Geotechnical Report for
MEYERTON WWTW UPGRADE

Gauteng

REPORT TO

MSA Group Environmental

BY ***Vela VKE*** Consulting Engineers

GEOTECHNICAL DIVISION

REPORT NO.: PJ096/KJP/2012/03/ 2371 **May 2012**

CONTENTS

1. INTRODUCTION AND TERMS OF REFERENCE

1.1. Scope

VelaVKE has been appointed by MSA Group Environmental to undertake a geotechnical investigation at the existing waste water treatment works in Meyerton. The objective of the study was to establish the soil properties and foundation characteristics for proposed upgrades on the facility to facilitate a 15Ml/day capacity increase to the existing plant.

This report presents the findings of the investigation that deals with the shallow foundation conditions and dolomite stability on the site.

1.2. Terms of Appointment

The work was carried out in accordance to our quote, Quote 313, dated 14 February 2011 and the e-mailed instruction to proceed from Mr D Muruven, dated 14 July 2011. As the investigation followed the environmental studies, actual commencement of the work was delayed to December 2011, at which time the work was carried out according to Quote 313b, which included additional work, incorporating various proposed structural and civil engineering works.

1.3. Aims and Methodology

The objectives of the study are:

- To analyse the geotechnical conditions present, assess the general suitability of the site and to make recommendations for site works for the proposed development.
- To provide foundation recommendations for the proposed development and to comment on geotechnical factors that would have an impact on the development of the site to enable economic design and construction of the proposed development
- To identify relevant ground-related features and determine the variability of ground conditions and the effect of such variability on the proposed development
- To assess the dolomite stability for the site.

The following methodology was adopted to realise the aims of the study:

- Review of available geological records and site plans.
- Undertaking of a geotechnical site investigation including TLB excavated trial pits to profile soils, investigate soil strengths/capacities and identify potential problem soils on site.
- Undertake percussion drilling to investigate the dolomitic conditions on site

- Undertaking of in situ (DPL) and laboratory testing to establish geotechnical and design parameters of the soils.
- Identification of relevant ground-related features and their influence on the proposed development.

1.4. Limitations of Assessment

The services performed by ***Vela VKE*** were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession practising under similar conditions in the locality of the project. Variations in what is reported here may become evident during construction and it is thus imperative that a Competent Person inspects all excavations to ensure that conditions at variance with those predicted do not occur and to undertake an interpretation of the facts supplied in this report.

Limitations of the report are discussed in Appendix A. These limitations further explain the realities of geotechnical engineering and the limitations that exist in evaluating geotechnical issues.

This report has been prepared for the exclusive use of the client, with specific application to the proposed project.

2. INFORMATION ON THE SITE

2.1. Information Sources

The following sources were consulted and/or made available;

- Geological Map, Sheet 2626 East Rand at a scale of 1:250 000
- Site plan, showing the location of the proposed upgrades
- Published technical references (listed in Section 7 of this report)

2.2. Site Location

The Meyerton Waste Water Treatment Works (WWTW) is situated about 2km west of the R59, and just east of a brick factory and clay mine within an industrial area (Meydustria), in the south west of Meyerton CBD, located within the Midvaal Local Municipality, Gauteng. This site has approximate GPS co-ordinates of 26°35'0.00"S and 27°58'22.00"E. The site location and layout is given below as Diagram 2.1 below.

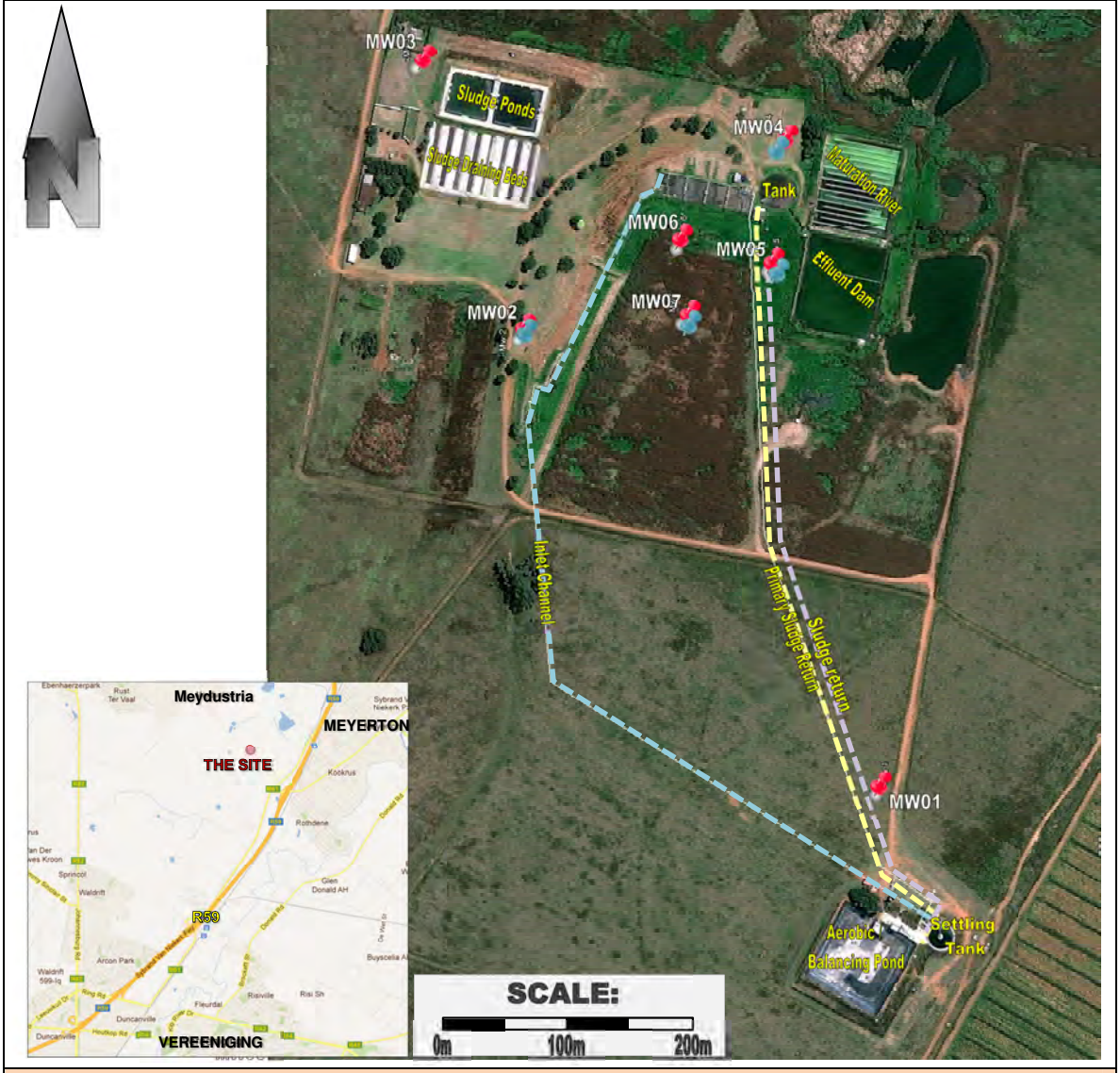


Diagram 2.1: Site Layout

2.3. Site Description, Topography and Vegetation

The WWTW comprises office buildings, sludge ponds, drying beds, effluent dam and a clarifier tank to the north, with irrigation fields covering the southern part of the site.

An aeration/balancing pond, with a settling plant, is located about 260m south-east of the site, connected to the rest of the plant by an underground channel, with an additional water and sludge pipeline.

The surrounding area is undeveloped and covered by dense grass.

According to Acock's field types of South Africa, the area is located on Moist Cool Highveld Grassland (Cymbopogon-Themeda Veld) that is characterised by Redgrass (Themeda triandra), Broom Needlegrass (Triraphis andropogonoides), Sawtooth Lovegrass (Eragrostis superba) and Velvet Signalgrass (Brachiaria serrata).

Locally, the PWV map (1977) shows shallow undermining to occur to the west of the aeration/balancing pond. This shallow undermining is associated with the abandoned Springfield Colliery. A waste dump, of which the dimensions are not known, also occurs to the north-west of the site.

The area is situated in the Highveld climatic zone, with warm summers (average temperatures ranging from 17 to 28°C) and cool days with cold nights during winter (average 0 to 14°C). Precipitation occurs during the summer, with most of the rain falling during December and January, predominantly in the form of thunderstorms, causing localised flooding (RSDF, 2003). The average precipitation is 559mm/annum.

Climate determines the mode of weathering and rate of weathering. The effect of climate on the weathering process (i.e. soil formation) is determined by the climatic N-value defined by Weinert (Ref. 6). The N-value for the site is less than 5, which implies a moderate climate, and is an indication that both chemical decomposition and mechanical disintegration can occur as the rock weathering mode, though chemical decomposition predominates. The soil profiles in this area are likely to comprise of thick chemically altered residual soils.

3. GEOTECHNICAL INVESTIGATION AND GROUND CONDITIONS

3.1. Overview

The geotechnical investigation comprised a desk study, site walkover, fieldwork and laboratory testing. Fieldwork on the site comprised the following;

- Seven trial pits excavated with an Komatsu PC220 excavator and profiled according to standard practice undertaken on 6 December 2011
- Four percussion boreholes at selected trial pit positions on 15 February 2012

Soil samples recovered from representative materials on site were submitted for laboratory testing; these are discussed in further detail in section 3.4 below

3.2. Geology and hydrogeology and soil

According to the geological map of the East Rand (sheet 2626, 1986) the entire site is underlain by sandstone, shale and coal of the Ecca Group, Karroo Supergroup. These Karroo sediments were deposited into a broad drainage basin carved into the underlying dolomite. The dolomite is divided into compartments, separated by intrusive bodies. Locally the site is situated within the Lower Klip River North Compartment, with the Vereeniging Dyke towards the south and the Klipreviersberg Dyke towards the north east of the site.

