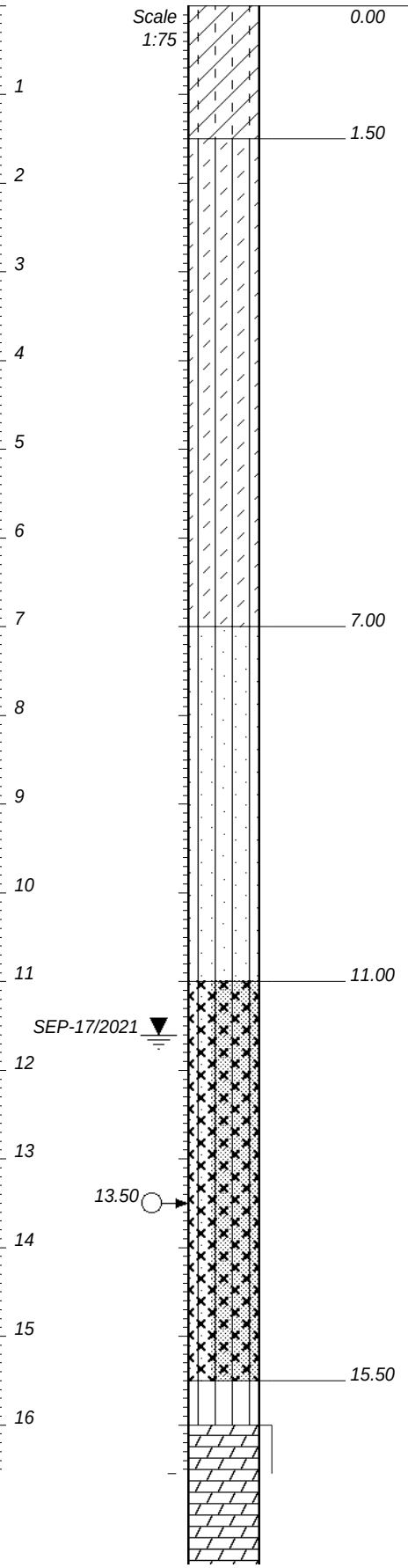
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH3
Sheet 1 of 2

JOB: 3110028872





0.00 — Orange brown, slightly sandy silty CLAY, with traces of gravel. Reworked **RESIDUAL DOLERITE**.

1.50 — Light yellow brown, slightly sandy clayey SILT, with traces to minor light grey, unctuous clay between 5m and 6m. **RESIDUAL DOLERITE**.

Note:
1. Between 6m and 7m predominantly light yellow brown slightly sandy silt.
2. Traces of completely to highly weathered dolerite between 4m and 6m.

7.00 — Light yellow brown, slightly clayey sandy SILT, with minor to abundant highly weathered dolerite. **RESIDUAL DOLERITE.**

11.00 — Light olive brown, sandy SILT, with abundant to equal amounts of highly weathered dolerite. Interpreted as highly weathered and possibly closely jointed DOLERITE.

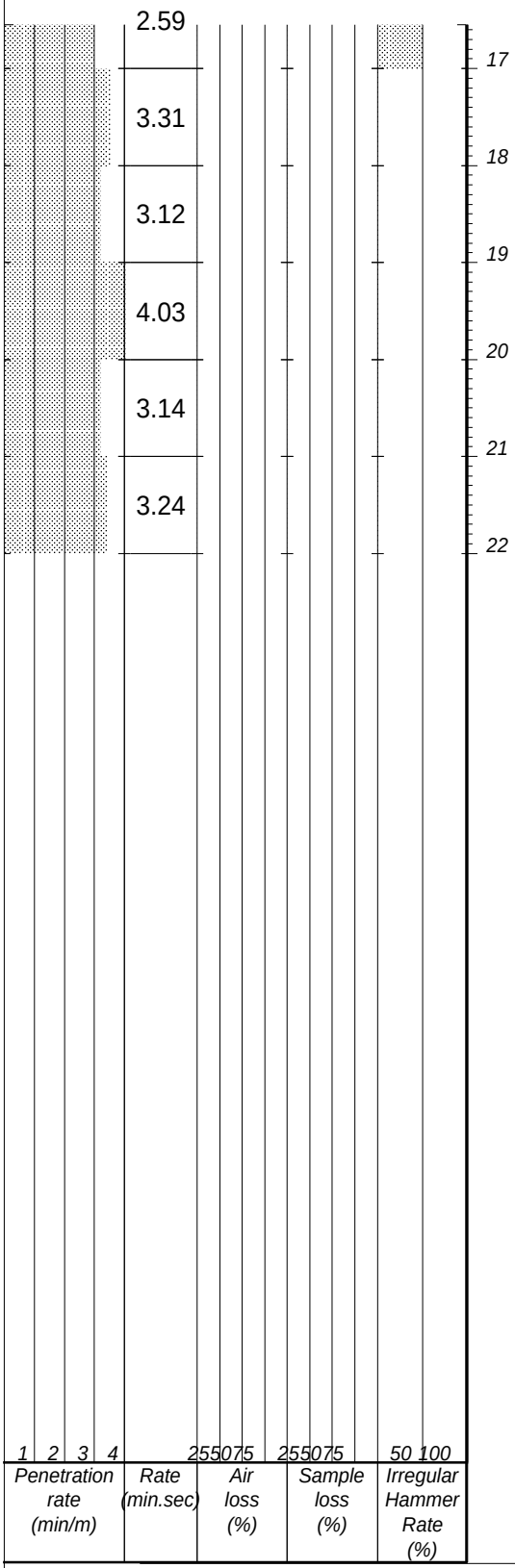
15.50

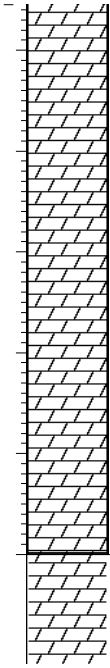
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH3
Sheet 2 of 2

JOB: 3110028872





Dark brown, slightly sandy SILT, with traces of highly weathered dolerite (possibly contamination). **RESIDUAL DOLOMITE**, with traces of wad.

Dark grey stained brown, moderately to slightly weathered, hard rock DOLOMITE.

Note:
1. Sample heavily contaminated with residual dolomite between 16m and 18m.
2. Abundant pulverised material between 19.5m and 21m.

EOH: Assumed that profile continues as above.

NOTES

1) Water strike at 13.50 m.

2) Water table level measured on SEP-17/2021 at 11.60 m.

3) Collar elevation at time of investigation: 1546.2 m.

CONTRACTOR : Hennie Erwee Drilling
MACHINE : Super Rock 1000
DRILLED BY : Japhta
PROFILED BY : Deon Bester (114260)

INCLINATION : Vertical
DIAM : 165mm
DATE : 17 Sep 2021
DATE : 17 Sep 2021

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916811.75
Y-COORD : 76190.88

HOLE No: PH3

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

DATE : 22/11/2021 09:34
TEXT : ..1\PROFILES\PEHPERCBH.TXT

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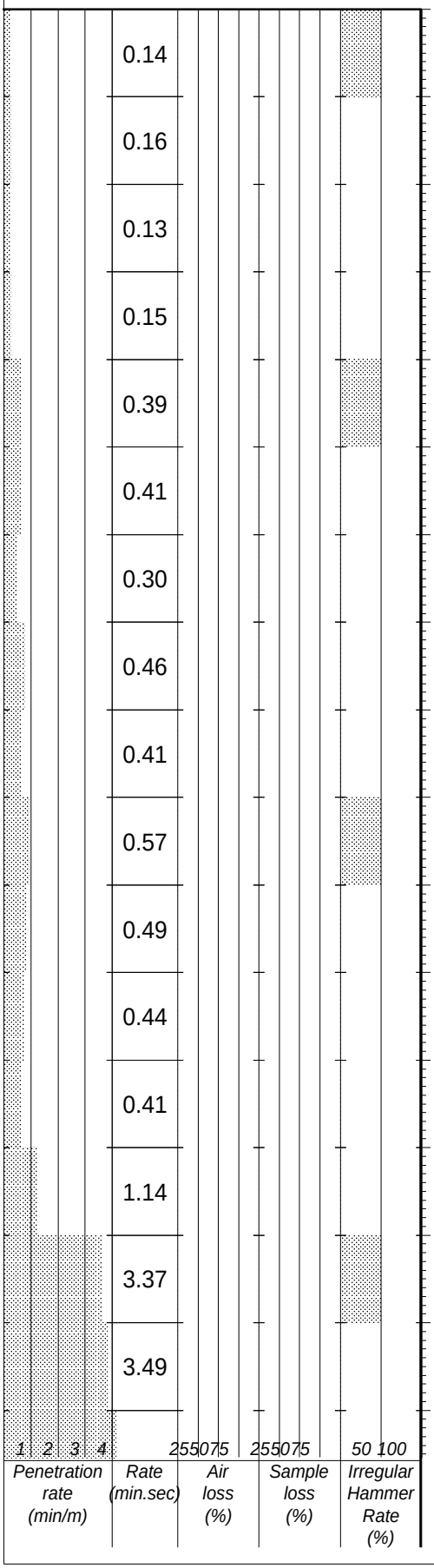
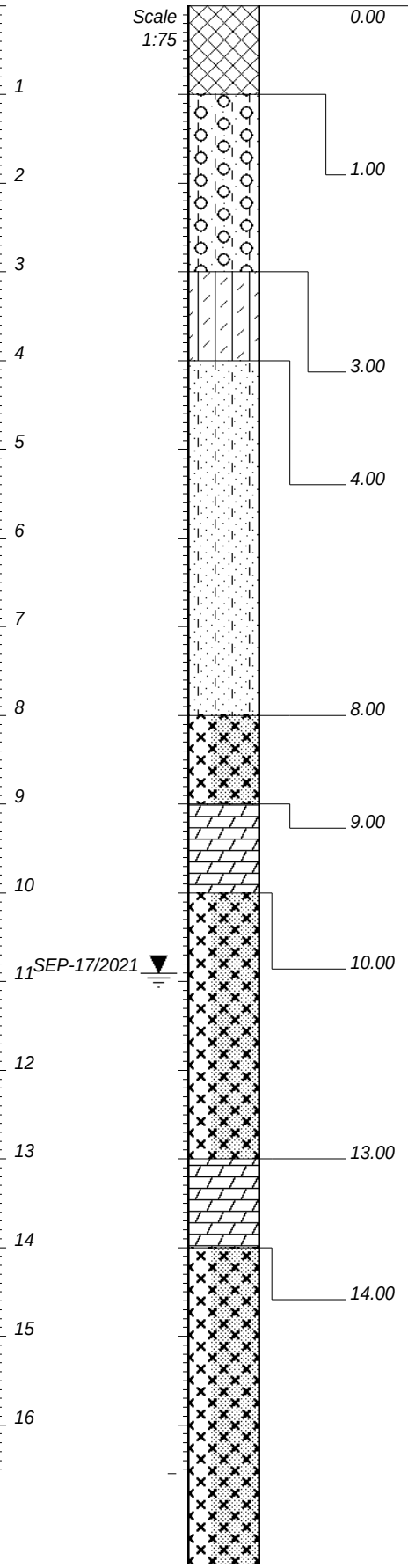
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH4
Sheet 1 of 2

JOB: 3110028872





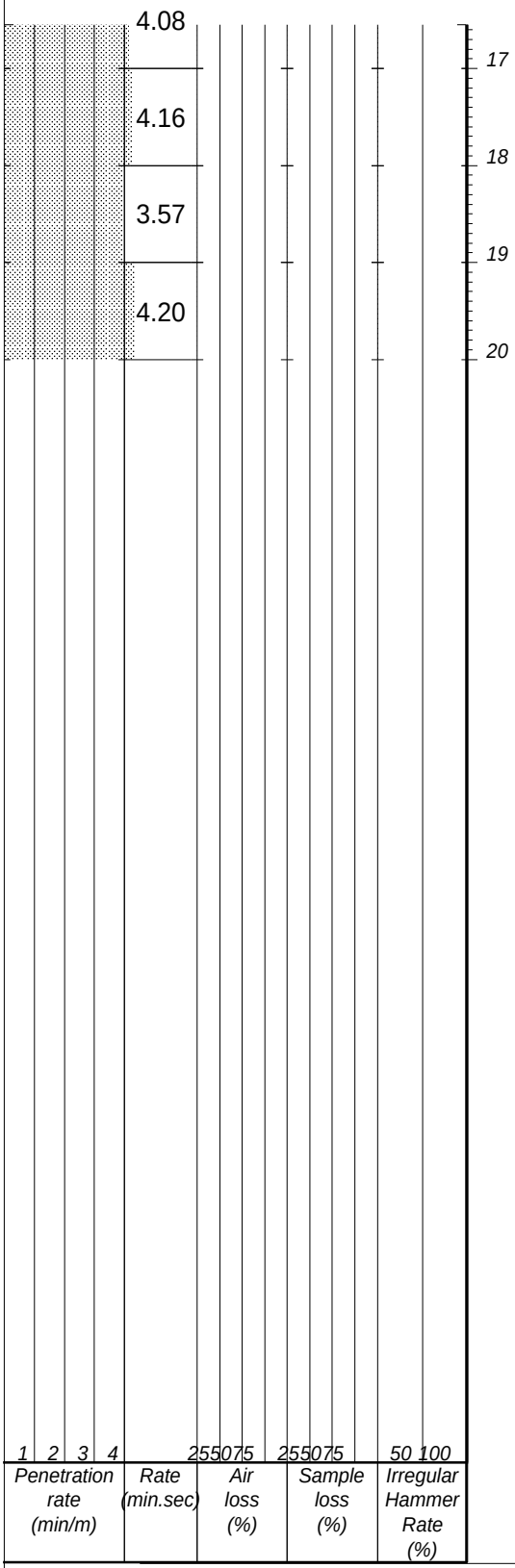
0.00 – 1.00	Dark grey brown, silty SAND, with abundant highly weathered white stained orange chert and traces of grey, slightly weathered dolomite. **FILL**.
1.00 – 3.00	Dark reddish brown, slightly clayey silty sandy GRAVEL, comprising white stained orange brown and black, highly weathered chert with iron oxide staining. Reworked **RESIDUAL DOLOMITE**.
3.00 – 4.00	Red brown, slightly sandy clayey SILT, with minor ferricrete nodules. Reworked **RESIDUAL DOLERITE**.
4.00 – 8.00	Light olive brown, silty SAND, with traces to minor highly weathered dolerite. **RESIDUAL DOLERITE**, tending to soft rock DOLERITE.
8.00 – 9.00	Olive brown speckled black, highly weathered DOLERITE, with abundant pulverised material.
9.00 – 10.00	Light grey and pinkish grey stained brown, moderately weathered DOLOMITE, with traces of light brown moderately weathered chert.
10.00 – 13.00	Olive brown speckled black, highly weathered DOLERITE, with abundant pulverised material.
13.00 – 14.00	Light grey and grey, moderately to slightly weathered DOLOMITE, with evidence of joint faces stained orange.

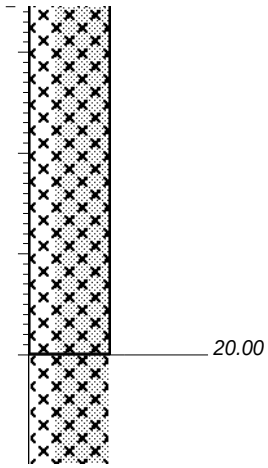
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH4
Sheet 2 of 2

JOB: 3110028872





Dark grey speckled white, slightly weathered, hard rock DOLERITE.
Note:
Between 16m and 17m minor slightly weathered dolomite recovered, interpreted as thin dolomite band within dolerite bedrock.

EOH: Assumed that profile continues as above.

NOTES

1) No water strikes noticed.

2) Water table level measured on SEP-17/2021 at 10.90 m.

3) Collar elevation at time of investigation: 1543.3 m.

CONTRACTOR : Hennie Erwee Drilling
MACHINE : Super Rock 1000
DRILLED BY : Jack
PROFILED BY : Deon Bester (114260)

INCLINATION : Vertical
DIAM : 165mm
DATE : 20 Sep 2021
DATE : 20 Sep 2021

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916880.06
Y-COORD : 76273.02

HOLE No: PH4

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

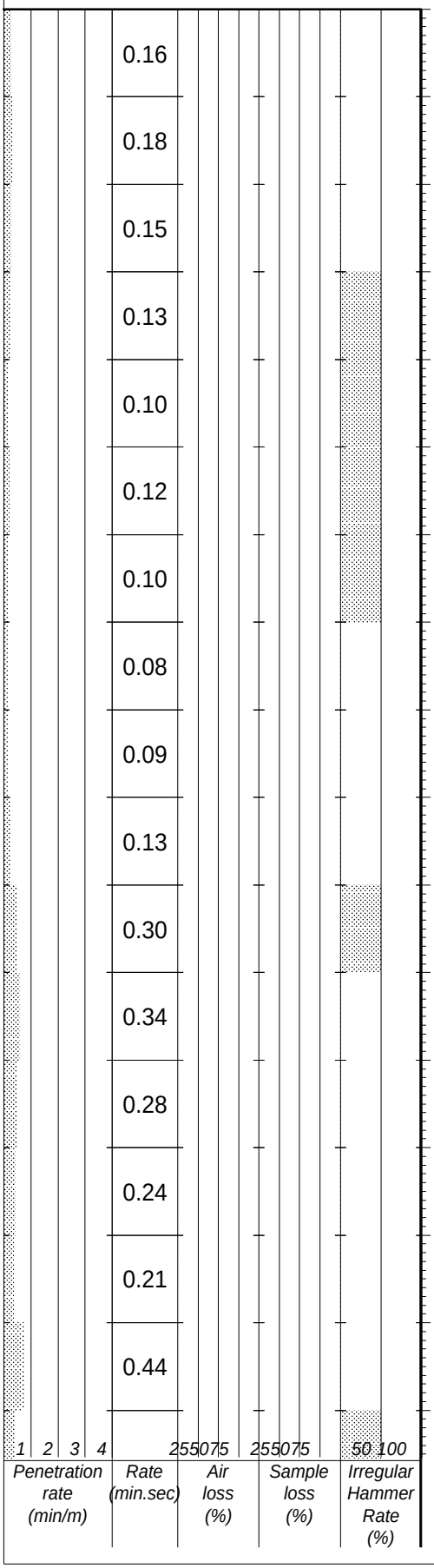
DATE : 22/11/2021 09:34
TEXT : ..1\PROFILES\PEHPERCBH.TXT

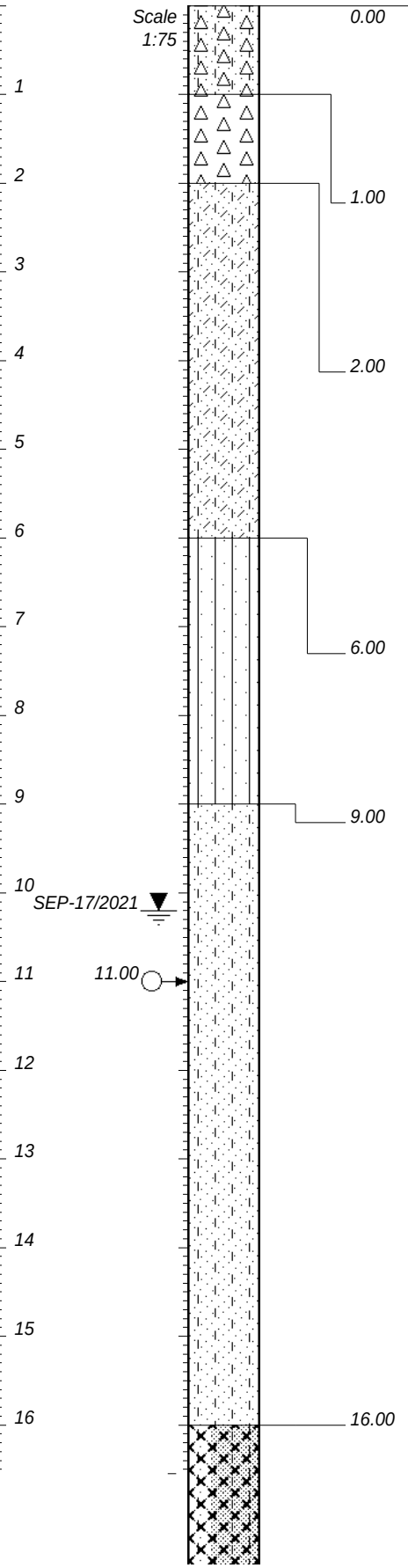
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH5
Sheet 1 of 2

JOB: 3110028872





Dark reddish brown, silty SAND, with abundant to equal amounts of white stained orange brown and black, highly weathered CHERT, with minor manganese nodules. Reworked **RESIDUAL DOLOMITE**.

White stained orange and black, completely to highly weathered CHERT, with minor grey, moderately weathered chert. **CHERT RESIDUUM**.

Dark reddish brown, clayey silty SAND, with minor white stained orange, highly weathered chert and traces of manganese nodules. Reworked **RESIDUAL DOLOMITE**.
Note:
Between 4m and 5m traces to minor grey stained brown moderately weathered dolomite.

Dark brown, slightly clayey sandy SILT, with traces to minor dark brown, highly weathered chert and dark brown to black clayey silt wad. **RESIDUAL DOLOMITE**.

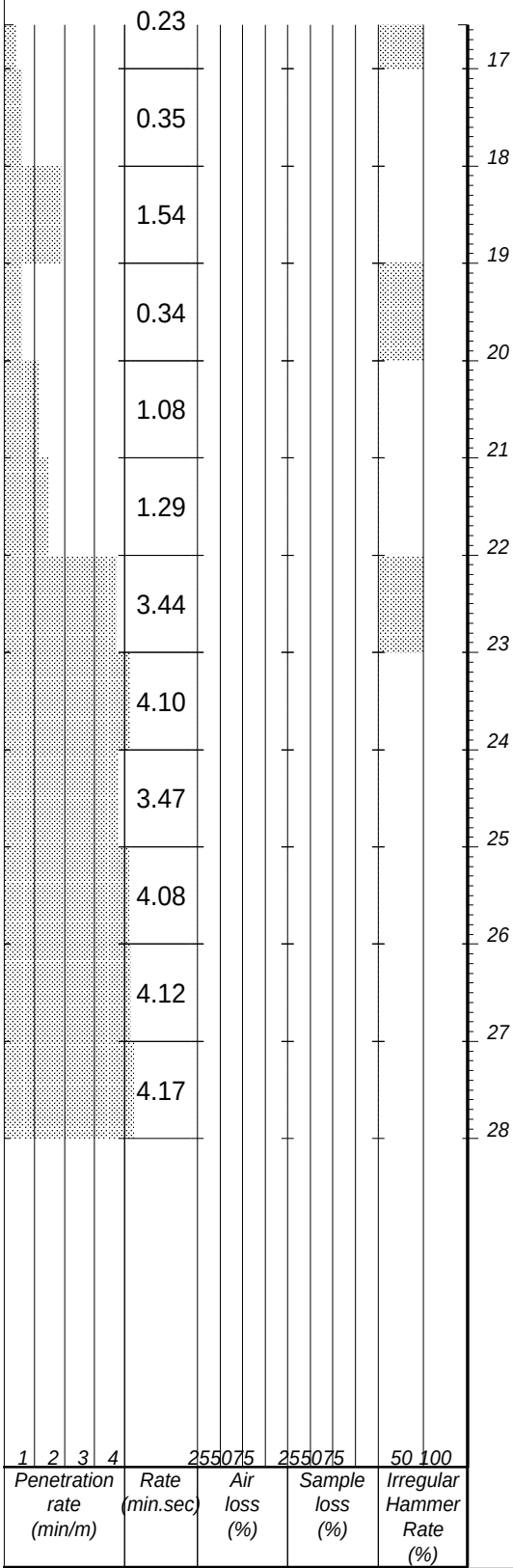
Light olive brown, silty SAND, with abundant becoming minor with depth, olive brown speckled black, highly weathered dolerite. Interpreted as highly weathered friable DOLERITE.

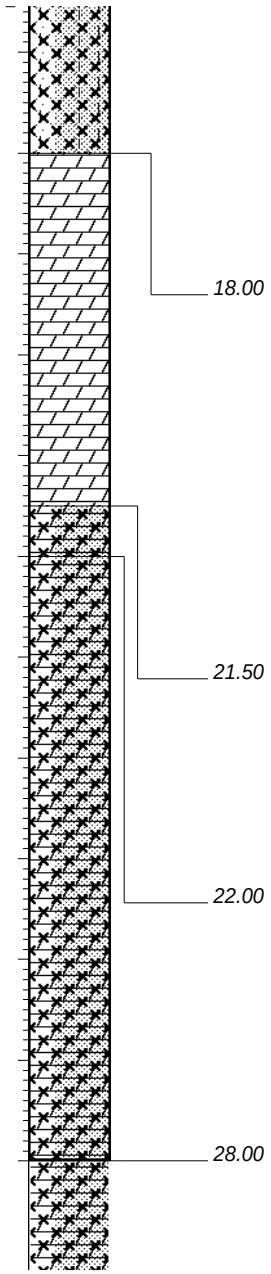
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH5
Sheet 2 of 2

JOB: 3110028872





Olive brown, highly weathered DOLERITE, with abundant brown silty sand and minor light brown, moderately weathered, chert, with traces of highly weathered, pitted and leached chert. Interpreted as highly weathered DOLERITE, near transition to DOLOMITE.

Dark grey stained orange, moderately weathered, DOLOMITE, with minor brown silty SAND and olive brown, highly weathered DOLERITE (possibly contamination).
Note:
From 19m to 20m abundant brown to dark brown, sandy silt with minor large chips recovered. Possible weathered zone.

Dark grey speckled black and white stained orange, moderately weathered DOLERITE.
Note: Sample heavily contaminated, with material from above.

Dark grey speckled black and white, slightly to highly weathered DOLERITE.
Note:
Sample heavily contaminated with material from above.

EOH: Assumed that profile continues as above.

NOTES

1) Water strike at 11.00 m.

2) Water table level measured on SEP-17/2021 at 10.20 m.

3) Collar elevation at time of investigation: 1546.9 m.

CONTRACTOR : Hennie Erwee Drilling
MACHINE : Super Rock 1000
DRILLED BY : Jack
PROFILED BY : Deon Bester (114260)

INCLINATION : Vertical
DIAM : 165mm
DATE : 20 Sep 2021
DATE : 20 Sep 2021

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916797.02
Y-COORD : 76116

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

DATE : 22/11/2021 09:34
TEXT : ..1\PROFILES\PEHPERCBH.TXT

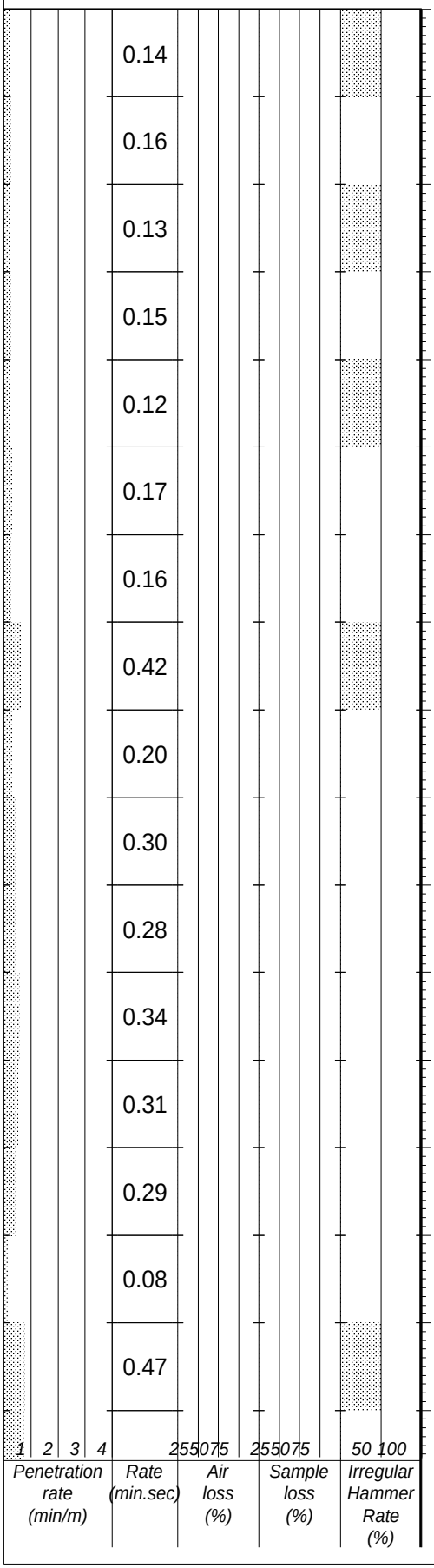
HOLE No: PH5

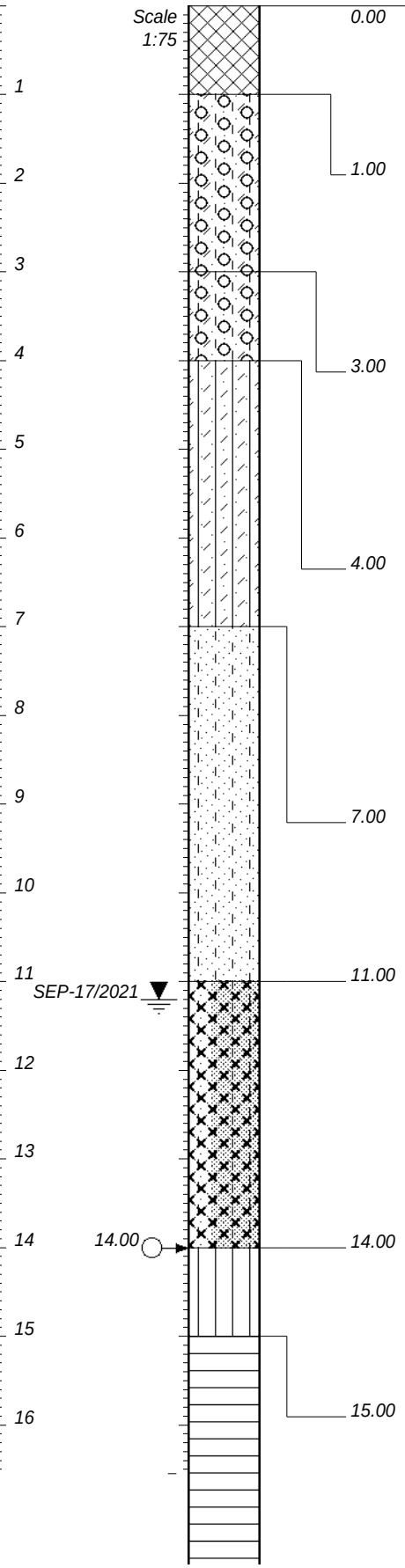
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH6
Sheet 1 of 2

JOB: 3110028872





Medium brown, slightly clayey silty SAND, with abundant to equal amounts of grey and white stained orange and black, highly weathered chert. **FILL**.

Reddish brown, clayey silty sandy GRAVEL, comprising completely to highly weathered, white stained orange and black, highly weathered chert and manganese nodules. Reworked **RESIDUAL DOLOMITE**.

Medium brown, clayey silty sandy GRAVEL, comprising highly weathered chert, with equal amounts of completely to highly weathered dolerite. **TRANSITIONAL ZONE**.

Medium pinkish brown, clayey sandy SILT, with abundant completely to highly weathered, light brown stained black dolerite and white stained orange and black chert. Latter is possibly contaminated from above. Reworked **RESIDUAL DOLERITE**.

Light olive brown, silty SAND, with traces to minor highly weathered dolerite. **RESIDUAL DOLERITE**.

Light olive brown, silty SAND, with abundant highly weathered dolerite. Interpreted as highly weathered, friable, soft rock DOLERITE.
Note:
Minor moderately weathered dolerite between 13m and 14m.

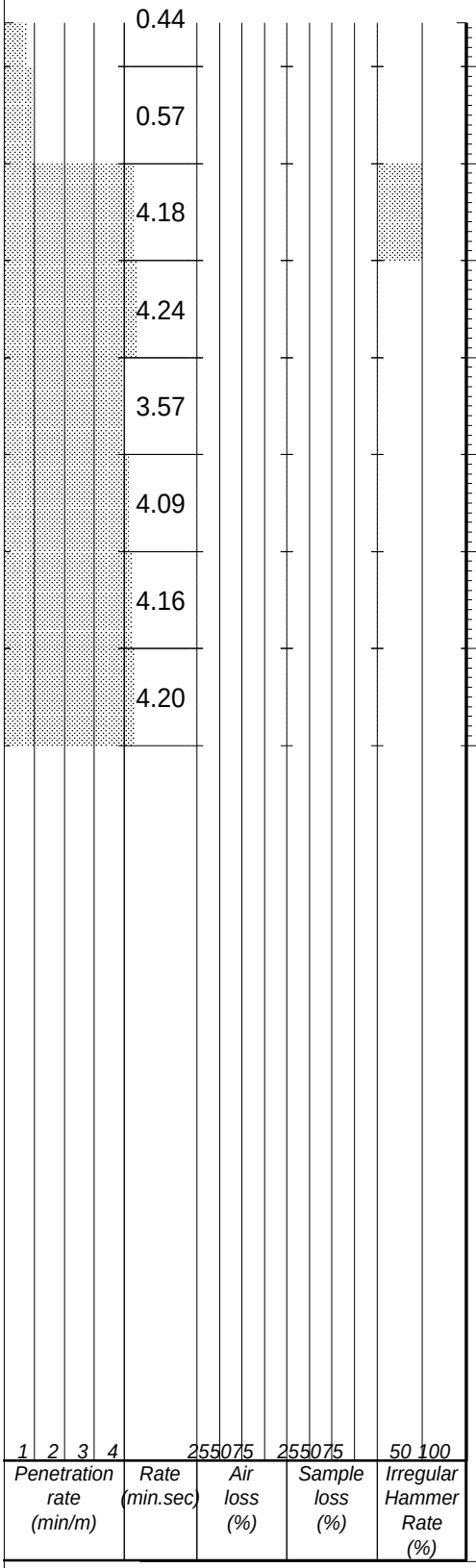
Dark brown, slightly clayey SILT, with abundant highly weathered dolerite and minor grey dolomitic shale. **RESIDUAL DOLERITE**, with traces of wad.

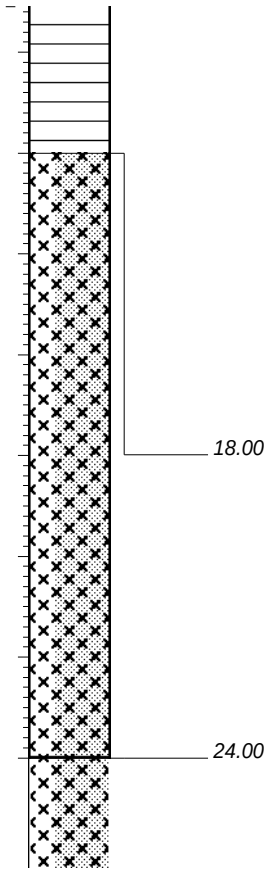
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH6
Sheet 2 of 2

JOB: 3110028872





Light yellow brown stained black, highly weathered DOLERITE, with equal amounts of light grey dolomitic SHALE and minor dark brown, clayey silt and traces of wad (possibly contamination). **RESIDUAL DOLOMITIC SHALE**, contaminated with highly weathered dolerite from above.

Notes:
1. Samples heavily contaminated, with material from above.

Dark grey to black speckled white, slightly weathered hard rock DOLERITE.

EOH: Assumed that profile continues as above.

NOTES

1) Water strike at 14.00 m.

2) Water table level measured on SEP-17/2021 at 11.20 m.

3) Collar elevation at time of investigation: 1545.7 m.

CONTRACTOR : Hennie Erwee Drilling
MACHINE : Super Rock 1000
DRILLED BY : Jack
PROFILED BY : Deon Bester (114260)

INCLINATION : Vertical
DIAM : 165mm
DATE : 17 Sep 2021
DATE : 17 Sep 2021

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916709.25
Y-COORD : 76206.66

HOLE No: PH6

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

DATE : 22/11/2021 09:34
TEXT : ..1\PROFILES\PEHPERCBH.TXT

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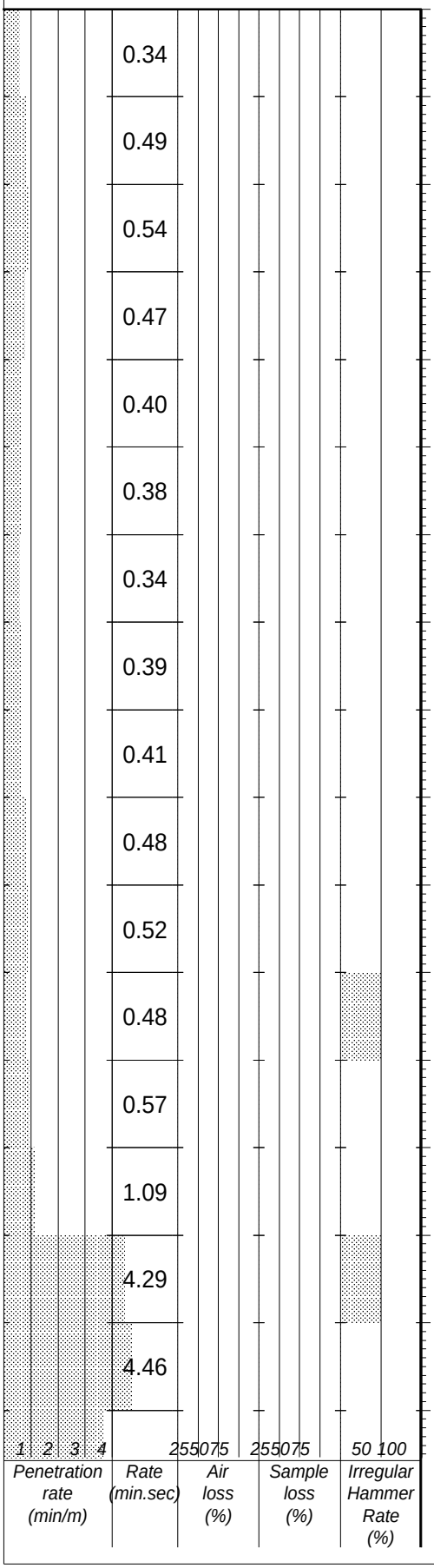
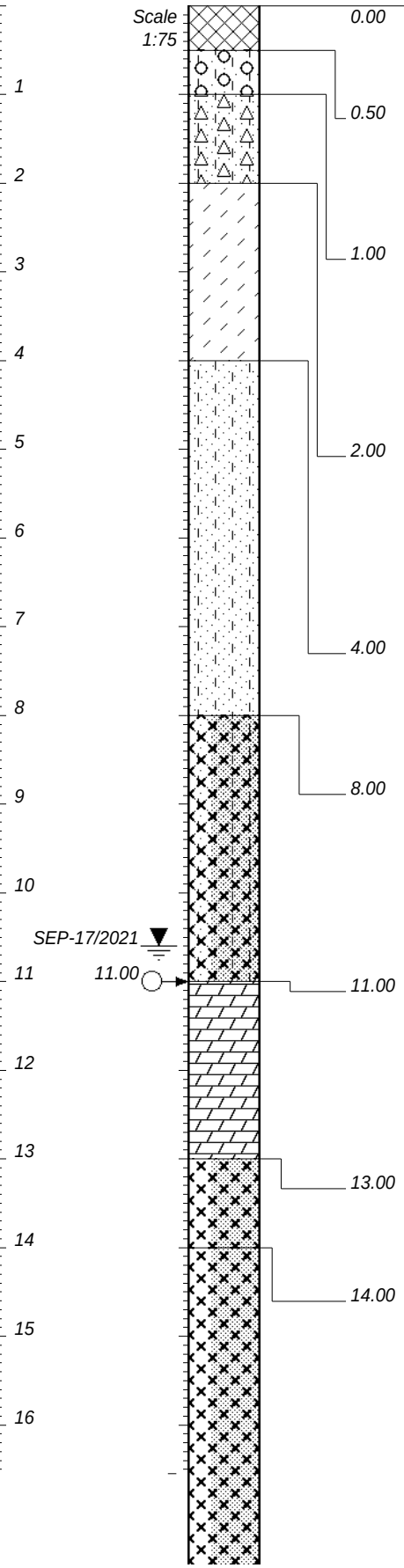
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH7
Sheet 1 of 2

JOB: 3110028872





0.00 – 0.50	Dark brown, silty sandy GRAVEL, comprising highly weathered chert and ion oxide coated gravel. **FILL**.
0.50 – 1.00	Red brown, slightly clayey silty sandy GRAVEL, comprising highly weathered, white stained orange brown chert. **HILLWASH**.
1.00 – 2.00	Dark reddish brown, slightly clayey silty SAND, with abundant white stained orange brown, highly weathered chert and traces of ferricrete nodules. Reworked **RESIDUAL DOLOMITE**.
2.00 – 4.00	Reddish brown, slightly sandy clayey SIT, with minor ferricrete nodules and traces of highly weathered chert (possibly contamination). Reworked **RESIDUAL DOLERITE**.
4.00 – 8.00	Light yellowish brown, slightly clayey silty SAND, with minor highly weathered dolerite. **RESIDUAL DOLERITE**.
8.00 – 11.00	Light olive brown, silty SAND, with equal amounts of highly weathered DOLERITE. Interpreted as highly weathered, friable DOLERITE of possibly very soft to soft rock consistency.
11.00 – 13.00	Dark grey and pinkish grey, moderately to slightly weathered DOLOMITE, with traces of dark brown sandy silt. Interpreted as DOLOMITE band within DOLERITE BEDROCK.
13.00 – 14.00	Dark grey speckled white stained brown, moderately weathered DOLERITE.