The local geology is shown in Diagram 3.1 below:

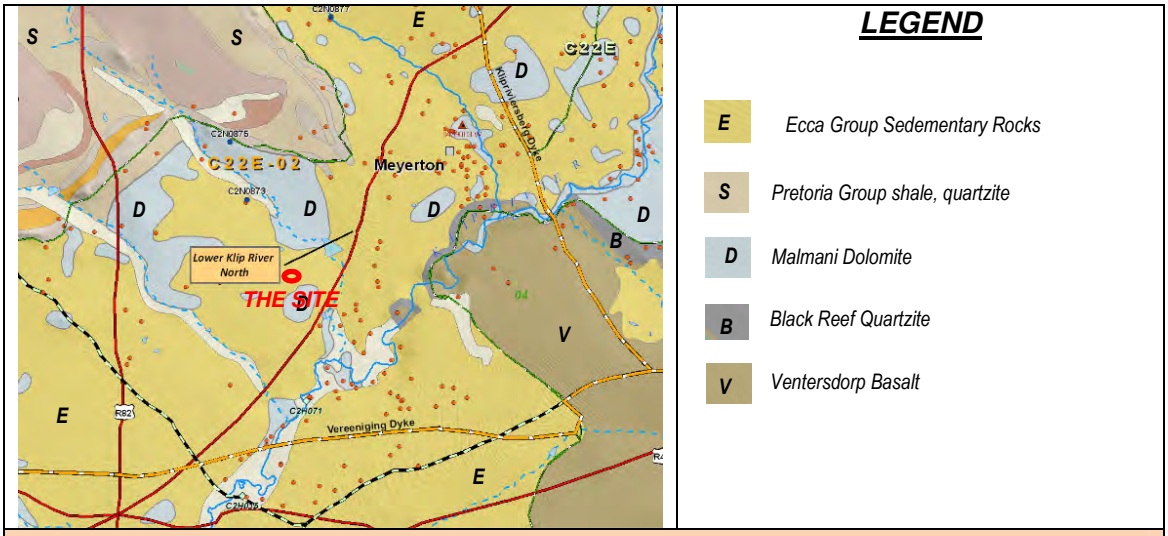


Diagram 3.1: Site Geology *(Extract of DWAF Dolomite compartment map, 1994)*

Boreholes in the vicinity of the site, carried out for a dolomite stability analysis in the area show dolomite and wad to be covered by 6 - >50m tick Ecca sediments. The PWV map (1977) shows shallow dolomite about 400m south-east and ferricrete formation to the south of the aeration/balancing pond. Several old sinkholes have been recorded on

the area south of the site, but no cavities were found in any of the boreholes in the vicinity of the site.

Long term monitoring of water levels over the Lower Klipriver North compartment shows the permanent water table to be between 40 – 60m below surface (DWAF Dolomite compartment map, 1994).

Water levels, recorded in some of the boreholes in the vicinity of the site were in the order of 25 – 27m below surface, and slow seepage on a perch water table occurred at 4.8m in test pit MW1, at the aeration/balancing pond, south east of the site.

From the soil survey (AGIS, 1970) the area is underlain by a combination of thick apedal sandy loam to sandy clay loam and shallow soil on either Karroo or dolomitic bedrock.

The local ground conditions are indicated in Diagram 3.2 below:

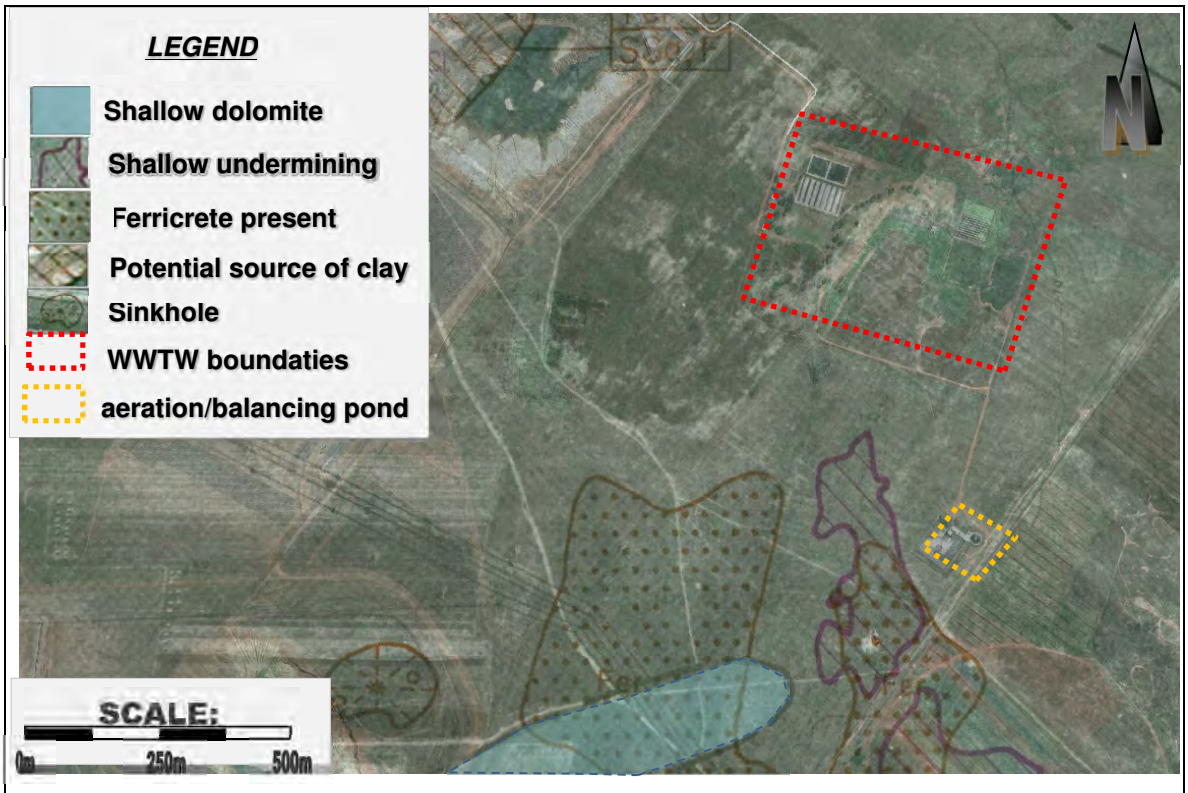


Diagram 3.2: Site Ground Conditions

3.3. Trial Pitting

The trial pits were excavated, using a Komatsu PC220 excavator and distributed across site to provide an overall assessment of the in-situ conditions. The location of the test pits is also indicated on Diagram 2.1 above.

These trial pits were excavated to 5m, or effective refusal of the excavator. Detailed trial pit profiles are included in Appendix B and a definition of the logging parameters used, in Appendix C.

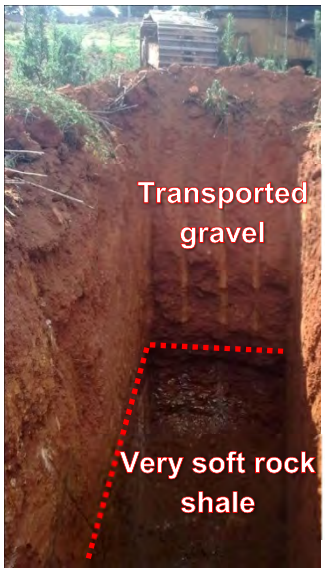
The test pits showed conditions on the site to be consistent, comprising transported silty sand covering a combination of transported and residual sandy to silty gravel, with soft rock fine sandstone / shale from 1.05 – 4.7m below surface. The soil cover is generally thicker in the northern part of the site and although no dolomite was encountered in any of the trial pits, dolomite and chert cobbles were seen on surface.

The profiles are summarised in Table 3.1 and photographs of the general profile shown on Diagram 3.3 below:

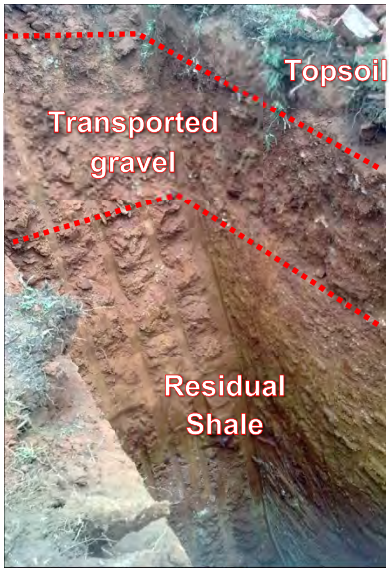
Table 3.1 Summary of Test Pit Profiles

Trial Pit No.	Transported sand/gravel	Residual shale/sandstone	Very soft rock shale/sandstone	Depth of Refusal	Seepage
MW01	0.0 – 0.5	0.5 – 1.5	1.5 – 5.04	>5.04	4.8
MW02	0.0 – 1.4	1.4 – 2.1	2.1 – 4.0	4.0	-
MW03	0.0 – 4.5	-	4.5 – 4.65	4.65	-
MW04	0.0 – 2.05	2.05 – 4.6	-	4.6	-
MW05	0 – 2.5	2.5 – 3.2	-	3.2	-
MW06	0 – 3.0	3.0 – 5.0	-	>5.0	-
MW07	0.0 – 3.0	3.0 – 3.8	-	3.8	-

All depths in metres.



MW06



MW02

MW03

Diagram 3.3: General Trial Pit Profiles

Additional observations made were as follows:

Excavatability: The excavator was stopped in some of the trial pits from 4m due to slow progress. The excavatability is thus seen as "soft" to "moderately hard" (according to SABS1200D).

Stability of Trenches: The side-walls of the trial pits were stable during the investigation.

Ground water seepage: Slow ground water seepage was seen in trial pit MW01 at 4.8m during the investigation.

Made Ground /Fill

Garbage was previously dumped in a pit of unknown dimensions within the far north eastern part of the site.

Foundations should not be placed on any made ground on the site, if encountered, due to its variability in nature and potential for settlement.