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RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH7
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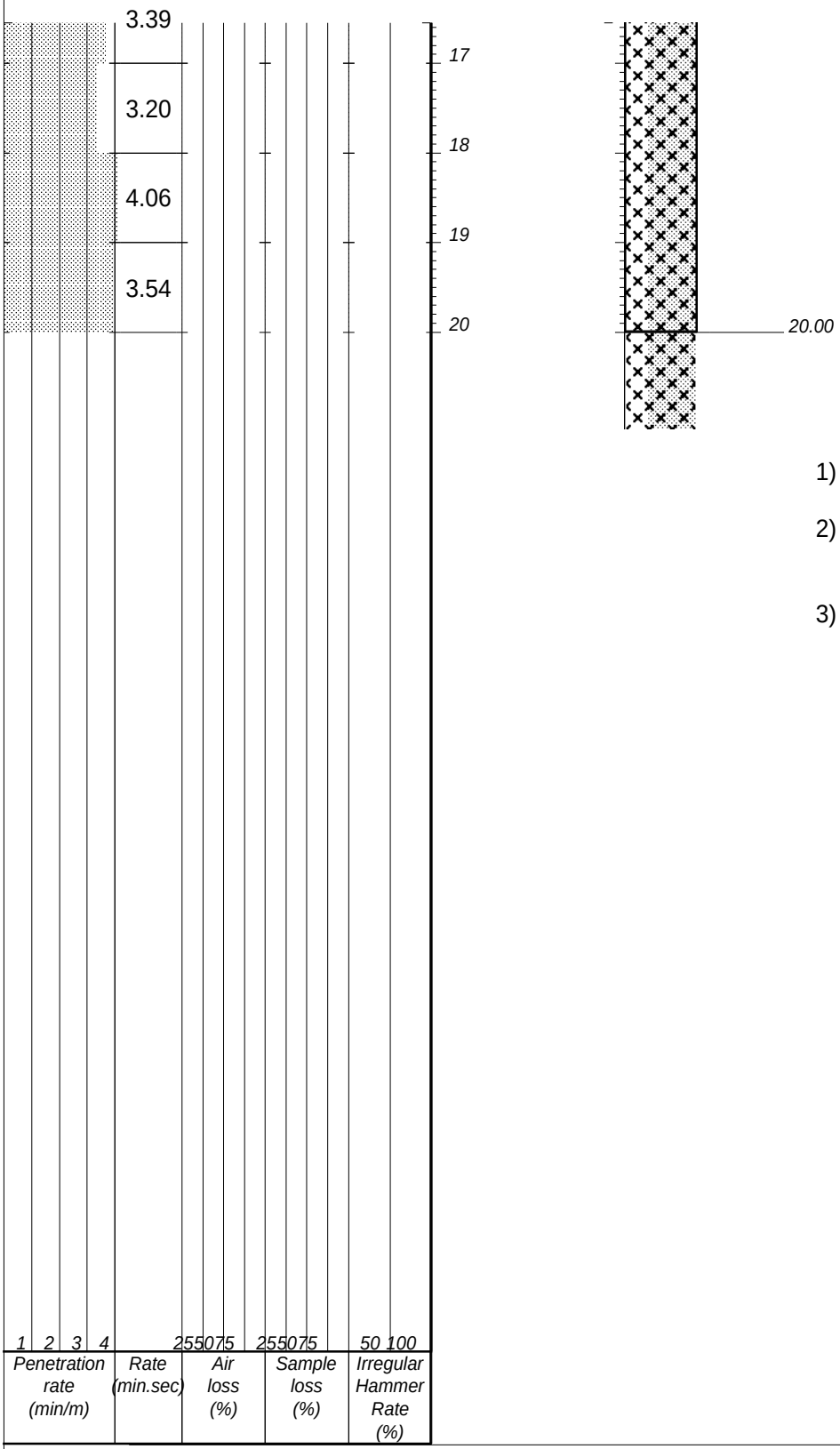
JOB: 3110028872



Dark grey speckled white, slightly weathered, hard rock DOLERITE.
Note:
Occasional moderately weathered chips, possibly moderately weathered/fractured in places.

EOH: Assumed that profile continues as above.

NOTES

1) Water strike at 11.00 m.
2) Water table level measured on SEP-17/2021 at 10.60 m.
3) Collar elevation at time of investigation: 1545 m.

CONTRACTOR : Hennie Erwee Drilling
MACHINE : Super Rock 1000
DRILLED BY : Jack
PROFILED BY : Deon Bester (114260)

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

INCLINATION : Vertical
DIAM : 165mm
DATE : 20 Sep 2021
DATE : 20 Sep 2021

DATE : 22/11/2021 09:34
TEXT : ..1\PROFILES\PEHPERCBH.TXT

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916845.85
Y-COORD : 76222.32

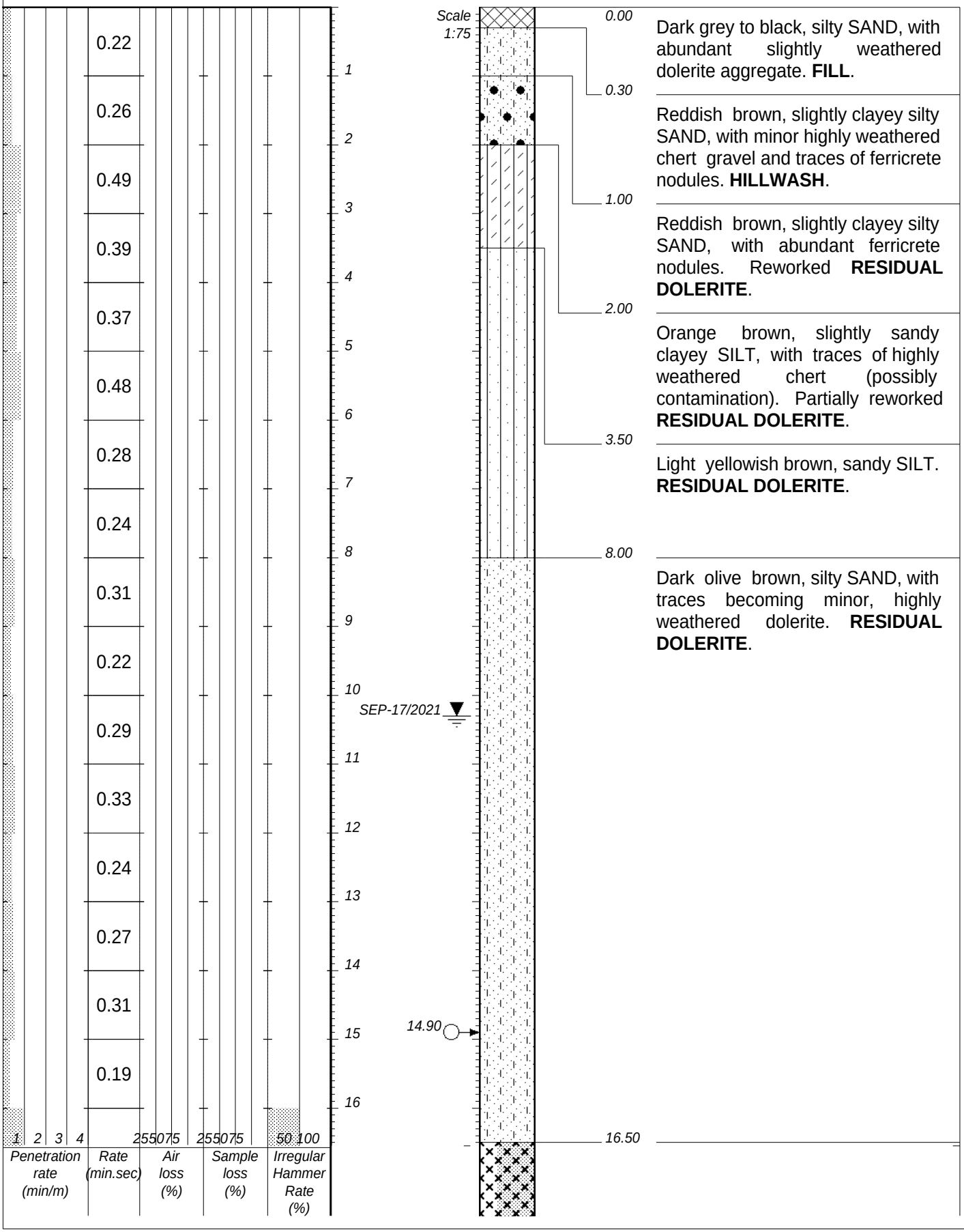
HOLE No: PH7

RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH8
Sheet 1 of 2

JOB: 3110028872



Dark grey to black, silty SAND, with abundant slightly weathered dolerite aggregate. **FILL**.

Reddish brown, slightly clayey silty SAND, with minor highly weathered chert gravel and traces of ferricrete nodules. **HILLWASH**.

Reddish brown, slightly clayey silty SAND, with abundant ferricrete nodules. Reworked **RESIDUAL DOLERITE**.

Orange brown, slightly sandy clayey SILT, with traces of highly weathered chert (possibly contamination). Partially reworked **RESIDUAL DOLERITE**.

Light yellowish brown, sandy SILT. **RESIDUAL DOLERITE**.

Dark olive brown, silty SAND, with traces becoming minor, highly weathered dolerite. **RESIDUAL DOLERITE**.

RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH8
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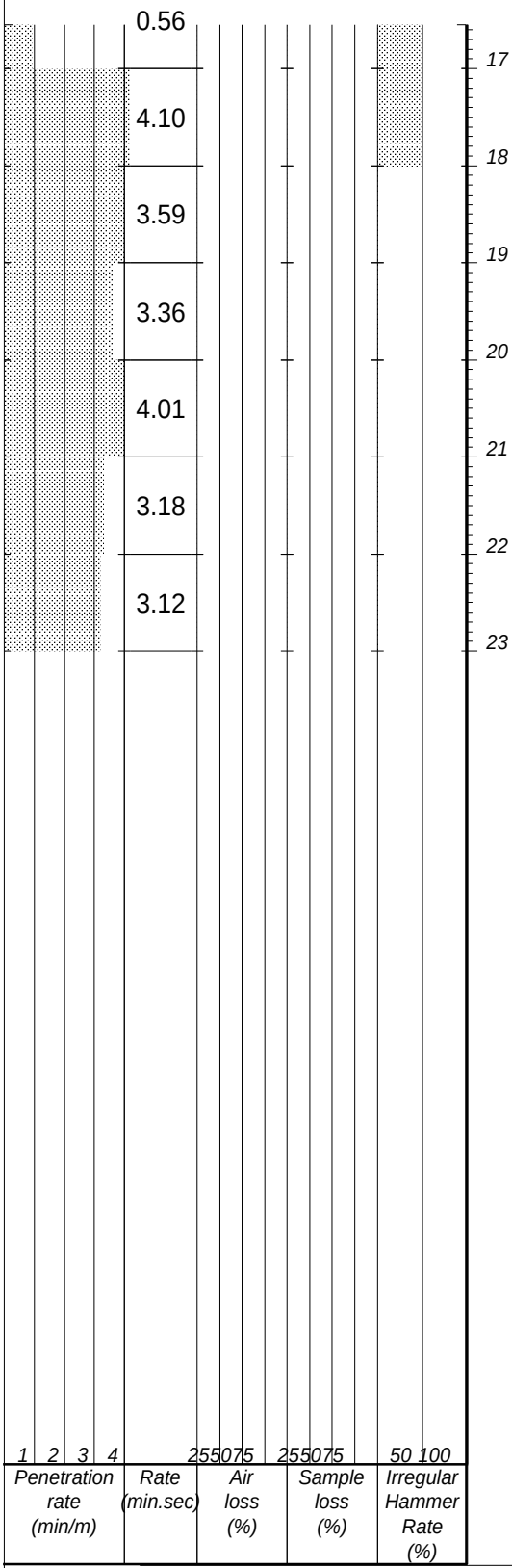

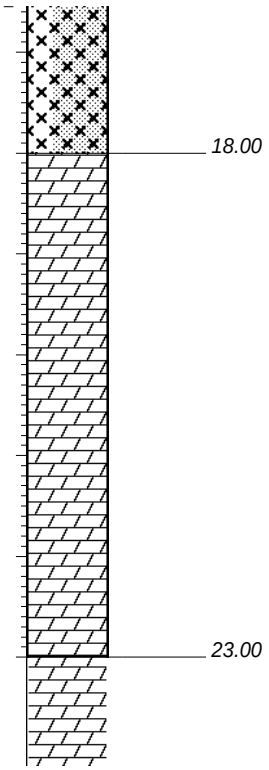

Dark greenish grey speckled white, slightly weathered, hard rock DOLERITE.

Dark grey and grey, slightly weathered, hard rock DOLOMITE.

EOH: Assumed that profile continues as above.

NOTES

1) Water strike at 14.90 m.

2) Water table level measured on SEP-17/2021 at 10.30 m.

3) Collar elevation at time of investigation: 1542 m.

CONTRACTOR : Hennie Erwee Drilling
MACHINE : Super Rock 1000
DRILLED BY : Japhta
PROFILED BY : Deon Bester (114260)

INCLINATION : Vertical
DIAM : 165mm
DATE : 20 Sep 2021
DATE : 20 Sep 2021

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916706.89
Y-COORD : 76370.48

HOLE No: PH8

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

DATE : 22/11/2021 09:34
TEXT : ..1\PROFILES\PEHPERCBH.TXT

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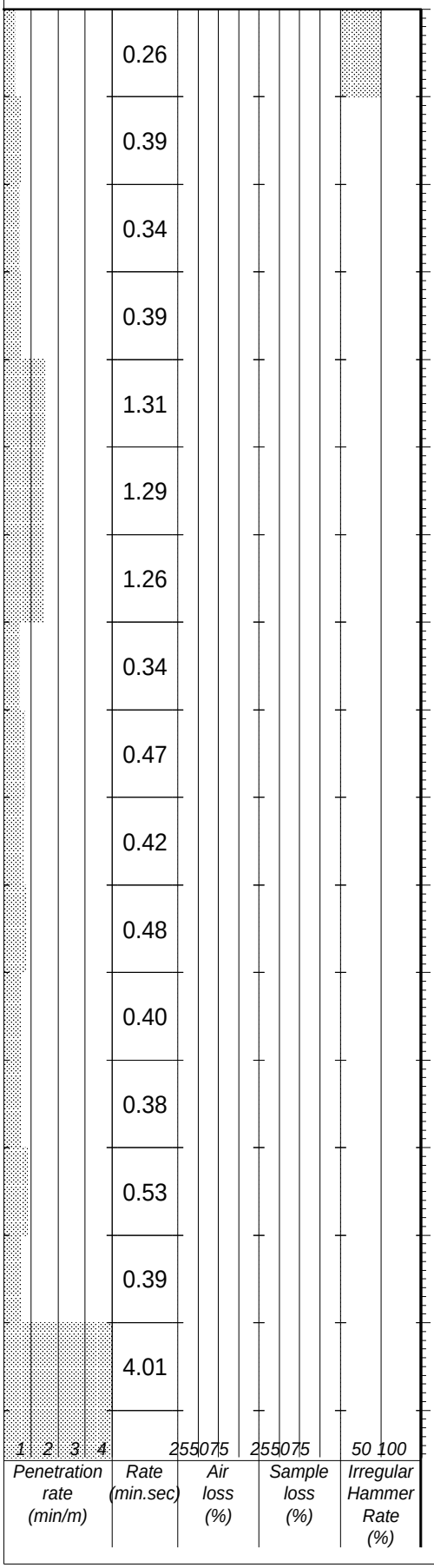
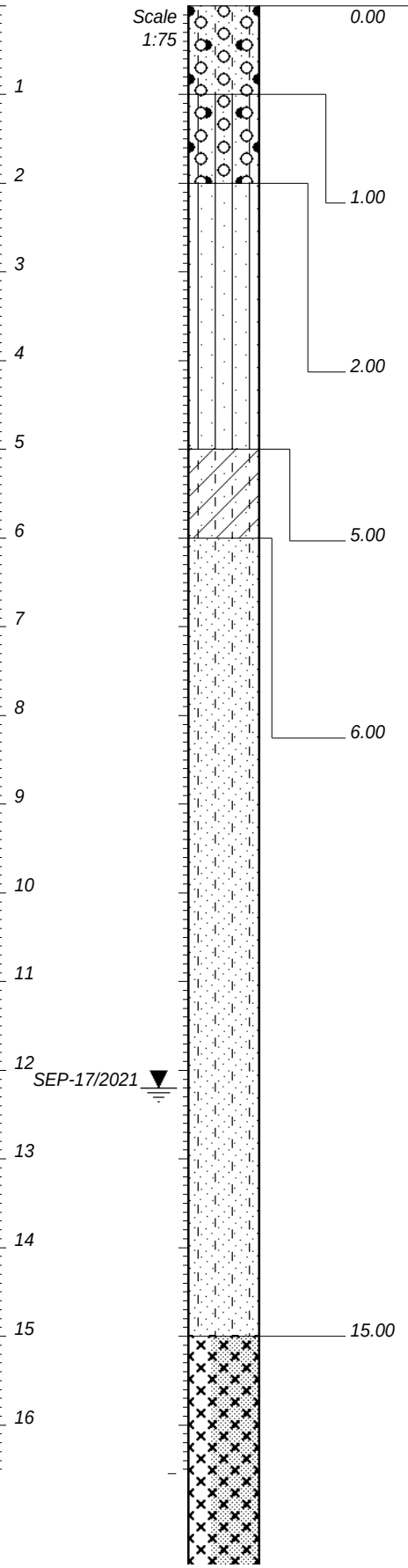
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH9
Sheet 1 of 2

JOB: 3110028872





0.00 – 1.00: Dark brown, slightly clayey silty SAND, with abundant highly weathered, white stained orange chert GRAVEL and rounded FERRICRETE NODULES. **HILLWASH**.

1.00 – 2.00: Medium brown, slightly clayey sandy SILT, with abundant highly weathered chert GRAVEL and FERRICRETE NODULES. Reworked **RESIDUAL DOLERITE**.

2.00 – 5.00: Light yellowish brown, slightly clayey sandy SILT, with minor highly weathered chert gravel and ferricrete nodules. Ferruginised **RESIDUAL DOLERITE**.

5.00 – 6.00: Reddish brown mottled black, sandy silty CLAY, with traces of ferricrete nodules and chert gravel. Interpreted as ferruginised reworked **RESIDUAL DOLERITE** zone within residual dolerite.

6.00 – 15.00: Light olive brown, silty SAND, with traces to minor highly weathered (friable) dolerite. **RESIDUAL DOLERITE**.

Note:
Possibly tends towards very closely jointed and friable soft rock below 10m.

15.00+: Dark grey speckled white, slightly weathered, hard rock DOLERITE.

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RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH9
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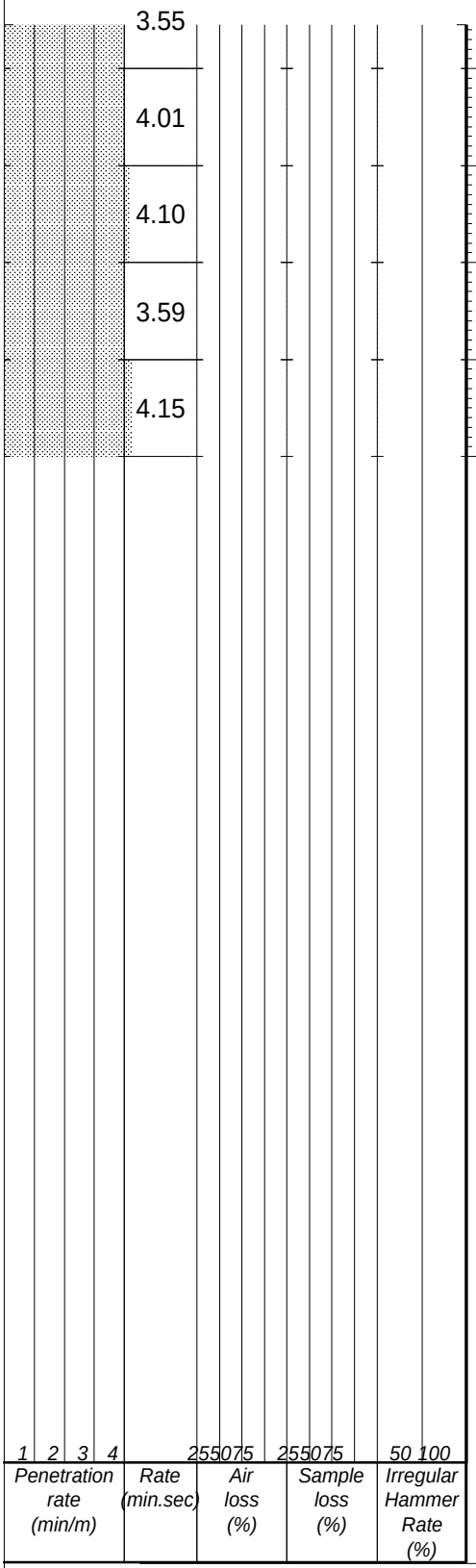
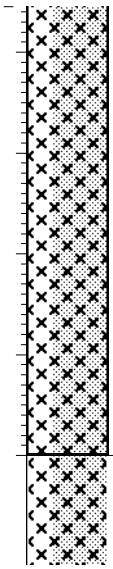
JOB: 3110028872





EOH: Assumed that profile continues as above.

NOTES

1) No water strikes noticed.

2) Water table level measured on SEP-17/2021 at 12.20 m.

3) Collar elevation at time of investigation: 1540.9 m.