3.4. Laboratory testing

Laboratory tests were scheduled to confirm the on-site investigation and establish engineering parameters for the soils. Tests were undertaken by our associated SANAS accredited laboratory Soillab (Pty) Ltd in Pretoria. The various tests and pertinent information from these tests are highlighted below and the detailed test results are included as Appendix D. Tests undertaken include:

- 7 Foundation Indicator tests (including full grading)
- 2 California Bearing Ratios (CBR) including Moisture/Density Relationship at Mod AASHTO density Tests
- 4 Chemical tests

Indicator Tests;

Particle size analyses (full grading) and indicator tests were undertaken on representative samples of the materials on site. The tests showed the transported material to have a moderate clay content and low to medium Plasticity (PI), whereas the residual to very soft rock shale has a moderate to high clay content with a moderate PI. All the material encountered on site, however tests as "Low" potential expansive according to the van der Merwe method.

The test results are summarised in the table below:

Table 3.2 Foundation Indicator Results

Trial pit No.	Depth of sample (m)	Material Type	Grading Modulus	Clay %	Silt %	Sand %	Gravel %	PI	Expansiveness classification*
MW01	0.0 – 0.50	TS	0.91	15	16	64	5	6	Low
MW02	1.40 – 2.00	RS	1.34	24	19	25	33	19	Low
MW02	3.00 – 4.00	VS	1.23	11	30	28	32	12	Low
MW03	1.00 – 1.50	TG	1.64	16	15	28	41	19	Low
MW03	2.00 – 2.50	TG	2.07	11	14	20	55	15	Low
MW04	3.50 – 4.00	RS	0.41	52	31	15	2	15	Low
MW05	2.50 – 3.20	RG	2.48	0	5	22	73	4	Low

Material Types: TS = Transported Sand; TG = Transported Gravel; RS = Residual Silt; RG = Residual Gravel; VS = Very soft rock Shale

* According to van der Merwe

CBR tests: Two representative samples were taken of the transported gravel on site. The results show that, although high CBR values were obtained (commensurate with a G6/G7 material, the material to classifies as G9 material (according to the TRH14 and Colto Classifications) as a result of the high plasticity. The results are summarised below.

Trial pit No.	Sample description	Optimum Moisture Content%	Max. Dry Density	Swell at 100% c*	CBR for compaction*	
					at 93%	at 95%
MW02	Transported Gravel	9.6	2039	0.1	27	47
MW04	Transported Gravel	9.1	2044	0	25	35

* Mod AASHTO compaction

From the results it can be seen that the transported gravel could potentially be used for engineering layerwork applications, but it will be necessary to treat the high plasticity, either with lime or cement. Further test would be required to establish the necessary quantity of lime/cement and the effects of such addition on the properties of the soil.

Chemical Tests were undertaken on selected samples. The results showed the transported soil to be slightly acidic to slightly basic, with a pH in the order of 5.12-7.82. The residual to very soft rock shale are highly basic (pH in the order of 10.02). Conductivity tests show all the transported soils to be moderately corrosive to corrosive, with the residual shale being highly corrosive towards steel.

4. DOLOMITE STABILITY

4.1. Overview

The site is situated within a broad drainage basin, filled with Karoo sediments within the Malmani Dolomite. Previous investigations within the area showed the Karroo cover to be from 6 to >50m thick. The existing plant has been in operation for more than 20years and during the investigation there was no evidence of any ground instability on the site.

4.2. Percussion Drilling

Four percussion holes were drilled at selected trial pit positions to cover the area for the proposed upgrades. These holes were drilled to 40m, 45m, 40m and 60m respectively. The positions of these holes are also indicated on Diagram 2.1 above.

Percussion drilling is a destructive technique and only chip samples are recovered. The hardness reflected on the percussion borehole logs is assessed by inspection of the chip samples and the rate of penetration of the drill. The holes have been logged by a geo-spesalist and the detailed logs are included as Appendix E.

The profiles generally show Karoo sediments to extend to at least 60m, with coal beds from 25m. No dolomite was encountered in any of the boreholes and conditions appear to be favourable.

Complete sample loss did however occur in MW07 between 15 and 22m, even though a clay cutter was used. The low penetration rate indicates a loose material rather than a void and the underlying material was still part of the overlying Karoo cover.

Boreholes were dry and piezometers were placed in two of the boreholes, but no additional water levels have been recorded to date.

4.3. Site Evaluation

From the boreholes it is shown that the Karoo cover on the site is significantly thick, up to a depth of 60m, with a low inherent hazard of sinkhole or doline formation (all sizes) with respect to ingress of water. The site thus classifies as a Class 1 site, with a D2 desecration and standard (dolomitic) precautions are required for the proposed upgrades. Focus should thus be placed on the landscaping of the site to prevent ponding and a concentrated ingress of water.

The Council of Geoscience support the low hazard conditions on site and have no objection to the planned upgrading of the plant, provided that a number of conditions are met. These conditions are included in the recommendations.

5. GEOTECHNICAL EVALUATION AND CONCLUSIONS

From the available site information, site investigation and laboratory testing, conditions on the site are generally seen as favourable for the proposed upgrades. An evaluation of the impact of the geotechnical characteristics on the development are discussed below.

5.1. Ground Conditions

The test pits showed conditions on the site to be generally consistent. The area is covered by transported silty sand concealing a combination of transported and residual sandy to silty gravel, with very soft to soft rock fine sandstone / shale from 1.05 – 4.7m below surface. Percussion logs show the Karoo shale and sandstone cover to extend to below 60m, with coal beds from 25m.

5.2. Geotechnical Constraints to Development

Unfavourable geotechnical conditions on the site include:

1. Materials are moderately plastic and variable, requiring treatment and selection prior to use for engineering applications.
2. Medium hard excavatability of the completely weathered to very soft rock shale / sandstone
3. The presence of a shallow perched water table on the site
4. The site is dolomitic with dolomitic bedrock that occur within 90m from surface

Precautionary measures for foundations and materials, as detailed below will have to be incorporated in the design and construction of the proposed upgrades.

5.3. Foundations

Founding conditions are seen as favourable on the site

The sedimentation tanks are to be in cut, with the planned foundation level at 7m below natural ground level. The excavator was unable to advance to this level, but it is expected that conditions will be very favourable as the quality of the fine sandstone / shale improves with depth.

The planned balancing basins, with a planned foundation level of 5m below natural ground level are situated in completely weathered shale, grading into very soft rock.

The Inlet Pump Station is planned to be founded at 3.6m below natural ground level. MW02 was excavated on the planned position and show very soft rock shale at this depth.

As it was not possible to excavate to some of the proposed founding levels it is recommended that excavations are inspected and approved by a competent person (geotechnical).

5.4. Excavatability

The excavator was stopped in some of the trial pits at 4m due to slow progress. The soil conditions are thus seen as "soft" becoming "hard". Excavation along the entire site to the planned depth of the foundation thus generally classify as "soft" (0 – 4m), "intermediate" (4 – 5m) and "hard" (5 – 7m) according to the SABS 1200 D Earthworks classification.

5.5. Stability of Trenches

The side-walls of the trial pits were stable during investigation. The trenches are thus generally seen as stable to 1.8m, however, it must be noted that this is based on an assessment of test pits of limited length and probably does not give an accurate assessment of the stability of long trenches required for a pipeline; it remains the responsibility of the contractor/engineer on site to ensure excavations are safe. Shoring or battering of excavations deeper than 1.2m will be required where shallow water tables are found, or deeper than 1.5m in dry excavations.

5.6. Geotechnical Evaluation; Other

1. *Mining activity and undermining.* Shallow undermining from the abandoned Springfield Colliery is present to the west of the aeration/balancing pond, but no mining occurred on site and, with the exception of generally low quality coal at great depth, there are no known occurrences of economic mineral deposits on the site.
2. *Dolomite.* The site is a "dolomitic" site, but is covered by significantly thick karoo sediments (at least 60m). The site has a D2 desecration and focus should thus be placed on the landscaping of the site to prevent ponding and a concentrated ingress of water.
3. *Contaminated soils (including tailings).* No contaminated soils were noted. The site is also not on or near a tailings dam

6. RECOMMENDATIONS

Based on the preceding discussions, the geotechnical conditions, constraints and recommendations can be briefly summarised as follows for significant geotechnical and structural (foundation) elements:

- Conditions are relatively consistent over the site. Transported silty sand conceals a combination of transported and residual sandy to silty gravel, with very soft to soft rock fine sandstone / shale from 1.05 – 4.7m. The soil cover is generally thicker towards the northern part of the site.
- The soils present on the site are silty and gravelly with shallow perched ground water tables.
- The site has a D2 desecration.
- Effective refusal of the excavator occurred from 3.2 on very soft to soft rock, which indicates some "intermediate" to "hard" excavation conditions over the site.

Recommendations include:

- The sedimentation tanks are to be founded at 7m on completely weathered shale, grading into very soft rock. Conventional foundations (depending on the actual design) can be used, with an allowable bearing pressure of 500kPa. Good compaction beneath the foundation is recommended if solid bedrock is not present at the base of the excavation.
- The planned balancing basins, with a planned foundation level of 5m below natural ground level are situated in completely weathered shale, grading into very soft rock. The same foundation recommendations as the sedimentation tanks apply.
- The Inlet Pump Station is planned to be founded at 3.6m below natural ground level. MW02 was excavated on the planned position and show very soft rock shale at this depth. The same foundation recommendations as the sedimentation tanks apply.
- Shoring of excavations deeper than 1.5m is recommended and allowance made for dewatering of excavations, especially after periods of heavy or continuous rain.
- Good landscaping to prevent ponding or a concentrated ingress of water on the site.
- Inspection and approval of foundation excavations by competent person.