CONTRACTOR : Hennie Erwee Drilling
MACHINE : Super Rock 1000
DRILLED BY : Japhta
PROFILED BY : Deon Bester (114260)

INCLINATION : Vertical
DIAM : 165mm
DATE : 17 Sep 2021
DATE : 17 Sep 2021

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916861.72
Y-COORD : 76377.64

HOLE No: PH9

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

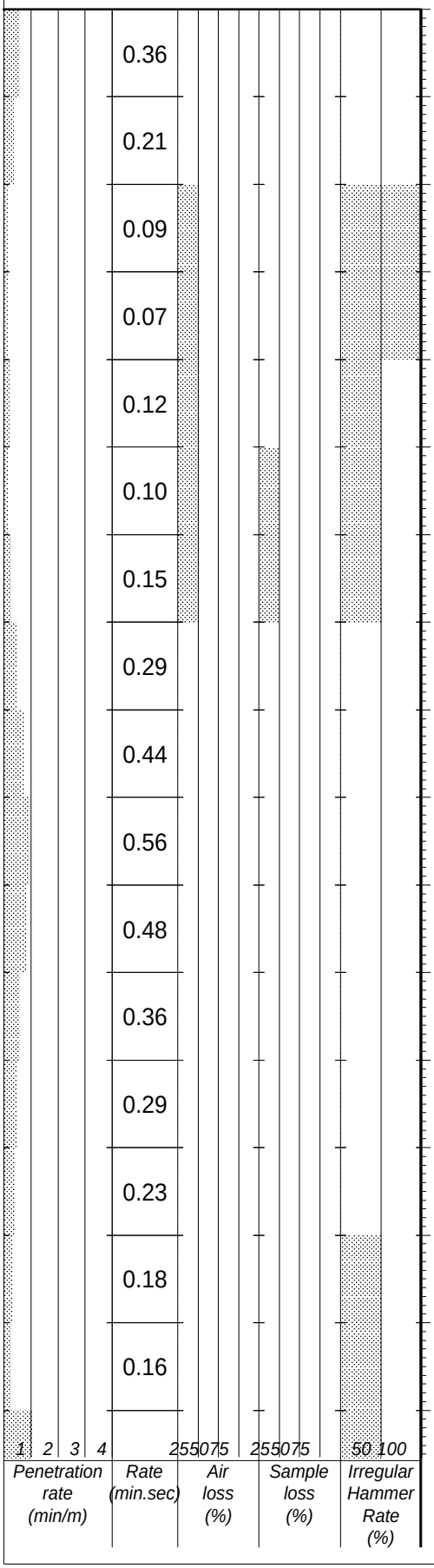
DATE : 22/11/2021 09:34
TEXT : ..1\PROFILES\PEHPERCBH.TXT

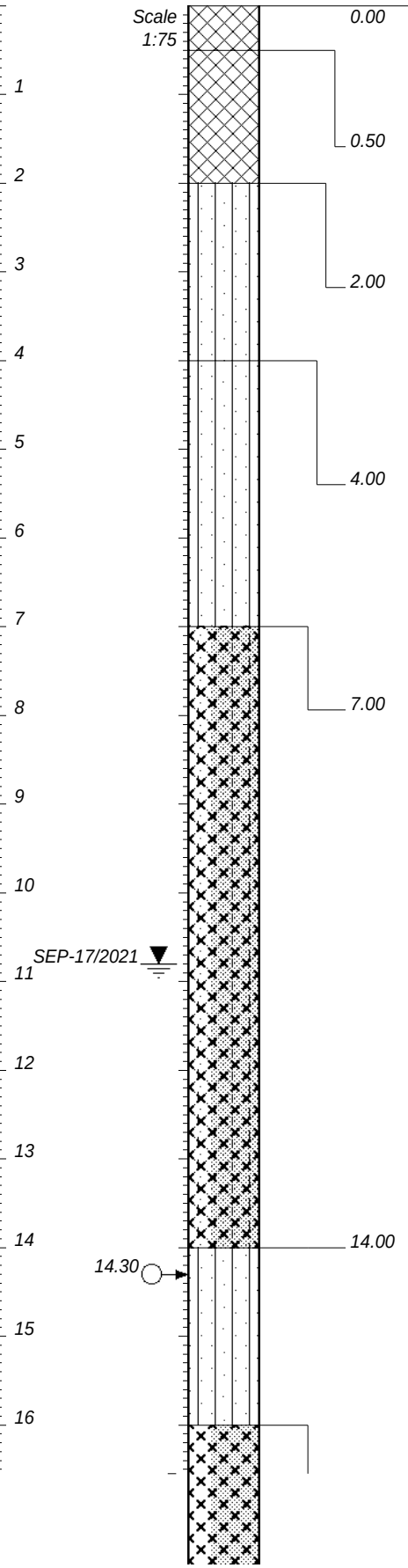
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH10
Sheet 1 of 2

JOB: 3110028872





Dark grey to black, silty SAND, with abundant moderately to slightly weathered dolomite and highly weathered chert. **FILL**.

Light yellow brown, slightly clayey silty SAND, with abundant moderately to slightly weathered chert and slag. **FILL**.

Dark brown, slightly clayey sandy SILT, with minor dark grey stained orange, highly weathered, chert and traces of light yellow brown and black, highly weathered dolerite. Reworked **RESIDUAL DOLOMITE**.

Dark brown, sandy SILT, with minor off-white, highly weathered (altered) chert of talcose appearance and traces of white stained orange, highly weathered chert and dark brown clayey silt (wad). **RESIDUAL DOLOMITE**, near dolerite contact.

Light olive brown, silty SAND, with abundant, highly weathered DOLERITE. Interpreted as highly weathered, friable DOLERITE, possibly very soft to soft rock strength.

RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: **PH10**
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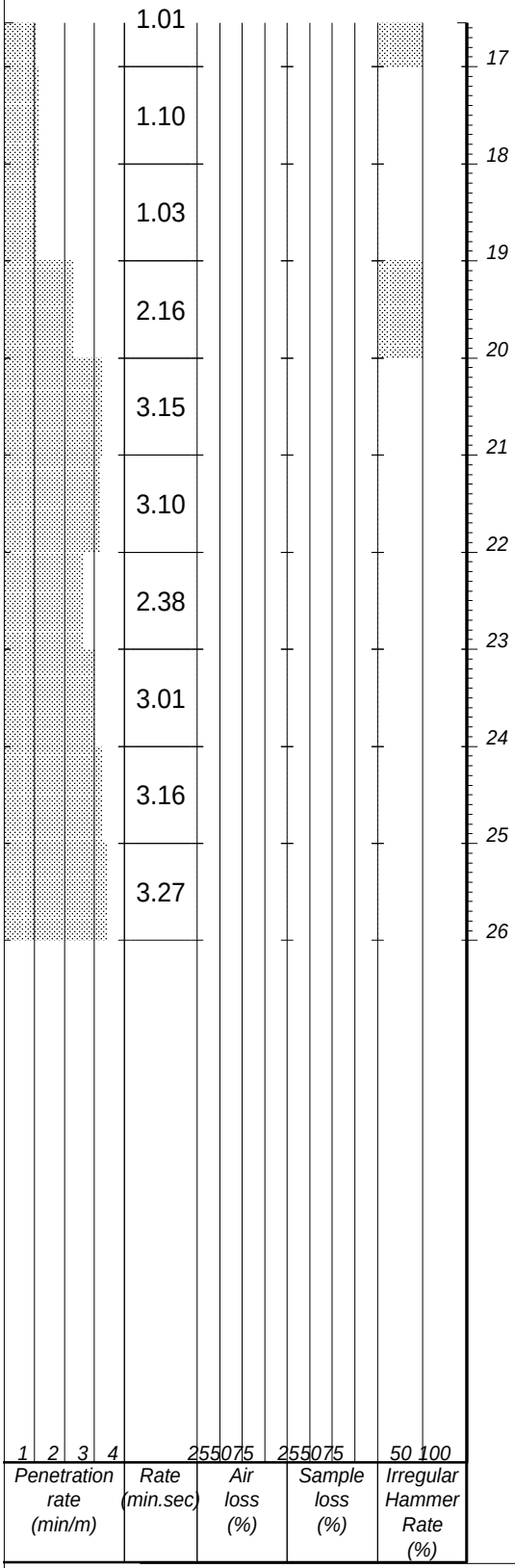
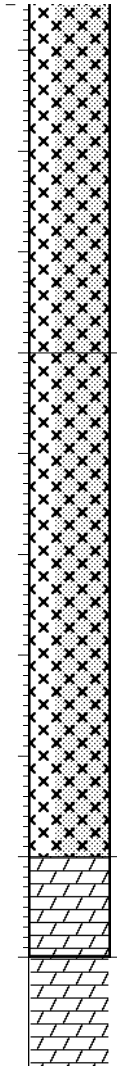
JOB: 3110028872





Dark brown, slightly clayey sandy SILT, with traces of highly weathered dolerite, slightly weathered dolomite, and wad. Interpreted as **RESIDUAL DOLOMITE**, with slightly weathered dolomite band/floater.
Note:
Heavily contaminated with pulverised dolerite from above.

Light olive brown speckled black, highly to moderately weathered, DOLERITE, with minor slightly weathered dolerite below 18.5m.
Note:
Interpreted as predominantly slightly weathered dolerite below 18.5m.

Dark grey speckled white, slightly weathered, hard rock DOLERITE.
Notes:
1. Minor contamination with residual dolomite between 20m and 23m.
2. Minor slightly weathered dolomite between 23m and 24m, interpreted as dolomite band within dolerite bedrock.

Grey and light grey, slightly weathered, hard rock DOLOMITE, with evidence of joint faces stained orange.

EOH: Assumed that profile continues as above.

NOTES

1) Water strike at 14.30 m.

2) Water table level measured on SEP-17/2021 at 10.80 m.

3) Collar elevation at time of investigation: 1547.5 m.

CONTRACTOR : Hennie Erwee Drilling
MACHINE : Super Rock 1000
DRILLED BY : Jack
PROFILED BY : Deon Bester (114260)

INCLINATION : Vertical
DIAM : 165mm
DATE : 20 Sep 2021
DATE : 20 Sep 2021

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916881.86
Y-COORD : 76109.91

HOLE No: **PH10**

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

DATE : 22/11/2021 09:34
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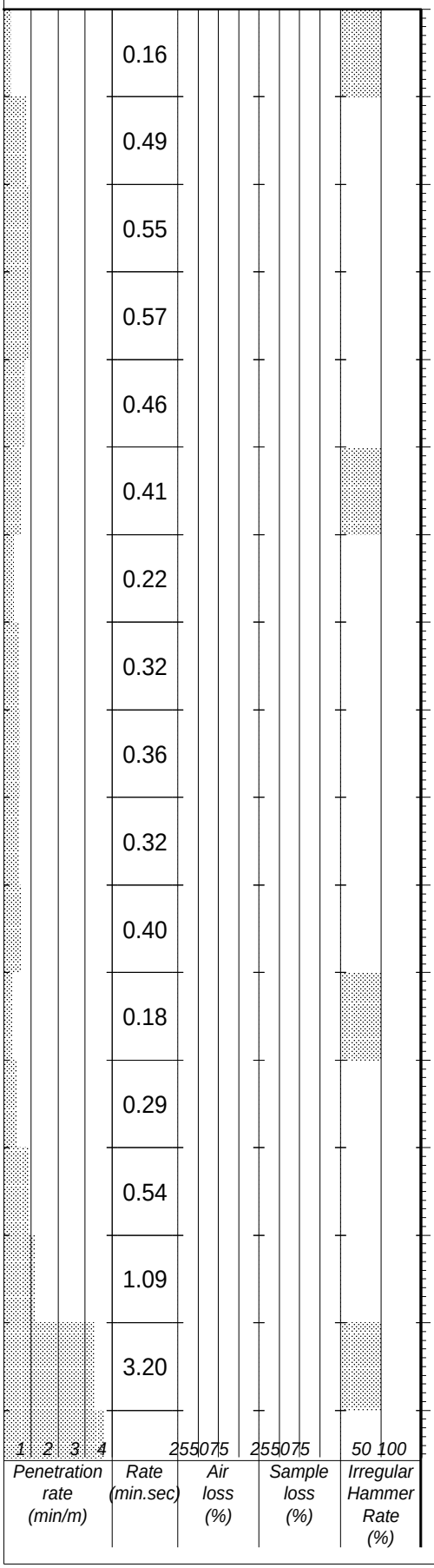
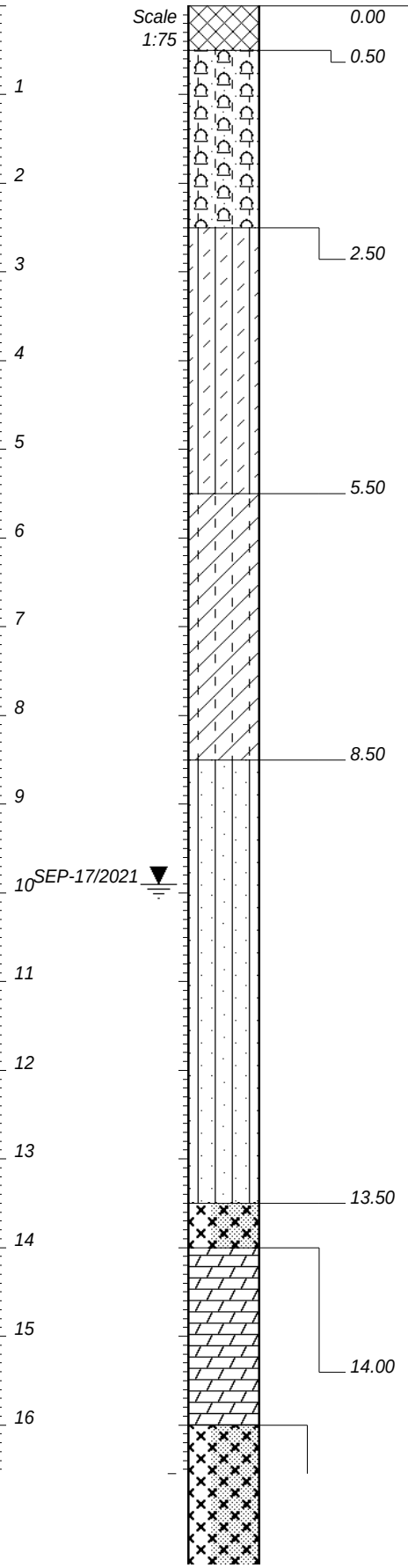
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: PH11
Sheet 1 of 2

JOB: 3110028872





FILL

Reddish brown, silty sandy GRAVEL, comprising highly weathered, white stained orange brown and black CHERT, with minor ferricrete nodules. **HILLWASH**.

Reddish brown mottled black, slightly sandy clayey SILT, with minor ferricrete nodules. Reworked **RESIDUAL DOLERITE**.

Dark brown, slightly sandy silty CLAY, with minor red brown unctuous clay. Traces of highly weathered chert (possibly contamination). **RESIDUAL DOLERITE**. Interpreted that addition of foam altered/blended colours.

Olive brown, sandy SILT, with traces of highly weathered dolerite. **RESIDUAL DOLERITE**.

Dark grey speckled white stained brown, moderately weathered DOLERITE, with minor dark olive brown sandy silt (pulverised material).

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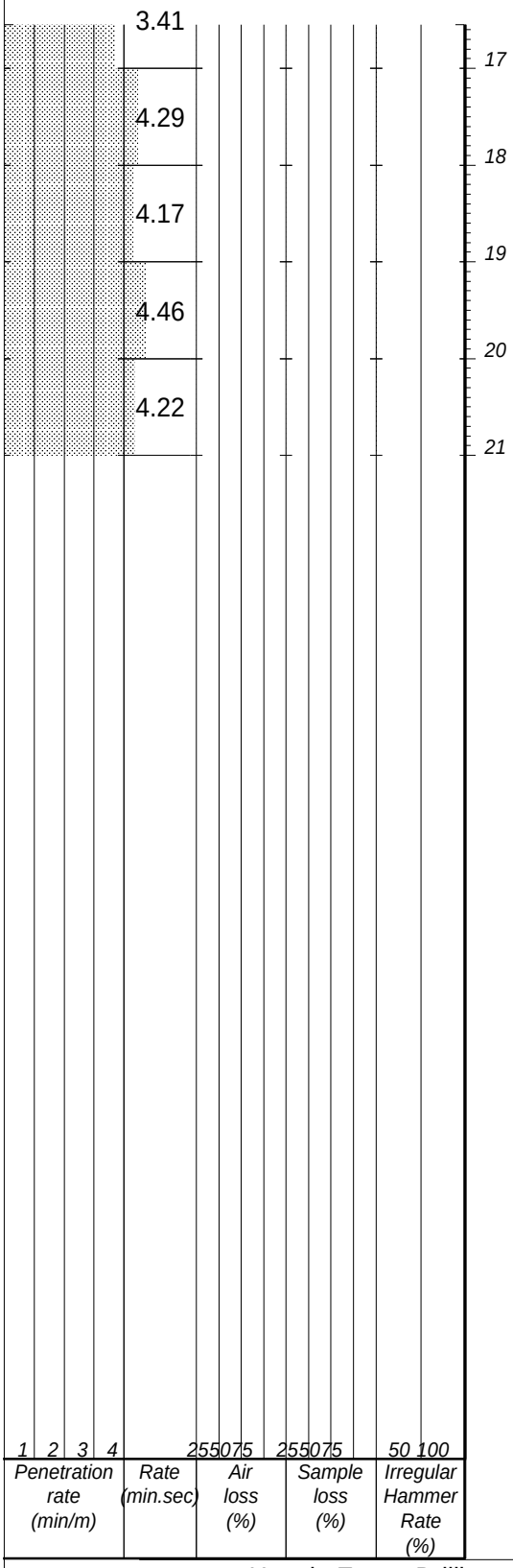
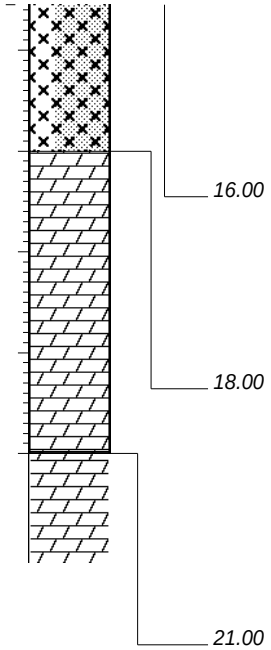
RICHBAY CHEMICALS (PTY) LTD
NEW CHEMICAL PLANT
VOSLOORUS

FEASIBILITY, GEOTECHNICAL AND
DOLOMITE STABILITY INVESTIGATION

HOLE No: **PH11**
Sheet 2 of 2

JOB: 3110028872





Grey and light grey, slightly weathered DOLOMITE.
Note:
Drill response indicates solid formation below 15.3m.

Dark greenish grey speckled white, slightly weathered, hard rock DOLERITE. Interpreted as DOLERITE STRINGER in DOLOMITE BEDROCK.

Grey and light grey, slightly weathered, hard rock DOLOMITE, with traces of slightly weathered chert. Evidence of quartz veins and joint faces-stained orange brown.
Note:
Very slow reaction to acid(HCl).

EOH: Assumed that profile continues as above.

NOTES

1) No water strikes noticed.

2) Water table level measured on SEP-17/2021 at 9.90 m.

3) Collar elevation at time of investigation: 1541.5 m.

CONTRACTOR : Hennie Erwee Drilling
MACHINE : Super Rock 1000
DRILLED BY : Jack
PROFILED BY : Deon Bester (114260)

INCLINATION : Vertical
DIAM : 165mm
DATE : 20 Sep 2021
DATE : 20 Sep 2021

COORDINATE SYSTEM : WGS84 (Lo29)
X-COORD : 2916780.35
Y-COORD : 76352.87

HOLE No: **PH11**

TYPE SET BY : EM
SETUP FILE : KPTP8.SET

DATE : 22/11/2021 09:34
TEXT : ..1\PROFILES\PEHPERCBH.TXT

D079 E Mouton

dotPLOT 7022 PBpH7

APPENDIX D

Laboratory Test Results

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

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

Client Name: Knight Piesold
Project Name: PR311-00288/72: Proposed New Chemical Plant, Vosloorus
Job Number: KNP-34
Date: 04-Nov-21
Method: SANS 3001 GR1, GR3, GR10, GR12 GR20, GR30, GR31, GR40, GR50, GR53, GR54 & BS 1377 (where applicable)

SUMMARY OF TEST DATA

Grading & Hydrometer Analysis (% Passing)

Sample	TP1/1	TP1/2	TP2/1	TP2/2	TP3/1	TP4/1	TP5/1	TP6/1
Depth (m)	2.1 - 3.0	1.0 - 1.4	1.0 - 1.4	1.4 - 2.7	1.9 - 3.1	1.3 - 3.2	1.6 - 2.7	0.85 - 1.5
Lab No	KNP-34-534	KNP-34-535	KNP-34-536	KNP-34-537	KNP-34-538	KNP-34-539	KNP-34-540	KNP-34-541
53.0	**100**	**100**	**100**	**96**	**100**	**90**	**100**	**100**
37.5	**100**	**100**	**100**	**96**	**100**	**90**	**100**	**100**
26.5	**100**	**100**	**100**	**93**	**100**	**90**	**100**	**100**
19.0	**100**	**100**	**100**	**85**	**100**	**89**	**100**	**100**
13.2	**100**	**100**	**99**	**68**	**100**	**88**	**100**	**100**
9.5	**100**	**100**	**98**	**60**	**100**	**86**	**100**	**100**
6.7	**97**	**100**	**96**	**53**	**100**	**83**	**100**	**100**
4.75	**93**	**100**	**95**	**49**	**99**	**79**	**100**	**99**
2.00	**85**	**98**	**92**	**42**	**95**	**68**	**98**	**94**
1.00	**81**	**94**	**90**	**39**	**88**	**63**	**97**	**89**
0.425	**78**	**87**	**85**	**35**	**74**	**58**	**95**	**84**
0.250	**74**	**79**	**81**	**31**	**62**	**55**	**90**	**79**
0.150	**70**	**73**	**77**	**28**	**49**	**51**	**84**	**75**
0.075	**62**	**64**	**72**	**25**	**33**	**45**	**74**	**69**
0.060	**57**	**60**	**68**	**24**	**28**	**42**	**69**	**65**
0.050	**53**	**58**	**65**	**23**	**25**	**40**	**66**	**62**
0.035	**45**	**53**	**60**	**21**	**19**	**37**	**59**	**56**
0.020	**36**	**46**	**54**	**20**	**14**	**33**	**51**	**49**
0.006	**25**	**38**	**42**	**17**	**8**	**27**	**35**	**38**
0.002	**19**	**32**	**37**	**14**	**5**	**22**	**25**	**30**
GM	**0.75**	**0.51**	**0.51**	**1.98**	**0.98**	**1.29**	**0.33**	**0.53**

Atterberg Limits

LL (%)	**42**	**35**	**41**	**38**	**31**	**40**	**54**	**44**
PI (%)	**22**	**18**	**19**	**16**	**8**	**20**	**24**	**20**
LS (%)	**11.0**	**9.5**	**9.5**	**8.5**	**4.0**	**10.0**	**11.0**	**10.5**

pH & Conductivity

pH	**5.7**				**5.5**			
EC (S/m)	**0.022**				**0.022**			

MDD / OMC

MDD (kg/m^3)				**1805**				
OMC (%)				**14.9**				

CBR

100%				**24**				
98%				**22**				
97%				**21**				
95%				**19**				
93%				**16**				
90%				**13**				
Swell (%)				**0.1**				

UCS (MPa)

100%								
97%								
90%								

COLTO Classification

				*				

Remarks: * = Not Classifiable

Specialised Testing Laboratory (Pty) Ltd
Asphalt | Aggregate | Bitumen | Geotechnical
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Project Name: PR311-00288/72: Proposed New Chemical Plant, Vosloorus
Job Number: KNP-34
Date: 04-Nov-21
Method: SANS 3001 GR1, GR3, GR10, GR12 GR20, GR30, GR31, GR40, GR50, GR53, GR54 & BS 1377 (where applicable)

SUMMARY OF TEST DATA

Grading & Hydrometer Analysis (% Passing)

Sample	TP8/1	TP8/2	TP9/1	TP11/1				
Depth (m)	2.2 - 3.2	0.8 - 2.2	2.8 - 3.2	0.7 - 2.6				
Lab No	KNP-34-542	KNP-34-543	KNP-34-544	KNP-34-545				
53.0	**100**	**79**	**100**	**70**				
37.5	**100**	**71**	**100**	**65**				
26.5	**100**	**67**	**98**	**61**				
19.0	**100**	**60**	**95**	**55**				
13.2	**100**	**54**	**94**	**47**				
9.5	**99**	**48**	**92**	**44**				
6.7	**97**	**42**	**90**	**41**				
4.75	**95**	**38**	**89**	**38**				
2.00	**83**	**28**	**79**	**27**				
1.00	**77**	**25**	**75**	**25**				
0.425	**72**	**23**	**70**	**23**				
0.250	**66**	**20**	**65**	**21**				
0.150	**59**	**18**	**59**	**19**				
0.075	**50**	**14**	**45**	**16**				
0.060	**47**	**13**	**39**	**14**				
0.050	**45**	**12**	**37**	**13**				
0.035	**40**	**11**	**33**	**11**				
0.020	**35**	**10**	**30**	**10**				
0.006	**30**	**7**	**25**	**8**				
0.002	**24**	**5**	**22**	**5**				
GM	**0.95**	**2.35**	**1.06**	**2.34**				

Atterberg Limits

LL (%)	**29**	**27**	**31**	**31**				
PI (%)	**14**	**12**	**13**	**15**				
LS (%)	**7.0**	**6.0**	**6.5**	**7.5**				

pH & Conductivity

pH				**5.8**				
EC (S/m)				**0.011**				

MDD / OMC

MDD (kg/m^3)		**2079**		**2012**				
OMC (%)		**8.6**		**9.6**				

CBR

100%		**35**		**42**				
98%		**31**		**36**				
97%		**30**		**33**				
95%		**26**		**27**				
93%		**24**		**21**				
90%		**20**		**14**				
Swell (%)		**0.0**		**0.1**				

UCS (MPa)

100%								
97%								
90%								

COLTO Classification

		G6		**G6**				

Remarks: * = Not Classifiable

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Client Name: Knight Piesold
Project Name: PR311-00288/72: Proposed New Chemical Plant, Vosloorus
Job Number: KNP-34
Date: 2021-11-04
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Sheet Reference: R-STL-011 Rev02

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				Atterberg Limits & Classification			
Sample	TP1/1	TP1/2	TP2/1	Sample	TP1/1	TP1/2	TP2/1
Depth (m)	2.1 - 3.0	1.0 - 1.4	1.0 - 1.4	Depth (m)	2.1 - 3.0	1.0 - 1.4	1.0 - 1.4
Lab No	KNP-34-534	KNP-34-535	KNP-34-536	Lab No	KNP-34-534	KNP-34-535	KNP-34-536
53.0	**100**	**100**	**100**	Liquid Limit (%)	**42**	**35**	**41**
37.5	**100**	**100**	**100**	Plastic Limit (%)	**20**	**17**	**22**
26.5	**100**	**100**	**100**	Plasticity Index (%)	**22**	**18**	**19**
19.0	**100**	**100**	**100**	Linear Shrinkage (%)	**11.0**	**9.5**	**9.5**
13.2	**100**	**100**	**99**	PI of whole sample	**17**	**16**	**16**
9.5	**100**	**100**	**98**				
6.7	**97**	**100**	**96**	% Gravel	**15**	**2**	**8**
4.75	**93**	**100**	**95**	% Sand	**28**	**38**	**24**
2.00	**85**	**98**	**92**	% Silt	**38**	**28**	**31**
1.00	**81**	**94**	**90**	% Clay	**19**	**32**	**37**
0.425	**78**	**87**	**85**	Activity	**1.2**	**0.6**	**0.5**
0.250	**74**	**79**	**81**				
0.150	**70**	**73**	**77**	% Soil Mortar	**85**	**98**	**92**
0.075	**62**	**64**	**72**				
0.060	**57**	**60**	**68**	Grading Modulus	**0.75**	**0.51**	**0.51**
0.050	**53**	**58**	**65**	Moisture Content (%)	**N / T**	**N / T**	**N / T**
0.035	**45**	**53**	**60**	Relative Density (SG)*	**2.65**	**2.65**	**2.65**
0.020	**36**	**46**	**54**				
0.006	**25**	**38**	**42**	Unified (ASTM D2487)	**CL**	**CL**	**CL**
0.002	**19**	**32**	**37**	AASHTO (M145-91)	**A - 7 - 6**	**A - 6**	**A - 7 - 6**

Remarks: *: Assumed
N / T: Not Tested

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Quality | Excellence | On Time

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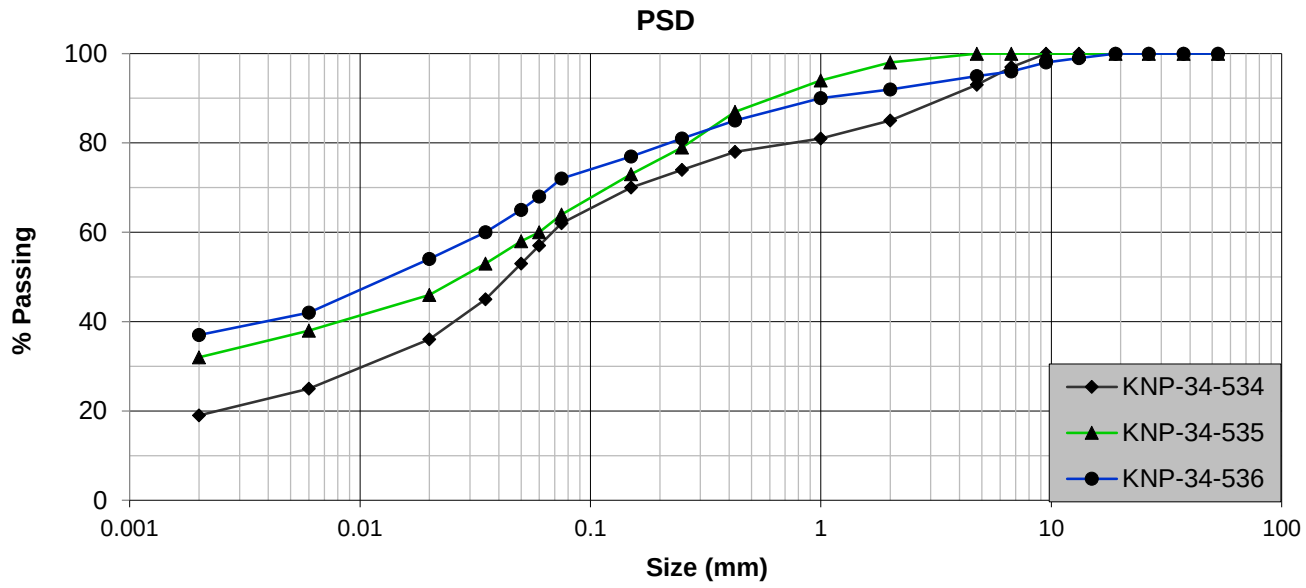
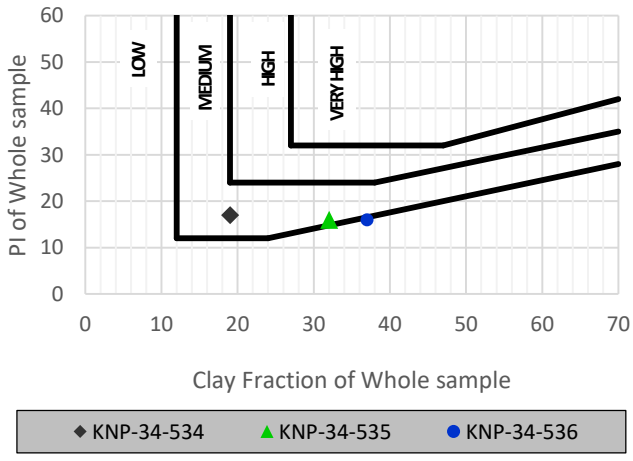
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

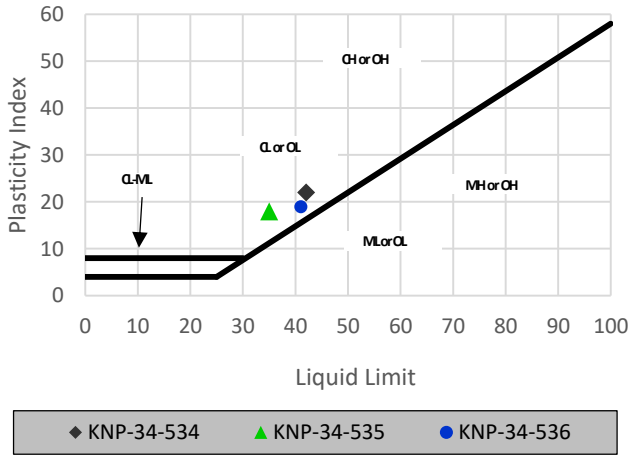
Sheet Reference: R-STL-011 Rev02



Potential Expansiveness



Casagrande Plasticity Chart



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FOUNDATION INDICATOR

Sheet Reference: R-STL-011 Rev02

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				**Atterberg Limits & Classification**			
Sample	TP2/2	TP3/1	TP4/1	Sample	TP2/2	TP3/1	TP4/1
Depth (m)	1.4 - 2.7	1.9 - 3.1	1.3 - 3.2	Depth (m)	1.4 - 2.7	1.9 - 3.1	1.3 - 3.2
Lab No	KNP-34-537	KNP-34-538	KNP-34-539	Lab No	KNP-34-537	KNP-34-538	KNP-34-539
53.0	**96**	**100**	**90**	Liquid Limit (%)	**38**	**31**	**40**
37.5	**96**	**100**	**90**	Plastic Limit (%)	**22**	**23**	**20**
26.5	**93**	**100**	**90**	Plasticity Index (%)	**16**	**8**	**20**
19.0	**85**	**100**	**89**	Linear Shrinkage (%)	**8.5**	**4.0**	**10.0**
13.2	**68**	**100**	**88**	PI of whole sample	**6**	**6**	**12**
9.5	**60**	**100**	**86**				
6.7	**53**	**100**	**83**	% Gravel	**58**	**5**	**32**
4.75	**49**	**99**	**79**	% Sand	**18**	**67**	**26**
2.00	**42**	**95**	**68**	% Silt	**10**	**23**	**20**
1.00	**39**	**88**	**63**	% Clay	**14**	**5**	**22**
0.425	**35**	**74**	**58**	Activity	**1.1**	**1.6**	**0.9**
0.250	**31**	**62**	**55**				
0.150	**28**	**49**	**51**	% Soil Mortar	**42**	**95**	**68**
0.075	**25**	**33**	**45**				
0.060	**24**	**28**	**42**	Grading Modulus	**1.98**	**0.98**	**1.29**
0.050	**23**	**25**	**40**	Moisture Content (%)	**N / T**	**N / T**	**N / T**
0.035	**21**	**19**	**37**	Relative Density (SG)*	**2.65**	**2.65**	**2.65**
0.020	**20**	**14**	**33**				
0.006	**17**	**8**	**27**	Unified (ASTM D2487)	**GC**	**SC**	**SC**
0.002	**14**	**5**	**22**	AASHTO (M145-91)	**A - 2 - 6**	**A - 2 - 4**	**A - 6**

Remarks: *: Assumed
N / T: Not Tested

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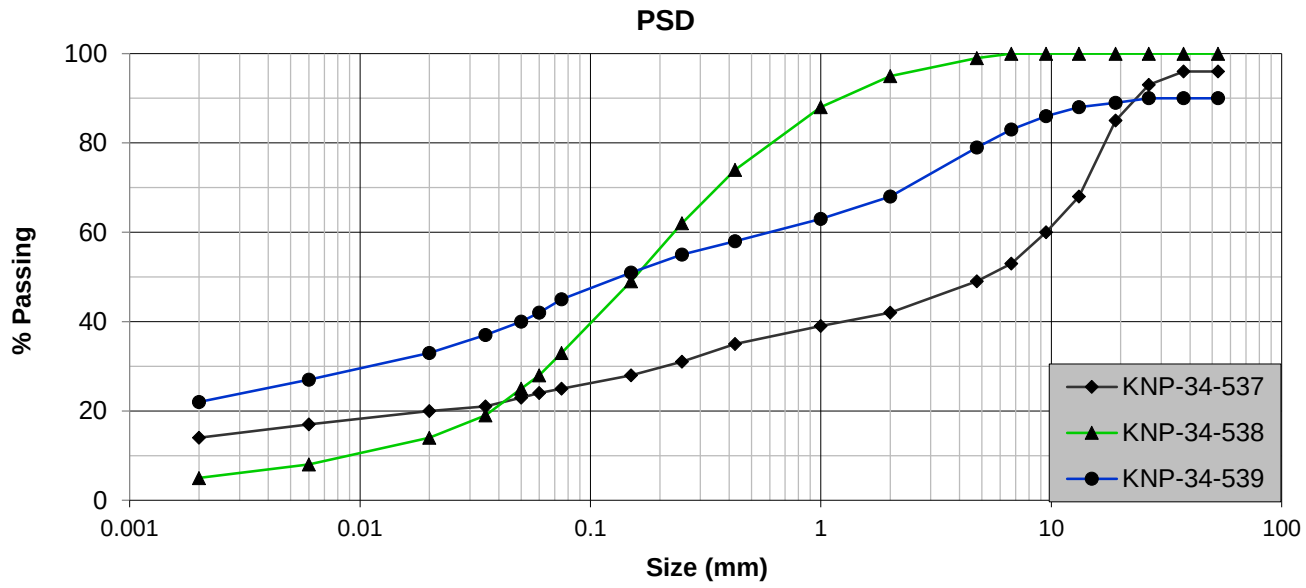
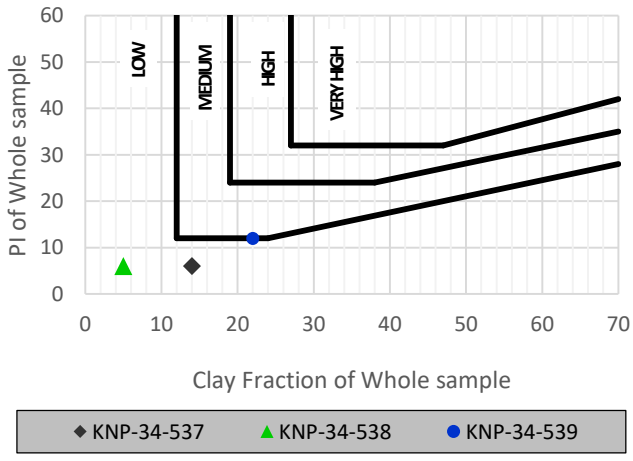
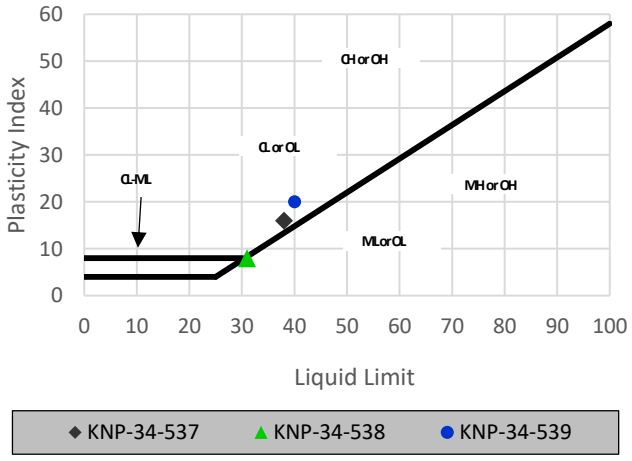


Potential Expansiveness



Casagrande Plasticity Chart



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FOUNDATION INDICATOR

Sheet Reference: R-STL-011 Rev02

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				**Atterberg Limits & Classification**			
Sample	TP5/1	TP6/1	TP8/1	Sample	TP5/1	TP6/1	TP8/1
Depth (m)	1.6 - 2.7	0.85 - 1.5	2.2 - 3.2	Depth (m)	1.6 - 2.7	0.85 - 1.5	2.2 - 3.2
Lab No	KNP-34-540	KNP-34-541	KNP-34-542	Lab No	KNP-34-540	KNP-34-541	KNP-34-542
53.0	**100**	**100**	**100**	Liquid Limit (%)	**54**	**44**	**29**
37.5	**100**	**100**	**100**	Plastic Limit (%)	**30**	**24**	**15**
26.5	**100**	**100**	**100**	Plasticity Index (%)	**24**	**20**	**14**
19.0	**100**	**100**	**100**	Linear Shrinkage (%)	**11.0**	**10.5**	**7.0**
13.2	**100**	**100**	**100**	PI of whole sample	**23**	**17**	**10**
9.5	**100**	**100**	**99**				
6.7	**100**	**100**	**97**	% Gravel	**2**	**6**	**17**
4.75	**100**	**99**	**95**	% Sand	**29**	**29**	**36**
2.00	**98**	**94**	**83**	% Silt	**44**	**35**	**23**
1.00	**97**	**89**	**77**	% Clay	**25**	**30**	**24**
0.425	**95**	**84**	**72**	Activity	**1.0**	**0.7**	**0.6**
0.250	**90**	**79**	**66**				
0.150	**84**	**75**	**59**	% Soil Mortar	**98**	**94**	**83**
0.075	**74**	**69**	**50**				
0.060	**69**	**65**	**47**	Grading Modulus	**0.33**	**0.53**	**0.95**
0.050	**66**	**62**	**45**	Moisture Content (%)	**N / T**	**N / T**	**N / T**
0.035	**59**	**56**	**40**	Relative Density (SG)*	**2.65**	**2.65**	**2.65**
0.020	**51**	**49**	**35**				
0.006	**35**	**38**	**30**	Unified (ASTM D2487)	**CH**	**CL**	**CL**
0.002	**25**	**30**	**24**	AASHTO (M145-91)	**A - 7 - 5**	**A - 7 - 6**	**A - 6**

Remarks: *: Assumed
N / T: Not Tested

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Asphalt | Aggregate | Bitumen | Geotechnical
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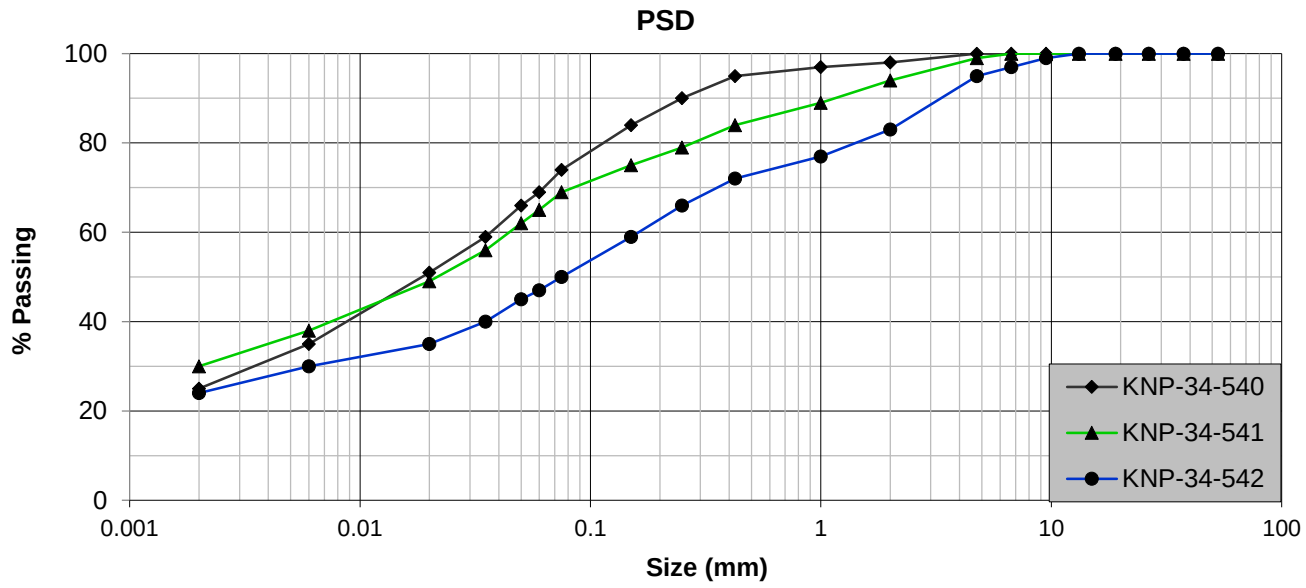
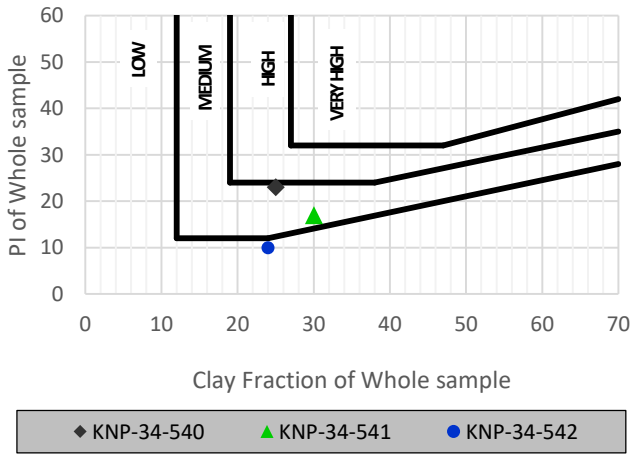
FOUNDATION INDICATOR