Additional conditions, requested from the Council of Geoscience:

- An audit of wet services shall be carried out on the entire site and reported to the Local Authority. Any shortcomings identified shall be rectified to the satisfication of the Local Authority.
- The Builder must inform the professional team when the service/foundation trenches are open for inspection. The results of these inspections and quality control must be recorded in a construction report (copy to the Local Authority and the Council of Geoscience)
- The professional team involved, shall carefully consider the appropriate water precautionary measures and then ensure and finally certify that these have been implemented
- A Dolomite Risk Management Plan must be implemented for the site
- Wet services should be laid exactly where indicated on drawings presented to the local Authority. The builder or his appointed professional team should certify that they have been placed as indicated. The owner/responsible person must also have a copy of the exact plan presented to the Council for Geoscience
- Adequate paving around the structures should always exist and all storm water must be discharged in the municipal storm water system. Roof water may thus not cascade off the apron and directly into the soil. The property should be landscaped in a way that the storm water is channelled away from the structures and in principle as shown on the drawings submitted. The Competent Person should, during the first year after completion of construction, visit the site after heavy rain storms to check that the storm water control system work effectively and should implement changes as deemed necessary.

We trust you find the above in order. ***Vela VKE*** appreciate the opportunity of providing our services on this project. Please do not hesitate to contact us should you require clarity on any item.

Vela VKE *Consulting Engineers (Pty) Ltd*

7. REFERENCES

1. 1:250 000 Geological Sheet, 2628 East Rand, Department of Mineral and Energy Affairs published in 1986.
2. ACOCKS J.P.H. "*Veld types of South Africa".* In; Memoirs of the Botanical Survey of South Africa No. 57. 3rd Edition, Botanical Research Institute, Pretoria, 1988.
3. AEG, SAICE AND SAIEG. "*Guidelines for Soil and Rock Logging in South Africa".* 2nd Impression 2001, eds. A.B.A. Brink and R.M.H. Bruin, Proceedings, Geoterminology Workshop. Johannesburg 2001.
4. Colto 1993 Standard specifications for subsurface investigations.
5. Department of Public Works. PW344. Appropriate development of infrastructure on dolomite. Guidelines for consultants.
6. SAICE Geotechnical Division. "*Site Investigation Code of Practice*". South African Institution of Civil Engineers. Midrand. January 2010.
7. VAN DER MERWE D.H. "*The prediction of heave from the plasticity index and percentage clay fraction of soils*". SAICE 1964.
8. Weinert, H.H. "The Natural Road Construction Materials of Southern Africa". H & R Academia Publ., Pretoria, 298 pp. 1980.
9. SABS 1200; "*Code of practice for use with standardised specifications for civil engineering construction and contract documents*". Second revision, SABS Pretoria, 1986.

Appendix

Limitations

1. It should be noted that all test pits excavated have only been lightly backfilled. Where necessary, tests pits should be re-excavated and suitably backfilled with compaction provided which is appropriate for the support/loads required.
2. This investigation has been performed primarily for provision of preliminary design parameters. A general outline of ground conditions is thus provided. However, for further site-specific foundation inspections the site will have to be opened up. This is recommended as it allows for the verification of final, for-construction details which may vary and influence individual structure footprints and particular structural requirements.

   It is, therefore, recommended that Vela VKE be appointed to inspect the earthworks, service trenches and foundation excavations during construction. Periodic inspection of the site will allow confirmation of the recommendations given in this report and any change from the anticipated conditions can then be taken into account timeously.
3. Vela VKE should be allowed the opportunity to review the geotechnical aspects of plans and specifications prior to construction, to allow confirmation of the correct interpretation of the recommendations provided in this report.
4. Foundation, earthworks or underground construction should be undertaken only with full time monitoring by qualified personnel.
5. The conclusions and recommendations submitted in this report are based on data obtained from a limited number of widely spaced subsurface explorations. The nature and extent of variations between these may not become evident until construction or further investigation. If variations or other latent conditions do become evident, it will be necessary to re-evaluate the recommendations of this report.
6. The recommendations contained herein are not intended to dictate construction methods or sequences. They are furnished to help designers identify potential construction problems related to foundation and earthwork plan and specifications.

   Recommendations may also be useful to personnel who monitor construction activity. Potential contractors for the project must evaluate potential construction problems on the basis of their review of the contract documents, their own knowledge of and experience in the local area, and on the basis of similar projects in other localities, taking into account their own proposed methods and procedures.
7. The Scope of Services did not include any environmental assessment for the presence of or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site. Any comments made in this regard are for the information of the client.

Appendix

B

Trial Pit Profiles

TRIAL PIT LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW Upgrade
PROJECT NO: PJ096/KJP

HOLE NO: MW01
X COORD: 2,942,197
Y COORD: WGS27 -96,980
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Loose to medium dense, silty SAND Dry, red brown, pinholed with scattered fine gravel, fine roots. Transported.	
0.5	0.50	**Medium dense, sandy GRAVEL** Sub-angular, gravel and cobbles (max 100, ave 50) with dark red brown silty sand. Residual.	
1.0	1.05	**Dense gravelly silt grading into Very soft rock, fine SHALE/Sandstone** Highly to moderately weathered, purplish red, becoming yellowish brown with depth, intensely jointed (near horizontal), very fine grained.	
1.5			
2.0			
2.5			
3.0			
3.5			
4.0			
4.5			
5.0	5.04	**Hole stopped maximum reach of rig**	
		End of Log	
5.5			

NOTES 1: Slow seepage from 4.8m
2: DCP from surface and 1.2m
3:
4:

MACHINE: KOMATSU PC220
DIAM: Trench
FILE REF: pj096/kjp

DATE PROFILED: 6/12/2011
PROFILED BY: eo

VELA VKE
Consulting Engineers
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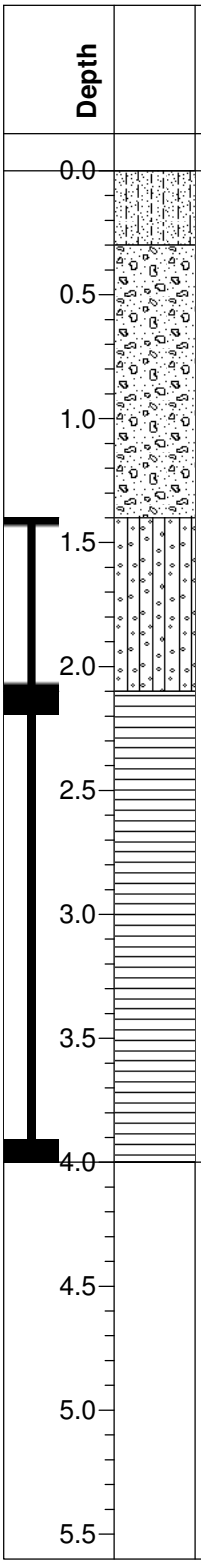
TRIAL PIT LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW Upgrade
PROJECT NO: PJ096/KJP

HOLE NO: MW02
X COORD: 2,941,801
Y COORD: WGS27 -96,736
ELEVATION:



	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.00	Ground Surface	
0.30	**Medium dense, silty SAND.** Dry, reddish brown, with scttered gravel. Topsoil.	
1.40	**GRAVEL and BOULDERS** Abundant gravel (max 30mm, ave 10mm), with scattered sub-rounded sandstone dolomite and chert cobbles and boulders (max 400mm, ave 15mm), and ferricrete nodules in matrix as above. Transported.	
2.10	**Dense, gravelly SILT** Slightly moist, dark red brown, mottled orange, with abundant fine gravel and scattered ferricrete nodules (maximum 4mm). Residual Shale	
4.00	**Dense silt, grading into Very soft rock SHALE** Moderately weathered, light orange grading into light grey with depth, intensely bedded (near horizontal stained orange) very fine grained. Medium hard rock SHALE at 2.6 - 3m. (Slightly weathered, purplish red, thin bedded, Very fine grained.)	
	Hole stopped, very slow going.	
	End of Log	

NOTES 1: No seepage
2: No DCP
3: F.I Samples at 1.4 - 2.1m and 2.1 - 4m
4:

MACHINE: KOMATSU PC220
DIAM: Trench
FILE REF: pj096/kjp

DATE PROFILED: 6/12/2011
PROFILED BY: eo

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TRIAL PIT LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW Upgrade
PROJECT NO: PJ096/KJP

HOLE NO: MW03
X COORD: 2,941,579
Y COORD: WGS27 -96,677
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.00	Ground Surface	
0.0	**Medium dense, silty SAND** Slightly moist, dark reddish brown, abundant fine gravel. Transported.	
0.40	**Very dense, silty GRAVEL** Moist, red brown, becoming orange with depth, speckled black, with abundant gravel (max 50mm, average 10mm) scattered ferricrete nodules. Transported.	
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		
3.5		
4.0		
4.5		
4.50		
4.65	**Soft rock SHALE** Slightly to moderately weathered, light grey, with thin orange layers. Very fine grained.	
5.0	**Hole stopped, slow going.**	
	End of Log	
5.5		

NOTES 1: No seepage
2: No DCP
3: No samples
4:

MACHINE: KOMATSU PC220
DIAM: Trench
FILE REF: pj096/kjp

DATE PROFILED: 6/12/2011
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TRIAL PIT LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW Upgrade
PROJECT NO: PJ096/KJP

HOLE NO: MW04
X COORD: 2,941,672
Y COORD: WGS27 -96,962
ELEVATION:

Depth	Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.00	Ground Surface	
0.0	**(0.00 - 0.10m) Loose, silty SAND** Slightly moist, dark redish brown, with scattered fine gravel, fine roots. Topsoil	
0.5	**Dense, silty GRAVEL** Dry sub-angular shale gravel with red brown sandy silt, scattered ferricrete. Transported	
1.0		
1.5		
2.0	2.05	
2.05	**Very dense, sandy SILT** Slightly moist, pale white , mottled yelowish grey and red brown, with scattered ferricrete nodules. Completely weathered shale.	
2.5		
3.0		
3.5		
4.0		
4.5	4.60	
4.60	**Hole stopped, slow going.**	
	End of Log	
5.0		
5.5		

NOTES 1: No seepage
2: No DCP
3: F.I Sample at 4.3m and CBR Sample at 2.05m
4:

MACHINE: KOMATSU PC220
DIAM: Trench
FILE REF: pj096/kjp

DATE PROFILED: 6/12/2011
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TRIAL PIT LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW Upgrade
PROJECT NO: PJ096/KJP