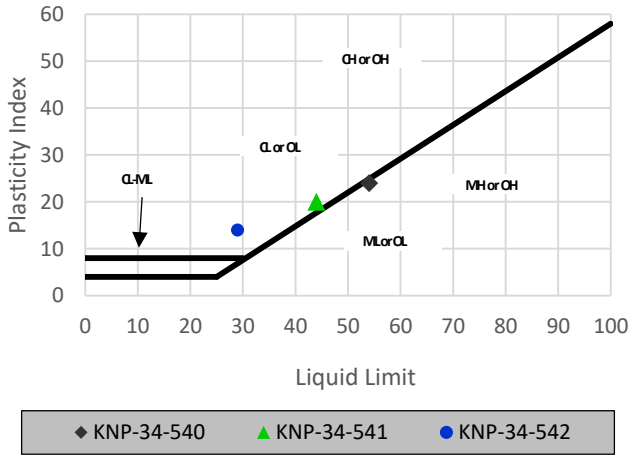
Sheet Reference: R-STL-011 Rev02



Potential Expansiveness



Casagrande Plasticity Chart



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Date: 2021-11-04
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Sheet Reference: R-STL-011 Rev02

Grading & Hydrometer Analysis (Particle Size (mm) & % Passing)				**Atterberg Limits & Classification**			
Sample	TP8/2	TP9/1	TP11/1	Sample	TP8/2	TP9/1	TP11/1
Depth (m)	0.8 - 2.2	2.8 - 3.2	0.7 - 2.6	Depth (m)	0.8 - 2.2	2.8 - 3.2	0.7 - 2.6
Lab No	KNP-34-543	KNP-34-544	KNP-34-545	Lab No	KNP-34-543	KNP-34-544	KNP-34-545
53.0	**79**	**100**	**70**	Liquid Limit (%)	**27**	**31**	**31**
37.5	**71**	**100**	**65**	Plastic Limit (%)	**15**	**18**	**16**
26.5	**67**	**98**	**61**	Plasticity Index (%)	**12**	**13**	**15**
19.0	**60**	**95**	**55**	Linear Shrinkage (%)	**6.0**	**6.5**	**7.5**
13.2	**54**	**94**	**47**	PI of whole sample	**3**	**9**	**3**
9.5	**48**	**92**	**44**				
6.7	**42**	**90**	**41**	% Gravel	**72**	**21**	**73**
4.75	**38**	**89**	**38**	% Sand	**15**	**40**	**13**
2.00	**28**	**79**	**27**	% Silt	**8**	**17**	**9**
1.00	**25**	**75**	**25**	% Clay	**5**	**22**	**5**
0.425	**23**	**70**	**23**	Activity	**2.4**	**0.6**	**3.0**
0.250	**20**	**65**	**21**				
0.150	**18**	**59**	**19**	% Soil Mortar	**28**	**79**	**27**
0.075	**14**	**45**	**16**				
0.060	**13**	**39**	**14**	Grading Modulus	**2.35**	**1.06**	**2.34**
0.050	**12**	**37**	**13**	Moisture Content (%)	**N / T**	**N / T**	**N / T**
0.035	**11**	**33**	**11**	Relative Density (SG)*	**2.65**	**2.65**	**2.65**
0.020	**10**	**30**	**10**				
0.006	**7**	**25**	**8**	Unified (ASTM D2487)	**GC**	**SC**	**GC**
0.002	**5**	**22**	**5**	AASHTO (M145-91)	**A - 2 - 6**	**A - 6**	**A - 2 - 6**

Remarks: *: Assumed
N / T: Not Tested

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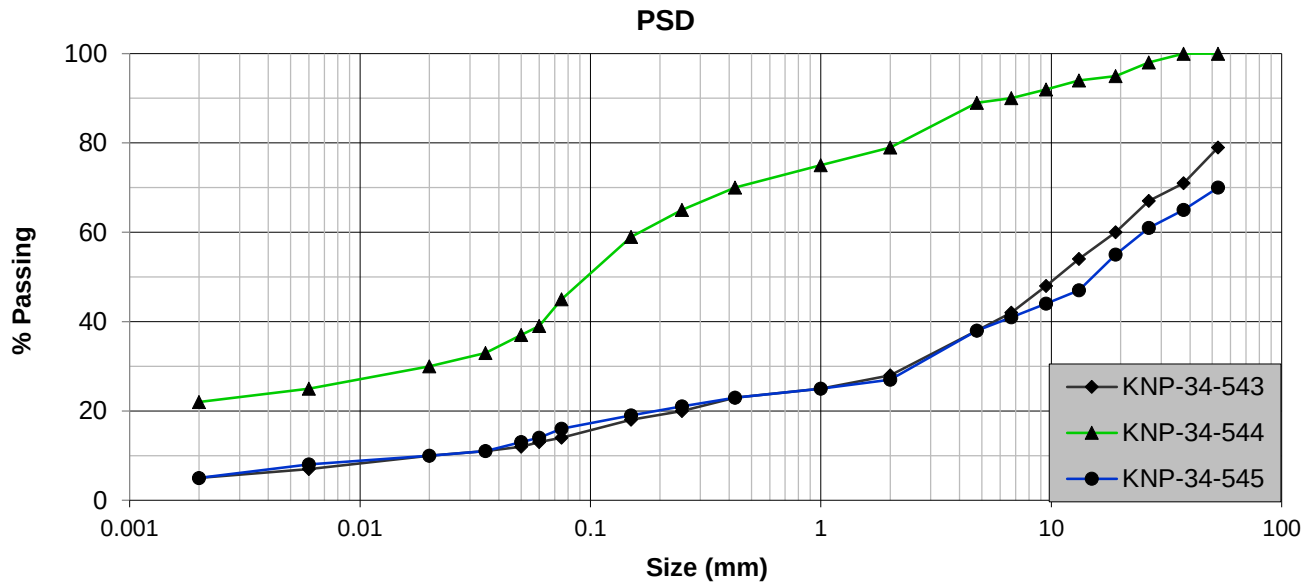
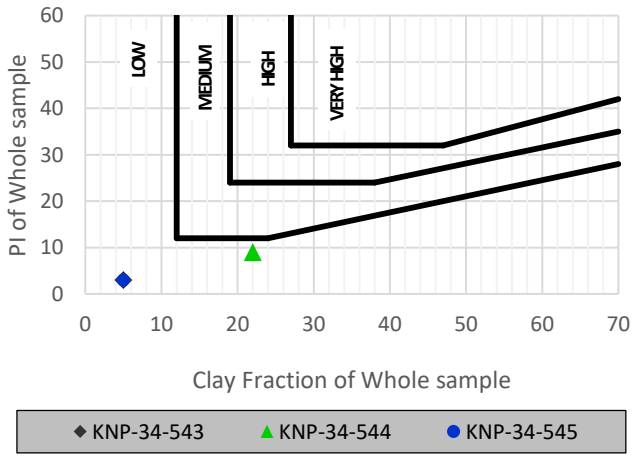
Client Name: Knight Piesold
Project Name: PR311-00288/72: Proposed New Chemical Plant, Vosloorus
Job Number: KNP-34
Date: 2021-11-04
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

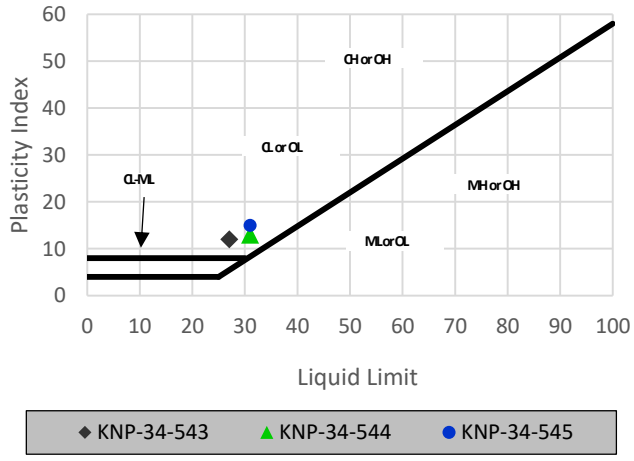
Sheet Reference: R-STL-011 Rev02



Potential Expansiveness



Casagrande Plasticity Chart



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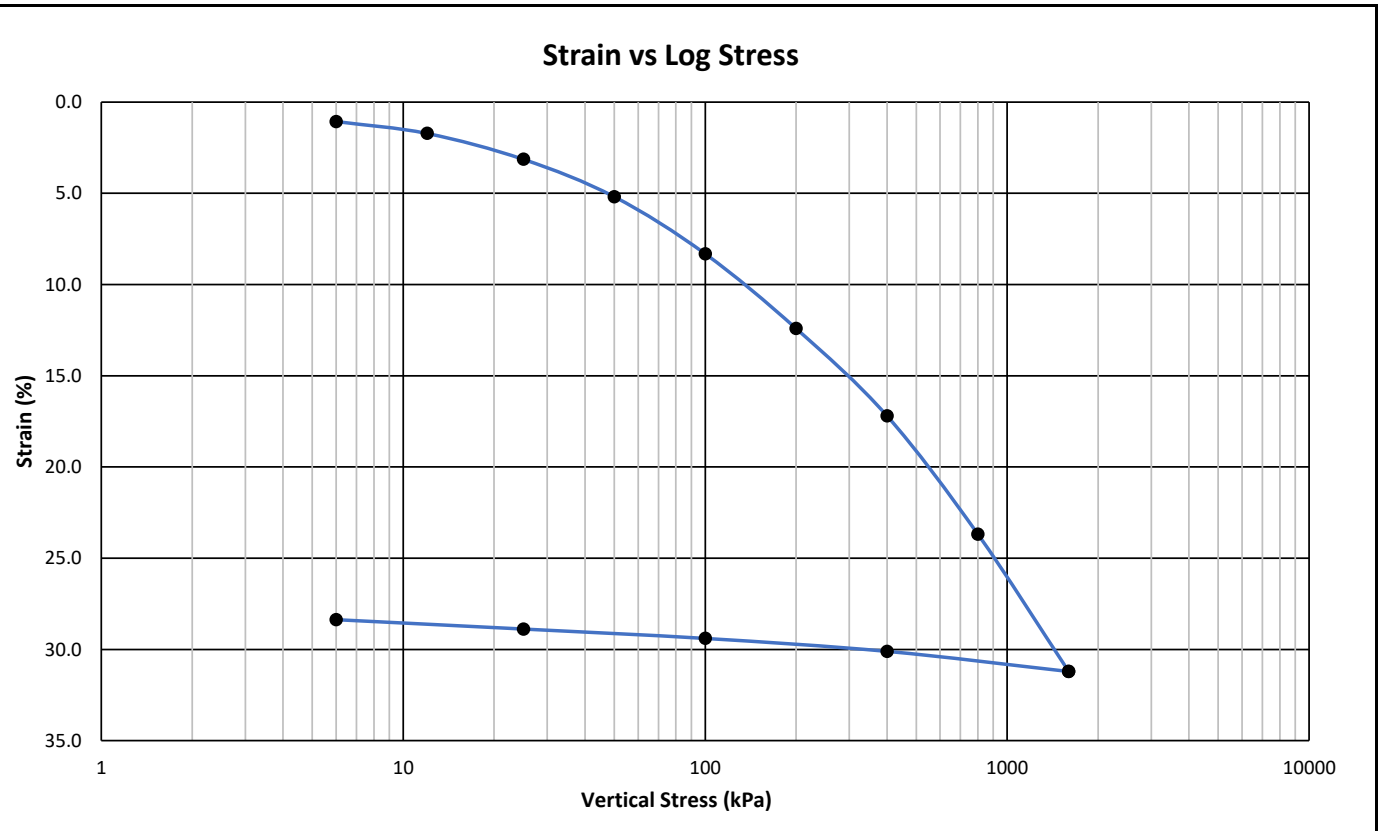
Client Name:	Knight Piesold	**Job Number:**	KNP-34
Project Name:	PR311-00288/72: Proposed New Chemical Plant, Vosloo	**Lab Number:**	KNP-34-535
Sample:	TP1/2	**Method:**	BS 1377 Part 5
Depth: (m)	1.0 - 1.4	**Date:**	04/11/2021

ONE DIMENSIONAL CONSOLIDATION TEST

Sample Info		Unit	Initial	Test Remarks:
Test Specimen Height		mm	25.4	Undisturbed
Moisture Content	Initial	%	15.0	
	Final	%	15.4	
Dry Density		kg/m³	1375	
Void Ratio		-	0.948	
Degree of Saturation		%	42.4	
Relative Density (SG)		-	2.679	Determined

Vertical Stress Applied:	kPa	6	12	25	50	100	200	400	800	1600	400	100	25	6
Load applied for:	Hrs	12	12	12	12	12	12	12	12	12	3	3	3	3
Height after increment	mm	25.13	24.96	24.60	24.08	23.29	22.25	21.03	19.38	17.47	17.75	17.93	18.06	18.19
Total Strain	%	1.07	1.72	3.14	5.19	8.32	12.41	17.20	23.68	31.21	30.11	29.40	28.89	28.37
Void Ratio	-	0.928	0.915	0.887	0.847	0.786	0.707	0.613	0.487	0.340	0.362	0.376	0.386	0.396
Mv (1/Mpa)	-	-	1.102	1.110	0.847	0.660	0.447	0.273	0.196	0.123	0.013	0.034	0.097	0.380



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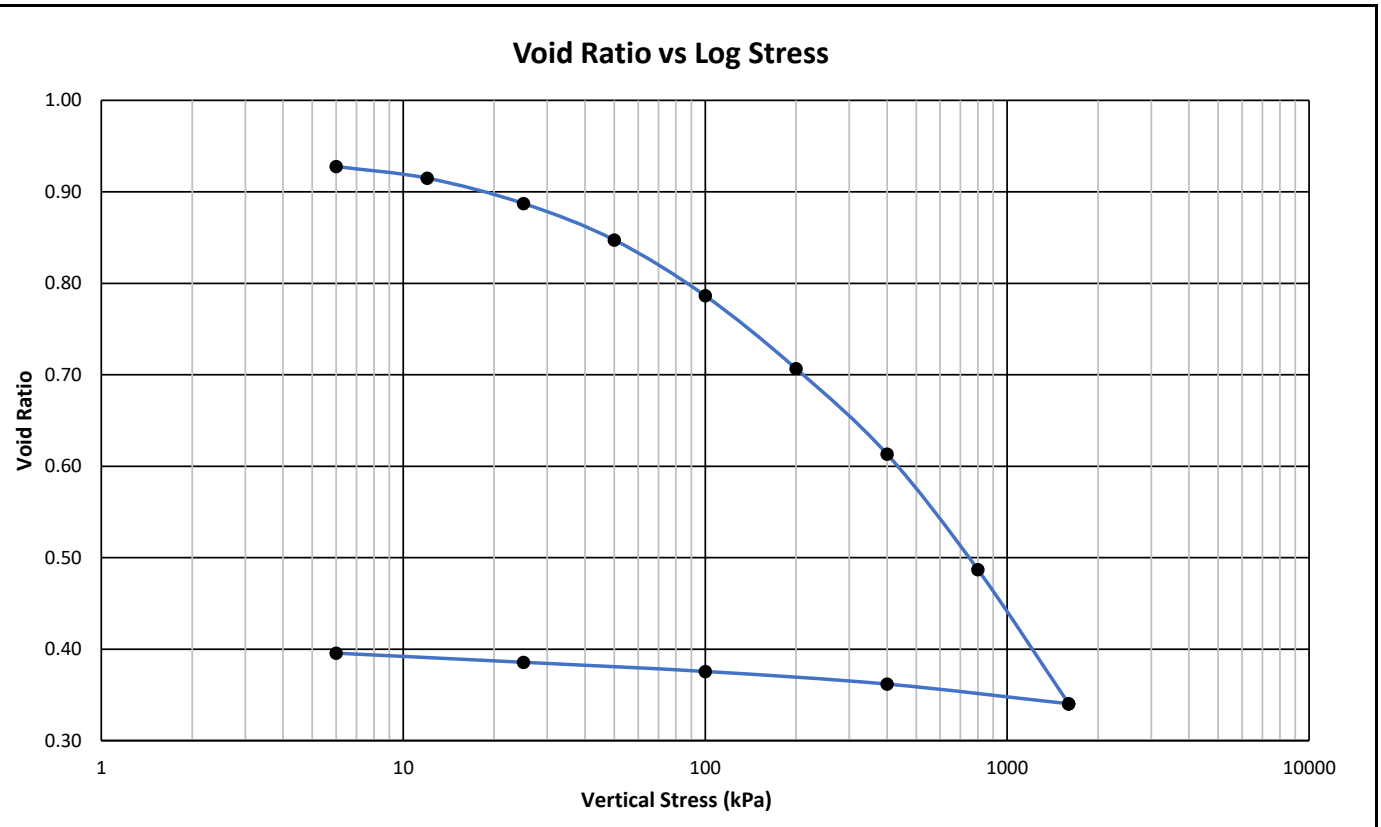
Client Name:	Knight Piesold	**Job Number:**	KNP-34
Project Name:	PR311-00288/72: Proposed New Chemical Plant, Vosloo	**Lab Number:**	KNP-34-535
Sample:	TP1/2	**Method:**	BS 1377 Part 5
Depth: (m)	1.0 - 1.4	**Date:**	04/11/2021

ONE DIMENSIONAL CONSOLIDATION TEST

Sample Info		Unit	Initial	Test Remarks:
Test Specimen Height		mm	25.4	Undisturbed
Moisture Content	Initial	%	15.0	
	Final	%	15.4	
Dry Density		kg/m³	1375	
Void Ratio		-	0.948	
Degree of Saturation		%	42.4	
Relative Density (SG)		-	2.679	Determined

Vertical Stress Applied:	kPa	6	12	25	50	100	200	400	800	1600	400	100	25	6
Load applied for:	Hrs	12	12	12	12	12	12	12	12	12	3	3	3	3
Height after increment	mm	25.13	24.96	24.60	24.08	23.29	22.25	21.03	19.38	17.47	17.75	17.93	18.06	18.19
Total Strain	%	1.07	1.72	3.14	5.19	8.32	12.41	17.20	23.68	31.21	30.11	29.40	28.89	28.37
Void Ratio	-	0.928	0.915	0.887	0.847	0.786	0.707	0.613	0.487	0.340	0.362	0.376	0.386	0.396
Mv (1/Mpa)	-	-	1.102	1.110	0.847	0.660	0.447	0.273	0.196	0.123	0.013	0.034	0.097	0.380



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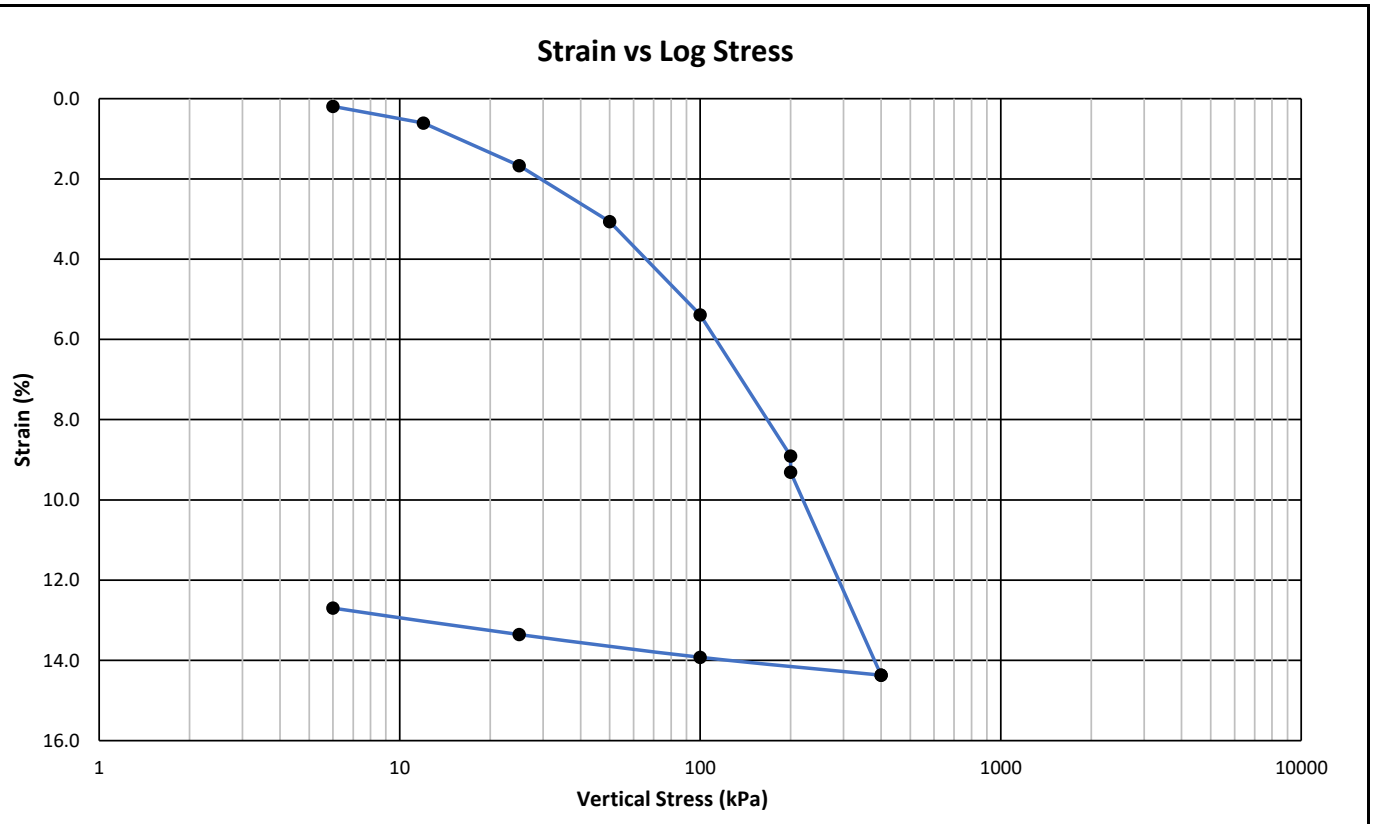
Client Name:	Knight Piesold	**Job Number:**	KNP-34
Project Name:	PR311-00288/72: Proposed New Chemical Plant, Vos	**Lab Number:**	KNP-34-536
Sample:	TP2/1	**Method:**	BS 1377 Part 5
Depth: (mm)	1.0 - 1.4	**Date:**	04-Nov-21

ONE DIMENSIONAL COLLAPSE POTENTIAL TEST

Sample Info		Unit	Initial	Test Remarks:
Test Specimen Height		mm	25.4	**Collapse Potential:** 0.40 %
Moisture Content	Initial	%	24.9	
	Final	%	28.3	
Dry Density		kg/m³	1345	
Void Ratio		-	0.970	
Degree of Saturation		%	67.9	
Relative Density (SG)		-	2.650	Assumed

Vertical Stress Applied:	kPa	6	12	25	50	100	200	200	400	100	25	6		
Load applied for:	Hrs	1	1	1	1	1	1	21	1	1	1	1		
Height after increment	mm	25.35	25.25	24.98	24.62	24.03	23.14	23.04	21.75	21.86	22.01	22.17		
Total Strain	%	0.19	0.61	1.67	3.06	5.39	8.91	9.31	14.37	13.92	13.36	12.70		
Void Ratio	-	0.966	0.958	0.937	0.910	0.864	0.795	0.787	0.687	0.696	0.707	0.720		
Mv (1/Mpa)	-	-	0.691	0.820	0.568	0.480	0.372	-	0.279	0.017	0.088	0.400		



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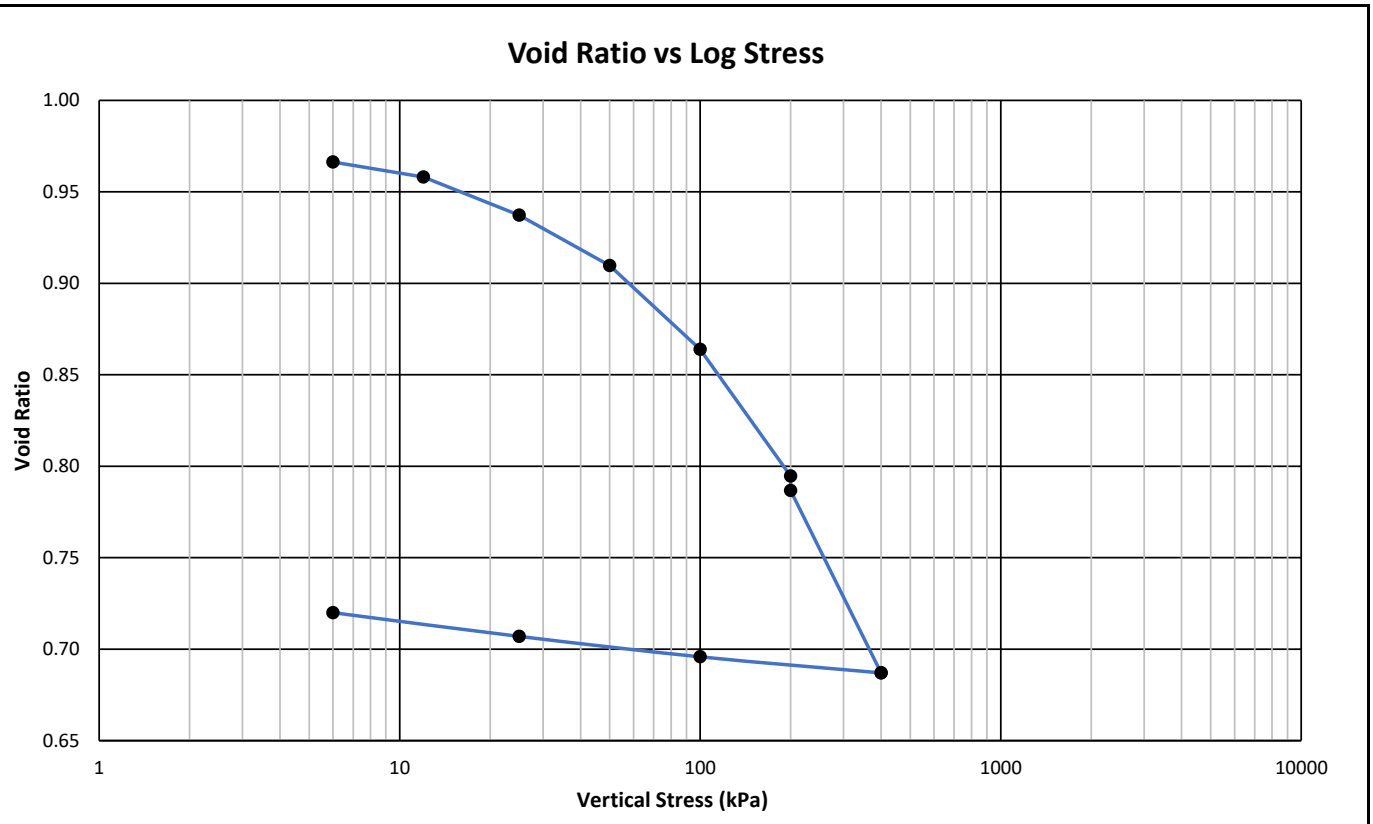
Client Name:	Knight Piesold	**Job Number:**	KNP-34
Project Name:	PR311-00288/72: Proposed New Chemical Plant, Vos	**Lab Number:**	KNP-34-536
Sample:	TP2/1	**Method:**	BS 1377 Part 5
Depth: (m)	1.0 - 1.4	**Date:**	04-Nov-21

ONE DIMENSIONAL COLLAPSE POTENTIAL TEST

Sample Info		Unit	Initial	Test Remarks:
Test Specimen Height		mm	25.4	**Collapse Potential:** 0.40 %
Moisture Content	Initial	%	24.9	
	Final	%	28.3	
Dry Density		kg/m³	1345	
Void Ratio		-	0.970	
Degree of Saturation		%	67.9	
Relative Density (SG)		-	2.650	Assumed

Vertical Stress Applied:	kPa	6	12	25	50	100	200	200	400	100	25	6		
Load applied for:	Hrs	1	1	1	1	1	1	21	1	1	1	1		
Height after increment	mm	25.35	25.25	24.98	24.62	24.03	23.14	23.04	21.75	21.86	22.01	22.17		
Total Strain	%	0.19	0.61	1.67	3.06	5.39	8.91	9.31	14.37	13.92	13.36	12.70		
Void Ratio	-	0.966	0.958	0.937	0.910	0.864	0.795	0.787	0.687	0.696	0.707	0.720		
Mv (1/Mpa)	-	-	0.691	0.820	0.568	0.480	0.372	-	0.279	0.017	0.088	0.400		



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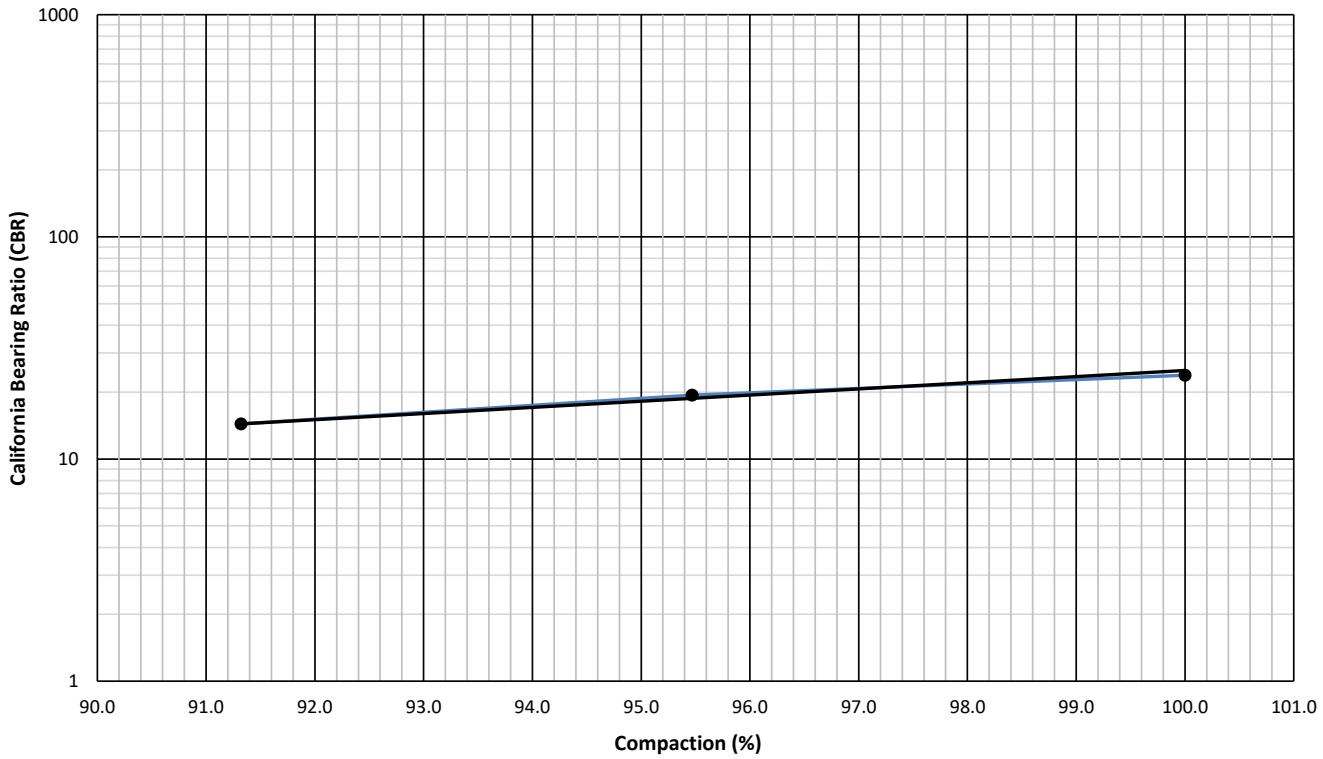
Client Name:	Knight Piesold	**Job Number:**	KNP-34
Project Name:	Proposed New Chemical Plant, Vosloorus	**Lab Number:**	KNP-34-537
Client Project No.:	PR311-00288/72		
Sample:	TP2/2	**Method:**	SANS 3001 GR40
Depth: (m)	1.4 - 2.7	**Date:**	04-Nov-21

CALIFORNIA BEARING RATIO

Sheet Reference: R-STL-014 Rev01

Mod. AASHTO Values		Compaction Data: CBR			Swell	CBR at (mm)			CBR Values	
MDD	OMC	Dry Dens.	MC	Comp.						
(kg/m³)	(%)	(kg/m³)	(%)	(%)	(%)	2.5	5.0	7.5	Compaction (%)	CBR
									100	**24**
1805	14.9	1809	15.6	100.0	0.1	24	26	24	98	**22**
									97	**21**
1805	14.9	1727	15.6	95.5	0.1	19	20	20	95	**19**
									93	**16**
1805	14.9	1652	15.6	91.3	0.2	14	13	12	90	**13**



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Gerrie | 082 309 4448 | gerrie@stlab.co.za
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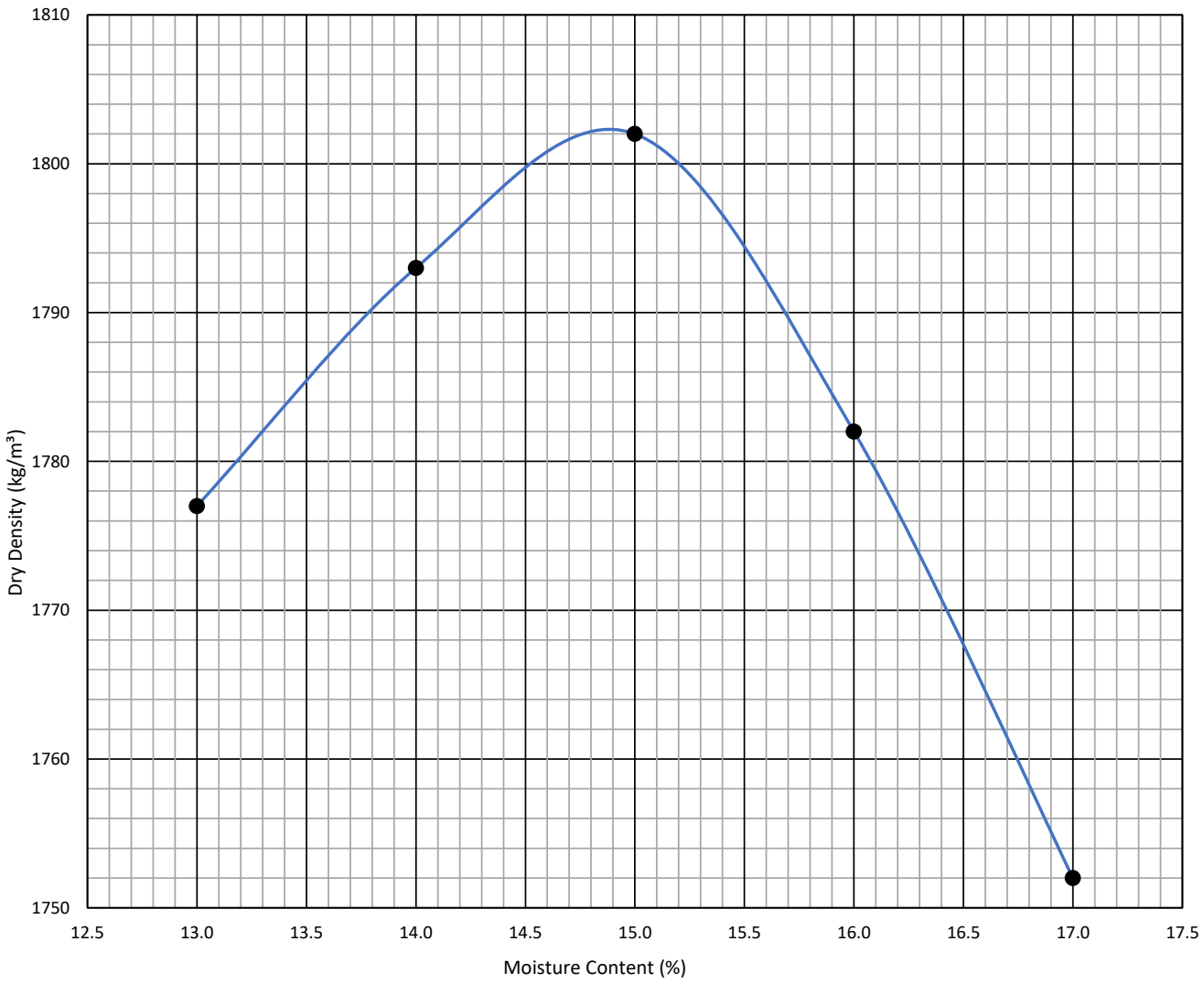
Client Name:	Knight Piesold	**Job Number:**	KNP-34
Project Name:	Proposed New Chemical Plant, Vosloorus	**Lab Number:**	KNP-34-537
Client Project No.:	PR311-00288/72		
Sample:	TP2/2	**Method:**	SANS 3001 GR30
Depth: (m)	1.4 - 2.7	**Date:**	19-Oct-21

MDD & OMC DETERMINATION (Mod. AASHTO)

Sheet Reference: R-STL-013 Rev01

Maximum Dry Density: **1805** kg/m³ Optimum Moisture Content: **14.9** %

Moisture Content (%)	13.0	14.0	15.0	16.0	17.0			
Dry Density (kg/m³)	1777	1793	1802	1782	1752			



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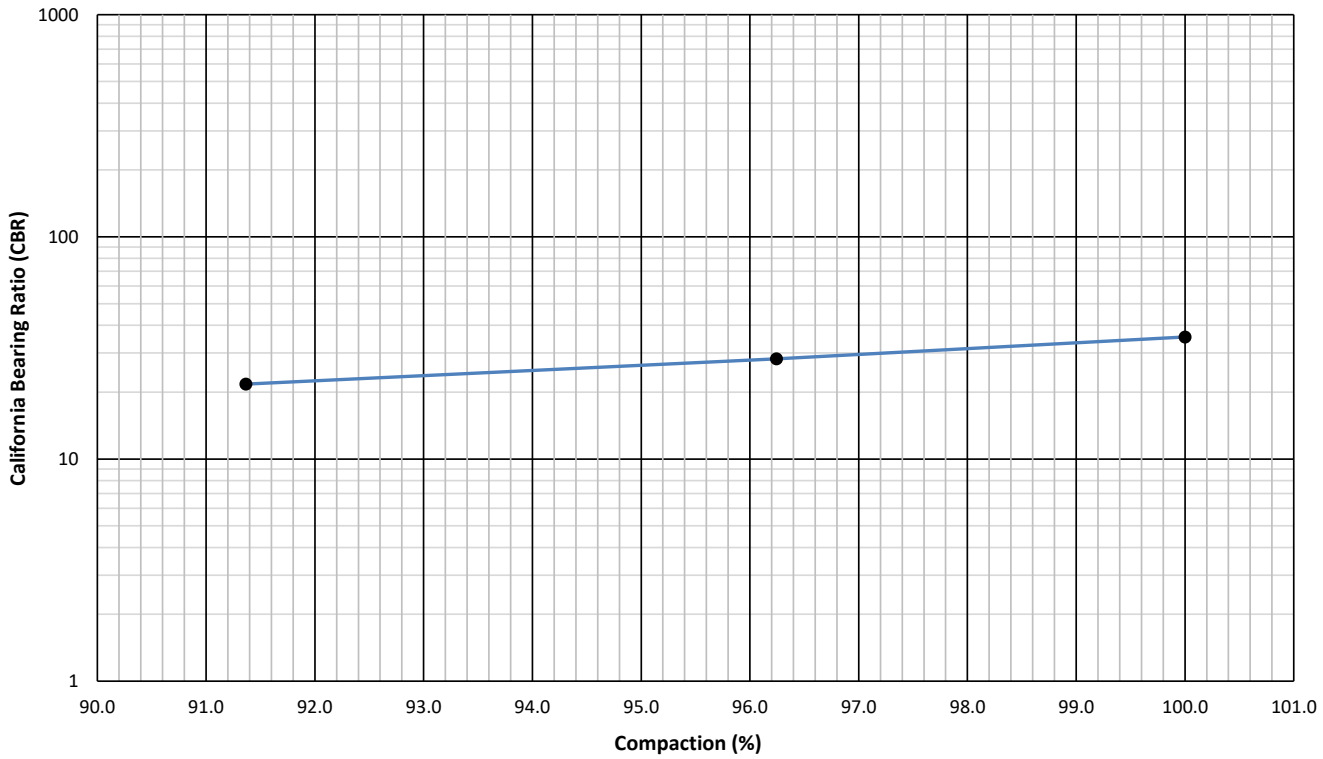
Client Name:	Knight Piesold	**Job Number:**	KNP-34
Project Name:	Proposed New Chemical Plant, Vosloorus	**Lab Number:**	KNP-34-543
Client Project No.:	PR311-00288/72		
Sample:	TP8/2	**Method:**	SANS 3001 GR40
Depth: (m)	0.8 - 2.2	**Date:**	04-Nov-21

CALIFORNIA BEARING RATIO

Sheet Reference: R-STL-014 Rev01

Mod. AASHTO Values		Compaction Data: CBR			Swell	CBR at (mm)			CBR Values	
MDD	OMC	Dry Dens.	MC	Comp.						
(kg/m³)	(%)	(kg/m³)	(%)	(%)	(%)	2.5	5.0	7.5	Compaction (%)	CBR
									100	**35**
2079	8.6	2050	9.3	100.0	0.0	35	41	42	98	**31**
									97	**30**
2079	8.6	1973	9.3	96.2	0.0	28	34	35	95	**26**
									93	**24**
2079	8.6	1873	9.3	91.4	0.0	22	22	20	90	**20**