HOLE NO: MW05
X COORD: 2,941,770
Y COORD: WGS27 -96,942
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		(0 - 0.3m) Loose, silty SAND Slightly moist, dark reddish brown, with scattered fine gravel, fine roots. Topsoil.	
	0.30	**Dense, silty GRAVEL** Moist, red brown, becoming orange with depth, speckled black, with abundant gravel (max 50mm, average 10mm) scattered ferricrete nodules. Transported	
2.5	2.50	**Dense GRAVEL, grading into very soft rock SHALE** Soft rock shale layers (orange brown, very fine grained), with sandy silt in between highly weathered shale.	
3.0	3.20	**Refusal on shale**	
		End of Log	

NOTES 1: No seepage
2: No DCP
3: F.I Sample at 3.2m
4:

MACHINE: KOMATSU PC220
DIAM: Trench
FILE REF: pj096/kjp

DATE PROFILED: 6/12/2011
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TRIAL PIT LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW Upgrade
PROJECT NO: PJ096/KJP

HOLE NO: MW06
X COORD: 2,941,743
Y COORD: WGS27 -96,870
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
0.0 – 3.0		**Dense, silty GRAVEL** Moist, red brown, becoming orange with depth, speckled black, with abundant gravel (maximum 50, average 10mm), scattered ferricrete nodules. Transported.	
3.0	3.00	**Dense silt, grading into Very soft rock SHALE** Moderately weathered, orange, intensely bedded (near horizontal) very fine grained. Note: Rock becomes more weathered towards the east, becoming a red brown, silty clayey silty with shale gravel.	
5.0	5.00	**Hole stopped at max reach of rig**	
		End of Log	

NOTES 1: No seepage
2: No DCP
3: No Samples
4:

MACHINE: KOMATSU PC220
DIAM: Trench
FILE REF: pj096/kjp

DATE PROFILED: 6/12/2011
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TRIAL PIT LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW Upgrade
PROJECT NO: PJ096/KJP

HOLE NO: MW07
X COORD: 2,941,785
Y COORD: WGS27 -96,855
ELEVATION:

Depth		Description	Dynamic Probe Light Equivalent SPT-N (10 20 30 40)
0.0	0.00	Ground Surface	
		Very loose to loose, silty SAND Slightly moist, red brown, with scattered fine gravel, fine roots. Transported.	
1.0	1.00	**Dense, sandy GRAVEL** Moist, red brown, speckled black, with abundant gravel (maximum 60mm, average 10mm) Scattered ferricrete nodules. Transported.	
3.0	3.00	**Dense GRAVEL grading into very soft rock SHALE** Moderately weathered, orange, intensely bedded (near horizontal) very fine grained.	
	3.80	**Hole stoped, very slow going.**	
		End of Log	

NOTES 1: No seepage
2: No DCP
3: No Samples
4:

MACHINE: KOMATSU PC220
DIAM: Trench
FILE REF: pj096/kjp

DATE PROFILED: 6/12/2011
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Appendix

Profiling and Logging Parameters

1. SOIL DESCRIPTIVE TERMS

DESCRIPTIVE ORDER: 1. CONSISTENCY 2. SOIL TYPE 3. MOISTURE CONDITION 4. COLOUR 5. SOIL STRUCTURE 6. ORIGIN

1.(a) CONSISTENCY: GRANULAR SOILS

S P T "N" (sat.)	GRAVELS & SANDS Generally free draining soils. Cohesionless materials		TYPICAL DRY DENSITY (kg/m^3)
< 4	VERY LOOSE	Crumbles very easily when scraped with geological pick	< 1450
4-10	LOOSE	Small resistance to penetration by sharp pick point	1450-1600
10-30	MEDIUM DENSE	Considerable resistance to penetration by sharp pick point	1600-1750
30-50	DENSE	V. high resistance to penetration by sharp pick point. Requires many blows of pick for excavation	1750-1925
> 50	VERY DENSE	High resistance to repeated blows of geological pick. Requires power tools for excavation	> 1925

1(b) CONSISTENCY: COHESIVE SOILS

S P T "N" (saturated)		SILTS & CLAYS and combinations with sand. Generally slow draining soils		UCS (kPa)
Sens.	Insens.			
< 2	<5	VERY SOFT	Pick point easily pushed in 100mm. Easily moulded by fingers	< 50
2-4	5 – 10	SOFT	Pick point pushed in 30-40mm. Moulded with some pressure. Easily penetrated by thumb.	50-125
5-8	11 - 25	FIRM	Pick point penetrates 0 - 10mm. Very difficult to mould. Just indented by thumb. Spade just penetrates.	125-500
9-15	26 - 50	STIFF	Slight indentation pushing in pick point. Cannot be moulded. Thumbnail penetrates. Excavate with pick.	250-500
16-30	51 - 80	VERY STIFF	Slight indentation by blow of pick point. Requires power tools for excavation.	500-1000

2. SOIL TYPE

SOIL TYPE	PARTICLE SIZE (mm)
CLAY	< 0,002
SILT	0,002 – 0,06
SAND - fine	0,06 – 0,2
SAND - medium	0.2 – 0.6
SAND - coarse	0.6 – 2
GRAVEL - fine	2 – 6*
GRAVEL - medium	6 – 20*
GRAVEL - coarse	20 – 60*
COBBLES	60 – 200*
BOULDERS	> 200*

* Specify ave/max sizes, hardness, shape and proportion

3. MOISTURE CONDITION

DRY	No water detectable
SLIGHTLY MOIST	Water just discernable
MOIST	Water easily discernable
VERY MOIST	Water can be squeezed out
WET	Generally below the water table

4. COLOUR

Described at natural moisture content, as seen in profile.

SPECKLED	Very small patches of colour < 2 mm
MOTTLED	Irregular patches of colour 2 – 6 mm
BLOTCHED	Large irregular patches 6 – 20 mm
BANDED	Approximately parallel bands of varying colour
STREAKED	Randomly orientated streaks of colour
STAINED	Local colour variations: associated with discontinuity surfaces
Described using bedding thickness criteria. (e.g. thickly banded, thinly streaked, etc. – see Rock Logging Terms)	

5. SOIL STRUCTURE

INTACT	No structure present
FISSURED	Presence of discontinuities, open or closed, stained or unstained
SLICKENSIDED	Very smooth or glossy, often striated discontinuity planes
SHATTERED	Presence of open fissures. Soil breaks into gravel size blocks
MICRO-SHATTERED	Small scale shattering, very closely spaced open fissures. Soil breaks into sand size crumbs
RESIDUAL STRUCTURES	Relict bedding, lamination, foliation, etc.
PINHOLED	Voids or pores (<2mm), hand lens required?
HONEYCOMBED	Similar to pinholed but >2mm (specify size)
SUPPORTED	Matrix – clasts supported by matrix Clast – Clasts touching (with/without matrix)

6. ORIGIN

TRANSPORTED	Alluvium, hillwash, talus, etc.
RESIDUAL	Weathered from parent rock e.g. residual granite
PEDOCRETES	Ferricrete, laterite, silcrete, calcrete, etc.

DEGREE OF CEMENTATION OF PEDOCRETES		UCS (MPa)
VERY WEAKLY CEMENTED	Some material can be crumbled between finger and thumb. Disintegrates under knife blade to a friable state.	0,1 – 0,5
WEAKLY CEMENTED	Cannot be crumbled between strong fingers. Some material can be crumbled by strong pressure between thumb and hard surface. Under light hammer blows disintegrates to friable state.	0,5 – 2
CEMENTED	Material crumbles under firm blows of sharp pick point. Grains can be dislodged with some difficulty by a knife blade.	2 – 5
STRONGLY CEMENTED	Firm blows of sharp pick point on hand-held specimen show 1-3mm indentations. Grains cannot be dislodged by knife blade.	5 – 10
VERY STRONGLY CEMENTED	Hand-held specimen can be broken by single firm blow of hammerhead. Similar appearance to concrete.	10 - 25

REFERENCE: AEG, SAICE and SAIEG. "***Guidelines for Soil and Rock Logging in South Africa".*** editors A.B.A. Brink and R.M.H. Bruin; Proceedings, Geoterminology Workshop. Johannesburg 2001.

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2. ROCK DESCRIPTIVE TERMS

DESCRIPTIVE ORDER: 1. HARDNESS 2. ROCK TYPE 3. WEATHERING 4. COLOUR 5. FRACTURE SPACING 6. DISCONTINUITY SURFACE DESCRIPTION 7. GRAIN SIZE 8. STRATIGRAPHIC UNIT

1. ROCK HARDNESS

HARDNESS	DESCRIPTION	UCS (MPa)
VERY SOFT	Material crumbles under firm blows of pick point. Can be peeled with a knife. SPT refusal. Too hard to cut triaxial sample by hand	1 – 3
SOFT ROCK	Firm blows with pick point: 2-4mm indents. Can just be scraped with a knife	3 - 10
MEDIUM HARD ROCK	Firm blows of pick head will break hand-held specimen. Cannot be scraped or peeled with a knife.	10 - 25

HARDNESS	DESCRIPTION	UCS (MPa)
HARD ROCK	Breaks with difficulty, rings when struck Point load or laboratory test results necessary to distinguish between categories. ***+ In the absence of any of the above tests, it must be accepted that any rock described as "hard" or "very hard" rock can and may include rock of greater hardness.***	25 – 70
VERY HARD ROCK+		70 – 200
EXTREMELY HARD ROCK+		> 200

2. ROCK TYPE

Quartzite, sandstone, granite, limestone, etc.

4. COLOUR

Described in dry state unless otherwise indicated

3. WEATHERING

DEGREE OF WEATHERING	EXTENT OF DISCOLOURATION	FRACTURE CONDITION	SURFACE CHARACTERISTICS	ORIG. FABRIC	GRAIN BOUNDARY CONDITION
UNWEATHERED	None	Closed or stained	Unchanged	Preserved	Tight
SLIGHTLY WEATHERED	< 20% of fracture spacing on both sides of fracture	Discoloured, may contain thin filling	Partial discolouration. Often unweathered rock colour	Preserved	Tight
MODERATELY WEATHERED	>20% of fracture spacing on both side of fracture	Discoloured, may contain filling	Partial/complete discolour-ation. Not friable, except poorly cemented rocks	Preserved	Partial opening
HIGHLY WEATHERED	Throughout	-	Friable, possibly pitted	Mainly preserved	Partial separation. Not easily indented with knife. Does not slake in water.
COMPLETELY WEATHERED	Throughout	-	Resembles a soil	Partially preserved	Complete separation. Easily indented with knife. Slakes in water.