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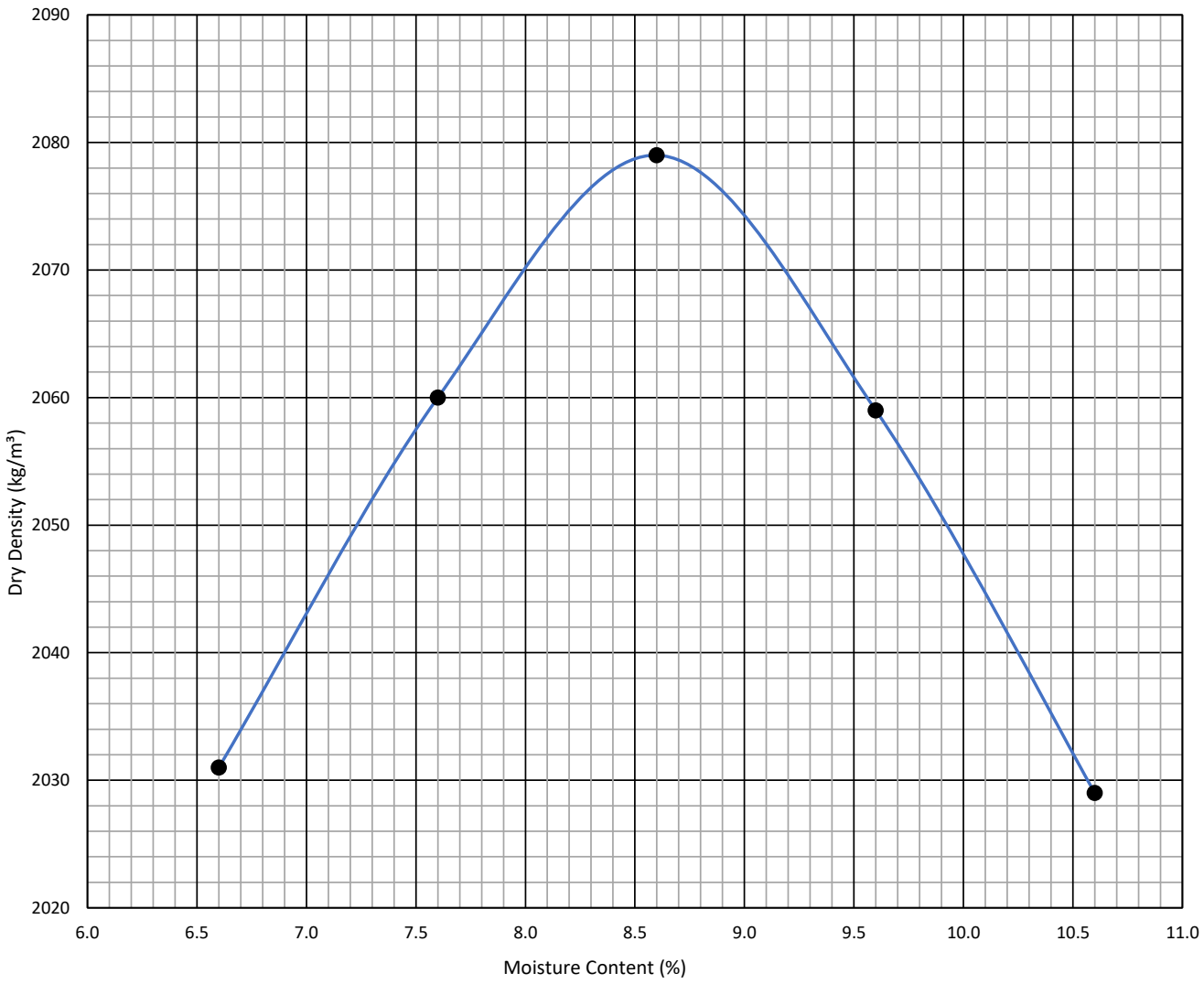
Client Name:	Knight Piesold	**Job Number:**	KNP-34
Project Name:	Proposed New Chemical Plant, Vosloorus	**Lab Number:**	KNP-34-543
Client Project No.:	PR311-00288/72		
Sample:	TP8/2	**Method:**	SANS 3001 GR30
Depth: (m)	0.8 - 2.2	**Date:**	19-Oct-21

MDD & OMC DETERMINATION (Mod. AASHTO)

Sheet Reference: R-STL-013 Rev01

Maximum Dry Density: **2079** kg/m³ Optimum Moisture Content: **8.6** %

Moisture Content (%)	6.6	7.6	8.6	9.6	10.6			
Dry Density (kg/m³)	2031	2060	2079	2059	2029			



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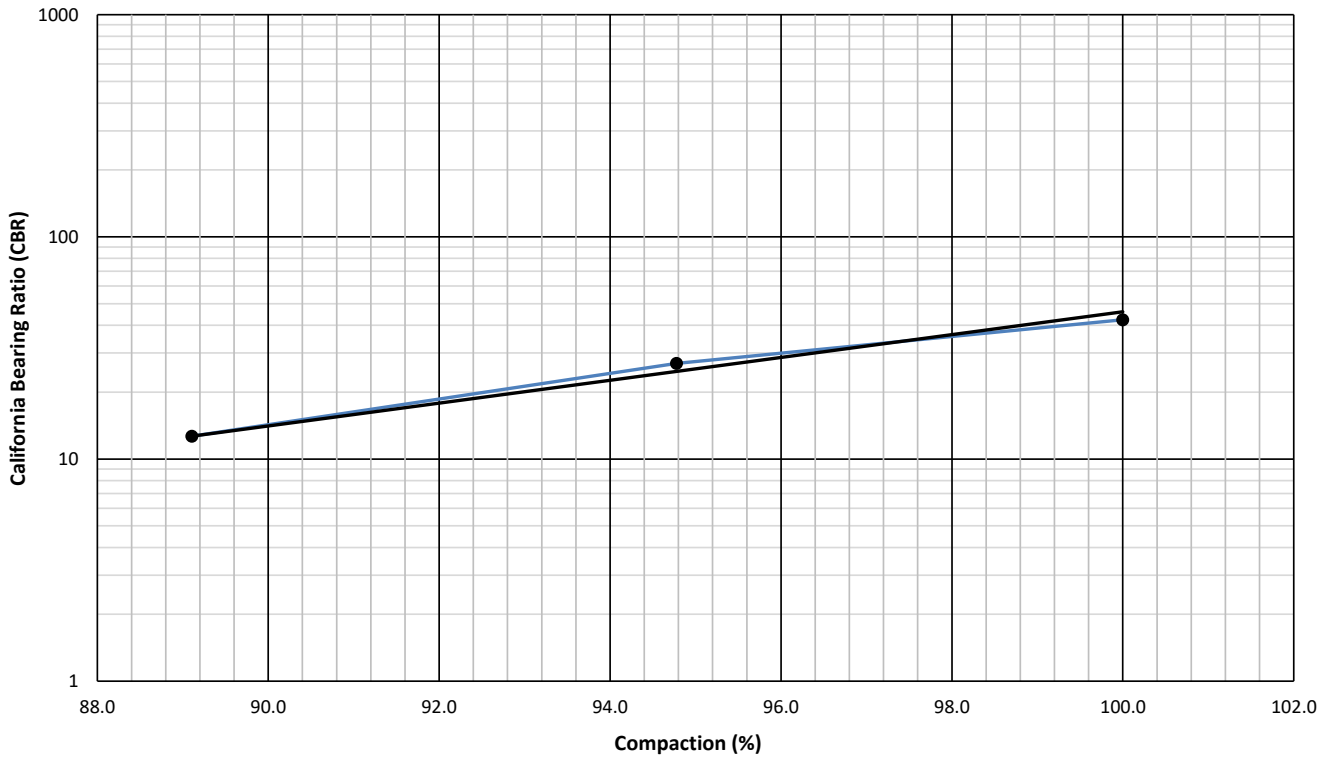
Client Name:	Knight Piesold	**Job Number:**	KNP-34
Project Name:	Proposed New Chemical Plant, Vosloorus	**Lab Number:**	KNP-34-545
Client Project No.:	PR311-00288/72		
Sample:	TP11/1	**Method:**	SANS 3001 GR40
Depth: (m)	0.7 - 2.6	**Date:**	04-Nov-21

CALIFORNIA BEARING RATIO

Sheet Reference: R-STL-014 Rev01

Mod. AASHTO Values		Compaction Data: CBR			Swell	CBR at (mm)			CBR Values	
MDD	OMC	Dry Dens.	MC	Comp.						
(kg/m³)	(%)	(kg/m³)	(%)	(%)	(%)	2.5	5.0	7.5	Compaction (%)	CBR
									100	**42**
2012	9.6	2010	9.3	100.0	0.1	42	48	47	98	**36**
									97	**33**
2012	9.6	1905	9.3	94.8	0.1	27	24	22	95	**27**
									93	**21**
2012	9.6	1791	9.3	89.1	0.2	13	10	8	90	**14**



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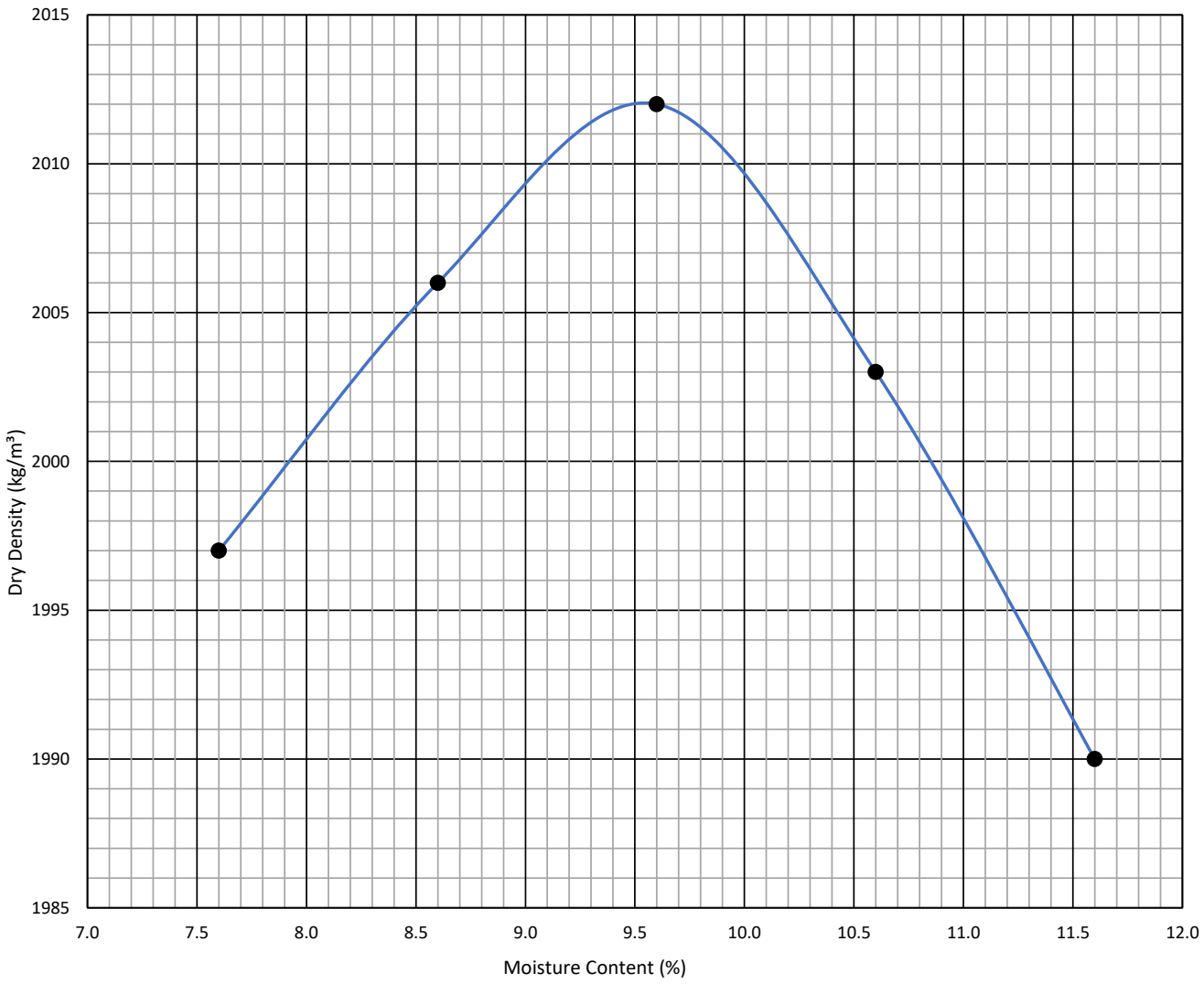
Client Name:	Knight Piesold	**Job Number:**	KNP-34
Project Name:	Proposed New Chemical Plant, Vosloorus	**Lab Number:**	KNP-34-545
Client Project No.:	PR311-00288/72		
Sample:	TP11/1	**Method:**	SANS 3001 GR30
Depth: (m)	0.7 - 2.6	**Date:**	19-Oct-21

MDD & OMC DETERMINATION (Mod. AASHTO)

Sheet Reference: R-STL-013 Rev01

Maximum Dry Density: **2012** kg/m³ Optimum Moisture Content: **9.6** %

Moisture Content (%)	7.6	8.6	9.6	10.6	11.6			
Dry Density (kg/m³)	1997	2006	2012	2003	1990			



APPENDIX E

Report on Gravity Survey Results

GeoFocus
Geophysical Services
Reg: 2016 / 324488 / 07

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Haenertsburg 0730
Limpopo
RSA

gavin@geofocus.co.za (083 478 4345)
bjorn@geofocus.co.za (072 086 9829)

12 October 2021

Knight Piésold

The Boardwalk Office Park
Eros Street
Faerie Glen
Pretoria, 0081

Attn Deon Bester

C 072 879 6797
E dbester@knightpiesold.com

Vosloorus – Waterkloof AFB Sinkhole 1 W

General

This report presents the results of a gravity survey, conducted in support of a dolomitic stability investigation, for Richards Bay Chemicals Vosloorus chemical plant located between the N3 and R103. Theo work was done on behalf of Knight Piésold.

A total of 242 gravity stations were acquired on a 20m grid covering roughly 8ha, in mid-September 2021.

Methodology

Gravity was observed with a Scintrex CG5 automated gravimeter in conjunction with a high resolution GNNS (RTK) GPS, the latter is used to record accurate station locations. The topography of the site sloped very gently from E to W (Figure 1).

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

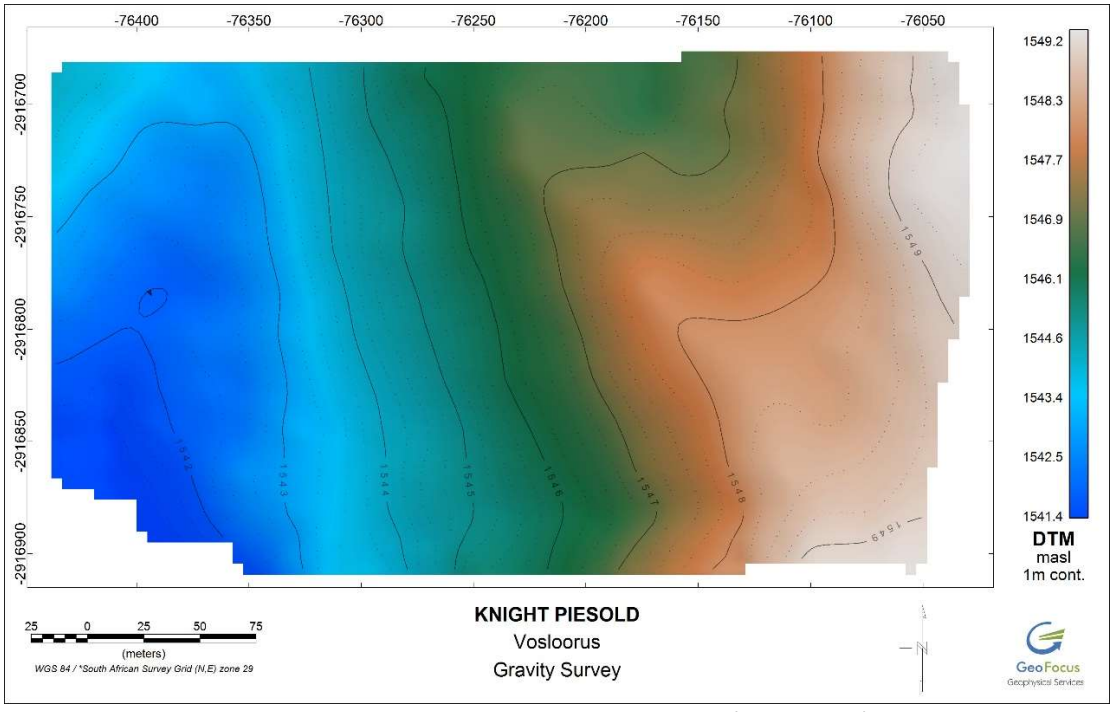

***Figure 1**: Elevation map & sinkhole outline (white dash)*

Results

The residual gravity results fall within a peak-to-peak envelope of circa 0.3 mGal. The results are typified by irregular highs in the extreme E and central W, the latter displaying a NW-SE orientation. The high straddle a broad low integrating multiple smaller lows. A gentle gradient is seen to the far W.

Eleven [11] boreholes were drilled across the site (Figure 2).

Borehole PH01 intersected dolomite from near surface to 12m with the formation becoming hard at 6m deep; it is to this depth that the residual gravity was corrected. Dolerite was intersected in horizons of varying thickness (up to several meters thick) and/or as the end-of-hole lithology.

Notwithstanding the highly variable geology and dolerite present, the hard-rock intersections correlate broadly with the residual gravity; bedrock is shallowest over the gravity high in the NW, dipping over the broad central low to between 16m (PH3) and 22m (PH5), thereafter it rises very slightly to 14m (PH4) in the central S. Hard-rock intersections of between 15m and 17m are observed to the NW.

Although influenced to a great degree by the presence of dolerite, the gravity results still give a fair reflection of the changes in bedrock depth.

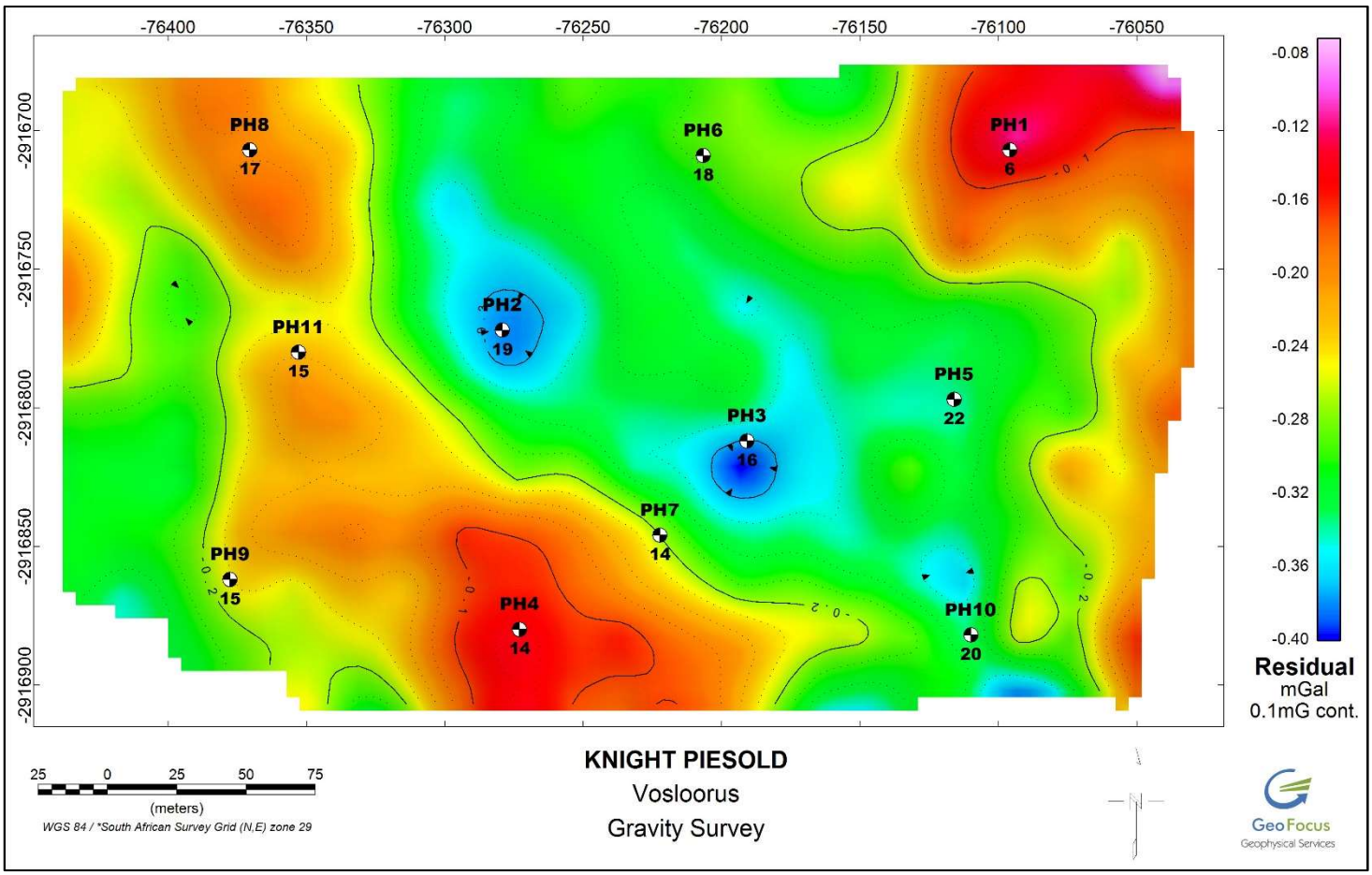

***Figure 2**: Residual gravity & drilling results. The dephts indicated are to competent formation.*