5. DISCONTINUITY SPACING

SEPARATION (mm)	SPACING (foliation, cleavage, bedding, etc.)	SPACING (fractures, joints, etc.)
< 6	very intensely	very highly
6 – 20	intensely	
20 – 60	very thinly	highly
60 – 200	thinly	
200 – 600	medium	moderately
600 – 2000	thickly	slightly
> 2000	very thickly	very slightly

6.1 JOINT FILLING

JOINT FILL TYPE	DEFINITION (wall separation specified in mm)
CLEAN	No fracture filling
STAINED	Colouration of rock only. No recognisable filling material
FILLED	Fracture filled with finite thickness filling material

6.2 DISCONTINUITY ORIENTATION

Discontinuity inclinations (i.e. of joints, bedding, faults) relative to down-axis of core (ie. 90° = vertical 0° = horizontal).
For oriented core, true azimuths given.

6.3 ROUGHNESS OF DISCONTINUITY PLANES

CLASSIFICATION	DESCRIPTION
SMOOTH	Appears smooth and is essentially smooth to the touch. May be slickensided *
SLIGHTLY ROUGH	Asperities on the fracture surface are visible and can be distinctly felt
MEDIUM ROUGH	Asperities are clearly visible and fracture surface feels abrasive
ROUGH	Large angular asperities can be seen. Some ridge and high side angle steps evident
VERY ROUGH	Near vertical steps and ridges occur on the fracture surface

* Where slickensides occur, their direction should be recorded

7. GRAIN SIZE

CLASSIFICATION	SIZE (mm)	RECOGNITION
VERY FINE GRAINED	< 0.2	Individual grains cannot be seen with a hand lens
FINE GRAINED	0.2 – 0.6	Just visible as individual grains under hand lens
MEDIUM GRAINED	0.6 – 2	Grains clearly visible under hand lens, just visible to the naked eye
COARSE GRAINED	2 – 6	Grains clearly visible to the naked eye
VERY COARSE GRAINED	> 6	Grains measurable

8. STRATIGRPHIC UNIT

Hekpoort Andesite Formation, Halfway House Granite, etc

REFERENCE: AEG, SAICE and SAIEG. "***Guidelines for Soil and Rock Logging in South Africa".*** editors A.B.A. Brink and R.M.H. Bruin; Proceedings, Geoterminology Workshop. Johannesburg 2001.

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Appendix

D

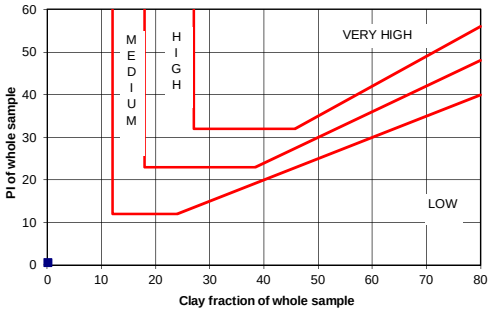
Laboratory Test Results

PARTICLE SIZE ANALYSIS

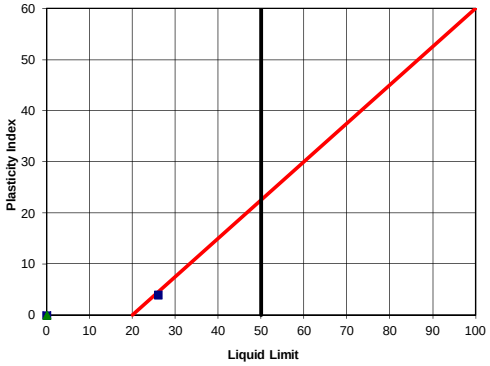
Sample No.		
Soillab sample no.	S11-1328-9	
Depth (m)	3	
Position	MW05	
Material Description	LIGHT BROWN DOLERITE SANDY GRAVEL	
Moisture (%)		
SG		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	
53.0 mm	97	
37.5 mm	95	
26.5 mm	88	
19.0 mm	73	
13.2 mm	59	
4.75 mm	38	
2.00 mm	27	
0.425 mm	18	
0.075 mm	6	
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	4	
0.027 mm	1	
0.013 mm	0	
0.005 mm	0	
0.002 mm	0	
% Clay	0	
% Silt	5	
% Sand	22	
% Gravel	73	
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	26	
Plasticity Index	4	
Linear Shrinkage (%)	2.0	
Grading Modulus	2.48	
Uniformity coefficient	104	
Coefficient of curvature	3.4	
Classification	A-1-a (0)	
Unified Classification	GP - GM	
Chart Reference		

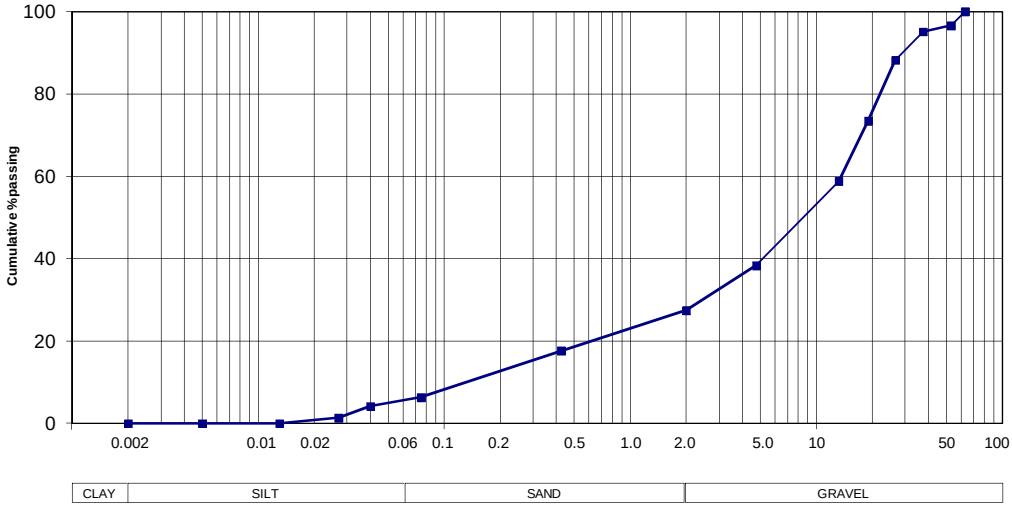
PROJECT : MEYERTON WWTW
JOB No. : S11-1328
DATE : 2011-12-13

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





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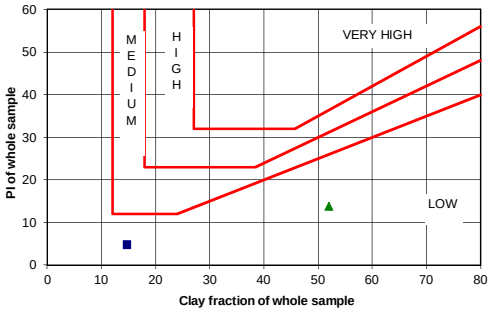
PARTICLE SIZE ANALYSIS

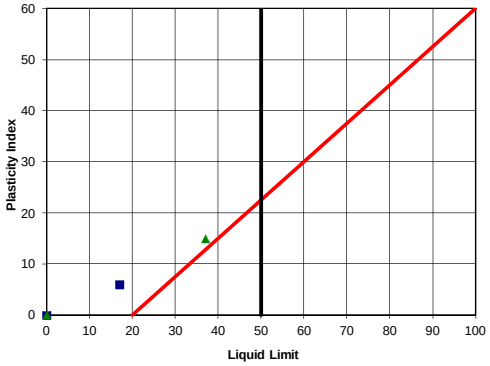
Sample No.		
Soillab sample no.	S11-1328-7	S11-1328-8
Depth (m)	0-0.5	3.5-4.0
Position	MW01	MW04
Material Description	DARK BROWN WEATHERED GRANITE SILTY SAND	LIGHT YELLOW SILTY CLAY
Moisture (%)		
Dispersion %		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	100	100
4.75 mm	98	100
2.00 mm	95	98
0.425 mm	81	93
0.075 mm	33	87
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	28	78
0.027 mm	24	76
0.013 mm	21	72
0.005 mm	18	61
0.002 mm	15	52
% Clay	15	52
% Silt	16	31
% Sand	64	15
% Gravel	5	2
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	17	37
Plasticity Index	6	15
Linear Shrinkage (%)	2.0	7.0
Grading Modulus	0.91	0.41
Uniformity coefficient	-	-
Coefficient of curvature	-	-
Classification	A-2-4 (0)	A-6 (13)
Unified Classification	SM & SC	CL
Chart Reference		

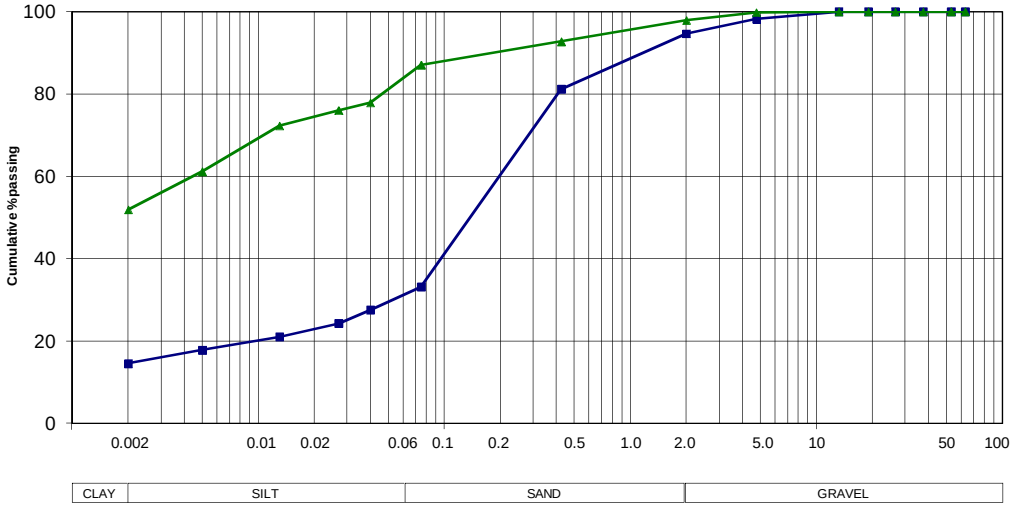
PROJECT : MEYERTON WWTW
JOB No. : S11-1328
DATE : 2011-12-13

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





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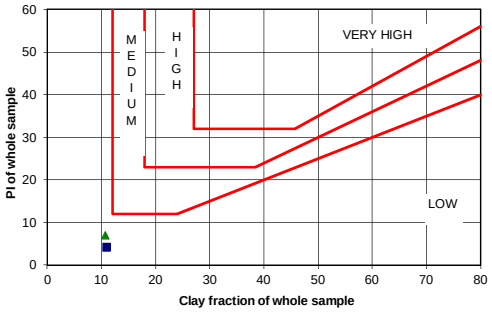
PARTICLE SIZE ANALYSIS

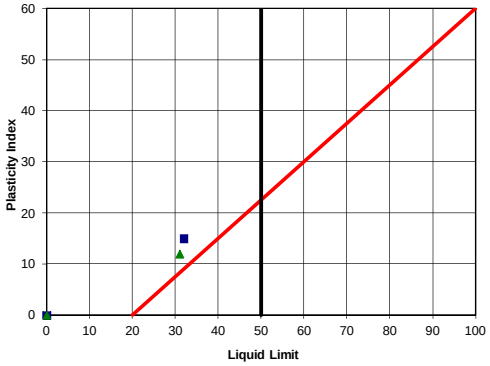
Sample No.		
Soillab sample no.	S11-1328-4	S11-1328-6
Depth (m)	2.0-2.5	3.0-4.0
Position	MW03	MW02
Material Description	DARK RED FERRICRETE SANDY GRAVEL	LIGHT OLIVE SHALE SILTY GRAVEL
Moisture (%)		
Dispersion %		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	98	92
4.75 mm	65	77
2.00 mm	45	68
0.425 mm	29	59
0.075 mm	26	50
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	23	28
0.027 mm	22	24
0.013 mm	20	15
0.005 mm	16	13
0.002 mm	11	11
% Clay	11	11
% Silt	14	30
% Sand	20	28
% Gravel	55	32
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	32	31
Plasticity Index	15	12
Linear Shrinkage (%)	7.0	6.0
Grading Modulus	2.07	1.23
Uniformity coefficient	-	-
Coefficient of curvature	-	-
Classification	A-2-6 (1)	A-6 (3)
Unified Classification	SC	SC
Chart Reference		

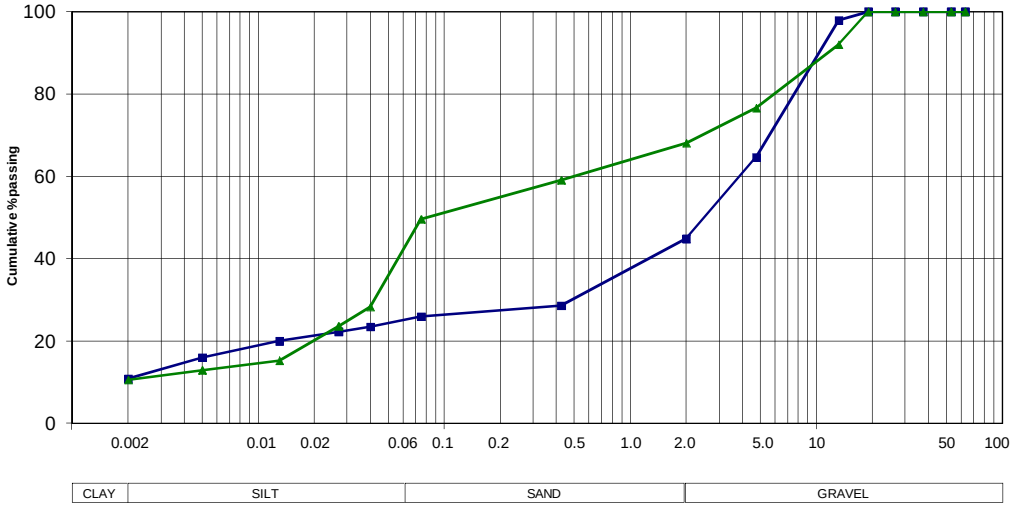
PROJECT : MEYERTON WWTW
JOB No. : S11-1328
DATE : 2011-12-13

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





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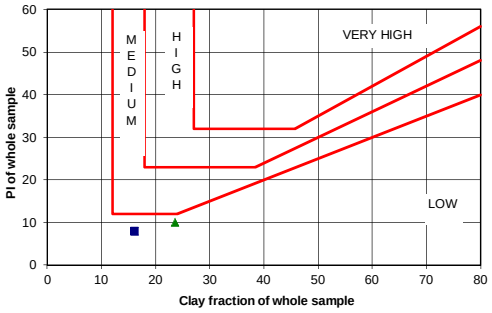
PARTICLE SIZE ANALYSIS

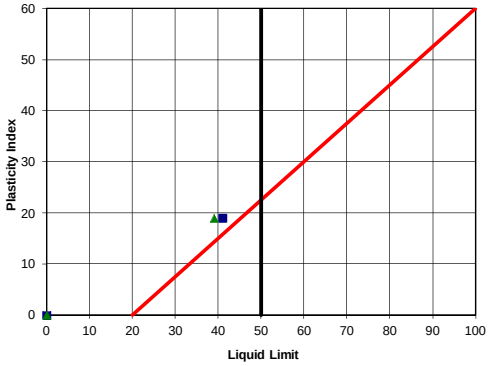
Sample No.		
Soillab sample no.	S11-1328-1	S11-1328-3
Depth (m)	1.0-1.5	1.4-2.0
Position	MW03	MW02
Material Description	DARK RED WEATHERED GRANITE SANDY GRAVEL	DARK RED WEATHERED GRANITE SANDY GRAVEL
Moisture (%)		
Dispersion %		
SCREEN ANALYSIS (% PASSING) **(TMH 1 A1(a) & A5)**		
63.0 mm	100	100
53.0 mm	100	100
37.5 mm	100	100
26.5 mm	100	100
19.0 mm	100	100
13.2 mm	98	99
4.75 mm	83	89
2.00 mm	59	67
0.425 mm	42	54
0.075 mm	35	46
HYDROMETER ANALYSIS (% PASSING) **(TMH 1 A6)**		
0.040 mm	27	37
0.027 mm	25	34
0.013 mm	24	31
0.005 mm	19	29
0.002 mm	16	24
% Clay	16	24
% Silt	15	19
% Sand	28	25
% Gravel	41	33
ATTERBERG LIMITS **(TMH 1 A2 - A4)**		
Liquid Limit	41	39
Plasticity Index	19	19
Linear Shrinkage (%)	8.5	9.5
Grading Modulus	1.64	1.34
Uniformity coefficient	-	-
Coefficient of curvature	-	-
Classification	A-2-7 (2)	A-6 (5)
Unified Classification	SC	SC
Chart Reference		

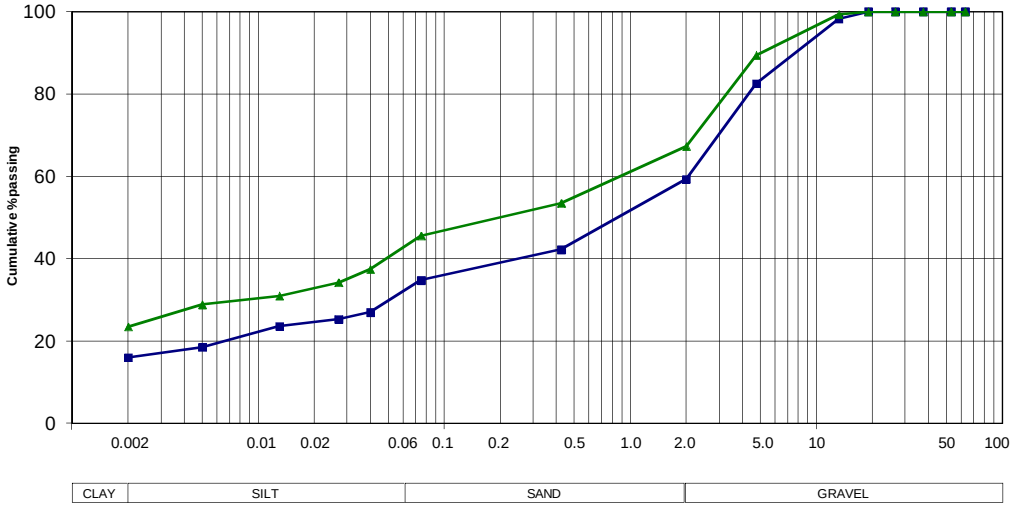
PROJECT : MEYERTON WWTW
JOB No. : S11-1328
DATE : 2011-12-13

POTENTIAL EXPANSIVENESS



PLASTICITY CHART





SOILLAB (PTY) LTD
Reg No 1971/000112/07
230 Albertus Street
La Montagne 0184
Tel (012) 481-3999
P O Box 72928
Lynnwood Ridge 0040
Fax (012) 481-3812

CLIENT : VELA VKE GEOTECH

PROJECT : MEYERTON WWTW

PROJECT NO. : S11-1328

DATE : 2012-01-23

pH & CONDUCTIVITY - TMH 1 A20 & A21T

Soillab No	Sample Position	Sample Depth (m)	pH	Electrical Conductivity S/m
S11-1328-02	MW 02B	0.3-1.0	7.82	0.0223
S11-1328-04	MW 03	2.0-2.5	6.51	0.0115
S11-1328-07	MW 01	0-0.5	5.12	0.0204
S11-1328-09	MW 05	3.0	10.02	0.0650

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Fax (012) 481-3812

SOIL ANALYSIS BY ..... : SOILLAB (Pty) Ltd
Lab reference No. ..... : S11-1328

Date Printed : 2012-02-01

Customer ..... : VELA VKE GEOTECHNICAL
Job Description ..... : MEYERTON WWTW
Road Number ..... :

Job Number ..... : S11-1328
Contract Number .... :
Date ..... : 2011-12-13

SAMPLE DESCRIPTION						
Sample Number	49215	49216				
Sample Position	MW02	MW04				
Sample Depth (mm)	300-1000	500-2000				
Material Description						
Max size of boulder (mm)						
SCREEN ANALYSIS (% PASS)						
75,00 mm						
63,00 mm						
53,00 mm						
37,50 mm						
26,50 mm						
19,00 mm						
13,20 mm						
4,750 mm						
2,000 mm						
0,425 mm						
0,075 mm						
SOIL MORTAR						
Coarse Sand 2,000-0,425						
Coarse Fine Sd 0,425-0,250						
Medium Fine Sd 0,250-0,150						
Fine Fine Sand 0,150-0,075						
Material <0,075						
CONSTANTS						
Grading Modulus						
Liquid Limit						
Plasticity Index						
Linear Shrinkage (%)						
Sand Equivalent						
Classification - TRB						
Classification - COLTO						
CBR / UCS VALUES	CBR	CBR				
MOD. AASHTO						
Max Dry Density (kg/m³)	2039	2044				
Optimum Moisture Cont (%) ...	9.6	9.1				
Moulding Moisture Cont (%) ...	9.4	8.8				
Dry Density (kg/m³)	2083	2079				
% of Max Dry Density	102.2	101.7				
100% Mod CBR/UCS	114	82				
% Swell	0.1	0.0				
NRB						
Dry Density (kg/m³)	1952	1987				
% of Max Dry Density	95.7	97.2				
100% NRB CBR/UCS	57	51				
% Swell	0.1	0.0				
PROCTOR						
Dry Density (kg/m³)	1878	1894				
% of Max Dry Density	92.1	92.7				
100% Proc CBR/UCS	21	24				
% Swell	0.1	0.0				
CBR / UCS VALUES						
100% Mod AASHTO	90	68				
98% Mod AASHTO	73	55				
97% Mod AASHTO	65	49				
95% Mod AASHTO	47	35				
93% Mod AASHTO	27	25				
90% Mod AASHTO	12	15				
SOILLAB NO.	S11-1328-02	S11-1238-05				

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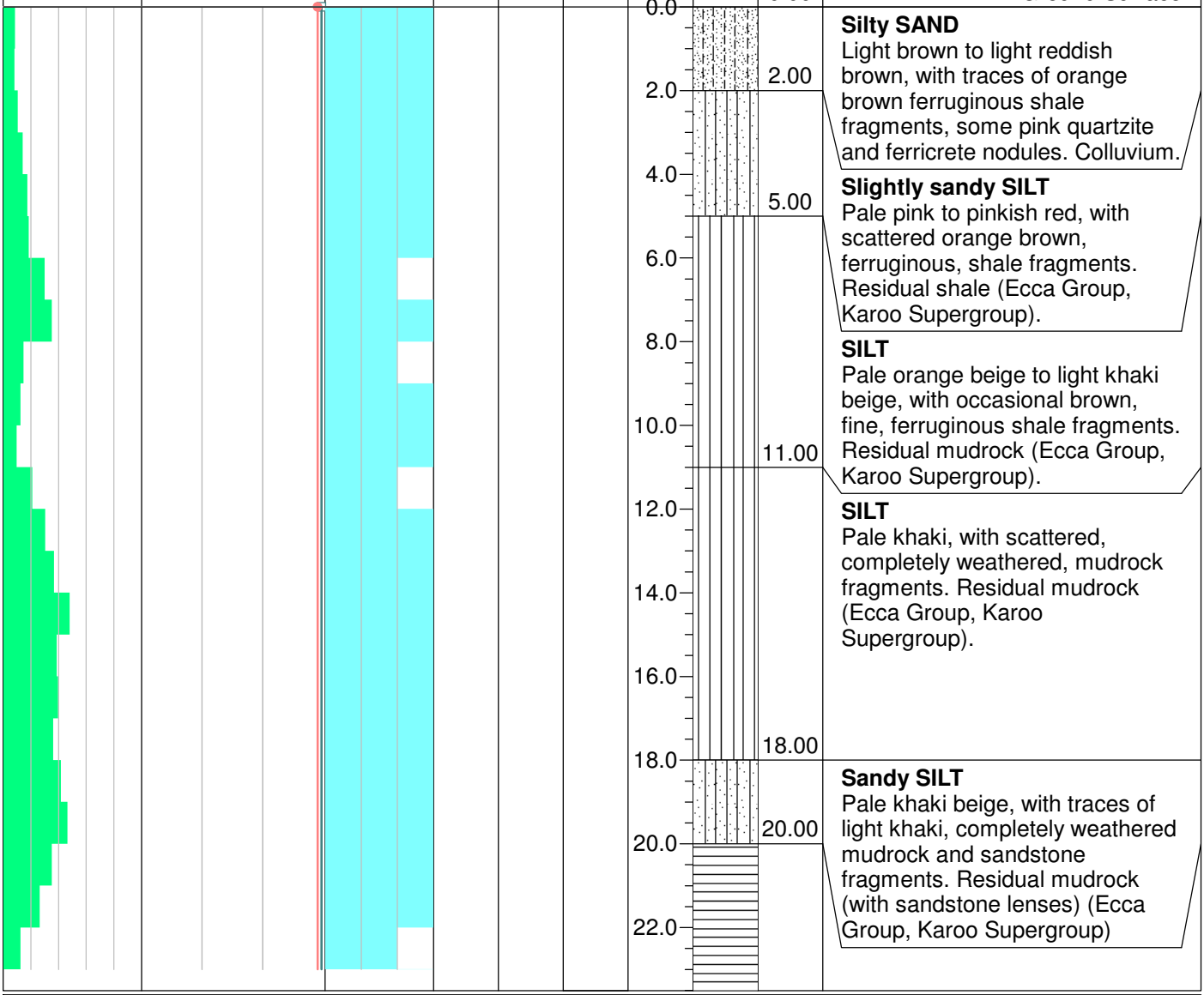
Appendix

Percussion Borehole Profile

PERCUSSION BOREHOLE LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW
PROJECT NO:

HOLE NO: MW02
X COORD: 2,941,736
Y COORD: WGS27 -96,736
ELEVATION:



Description
Ground Surface
Silty SAND Light brown to light reddish brown, with traces of orange brown ferruginous shale fragments, some pink quartzite and ferricrete nodules. Colluvium.
Slightly sandy SILT Pale pink to pinkish red, with scattered orange brown, ferruginous, shale fragments. Residual shale (Ecca Group, Karoo Supergroup).
SILT Pale orange beige to light khaki beige, with occasional brown, fine, ferruginous shale fragments. Residual mudrock (Ecca Group, Karoo Supergroup).
SILT Pale khaki, with scattered, completely weathered, mudrock fragments. Residual mudrock (Ecca Group, Karoo Supergroup).
Sandy SILT Pale khaki beige, with traces of light khaki, completely weathered mudrock and sandstone fragments. Residual mudrock (with sandstone lenses) (Ecca Group, Karoo Supergroup)

NOTES 1: Hammer Action: 0 = none, 1=v.irregular, 2=irregular, 3=regular
2: Groundwater strike at 31m and 36m during drilling operations
3:
4:
5:
6:

CONTRACTOR: J.K. Developments CC
INCLINATION: Vertical
DIAM/COMP: 165mm
MACHINE: Thor (18 Bar)
HAMMER TYPE:

DATE DRILLED: 15/02/2012
DATE LOGGED: 25-26/02/2012
LOGGED BY: Ed Shedden
PROF. REG.:

FILE REF:

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Consulting Engineers
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www.velavke.co.za

PERCUSSION BOREHOLE LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW
PROJECT NO:

HOLE NO: MW02
X COORD: 2,941,736
Y COORD: WGS27 -96,736
ELEVATION:

Penetration Rate (min/m) 1 2 3 4	Sample Recovery 33 66 / Air Return 33 66	Hammer Action *see note 1 2	Chip Size (max)	Chip Size (ave)	Scale	Symbol	Depth	Description
					25.0		25.00	**Very soft rock, carbonaceous SHALE** Grey to dark grey, weathered, in minor matrix of dark grey silt. (Ecca Group, Karoo Supergroup)
					27.0			**Coal** Black, vitrious (Ecca Group, Karoo Suprgroup)
					29.0			
					31.0			
					33.0		33.00	
							34.00	**COAL** Black, non-vitreous (Ecca Group, Karoo Supergroup)
					35.0		35.00	
							36.00	**Carbonaceous SHALE** Dark grey, weathered (Ecca Group, Karoo Supergroup).
					37.0		38.00	**COAL** Black, non-vitreous (Ecca Group, Karoo Supergroup).
					39.0		40.00	**Very soft rock SANDSTONE** Weathered, grey, with dark grey, weathered shale fragments and scattered fine chert fracments in minor matrix of grey silty sand.
					41.0			**Carbonaceous SHALE** Dark grey, weathered (Ecca Group, Karoo Supergroup)
					43.0			**Hole stopped at required depth** ~~No dolomitic sediments~~ encountered
					45.0			End of Log

NOTES 1: Hammer Action: 0 = none, 1=v.irregular, 2=irregular, 3=regular
2: Groundwater strike at 31m and 36m during drilling operations
3:
4:
5:
6:

CONTRACTOR: J.K. Developments CC
INCLINATION: Vertical
DIAM/COMP: 165mm
MACHINE: Thor (18 Bar)
HAMMER TYPE:
FILE REF:

DATE DRILLED: 15/02/2012
DATE LOGGED: 25-26/02/2012
LOGGED BY: Ed Shedden
PROF. REG.:

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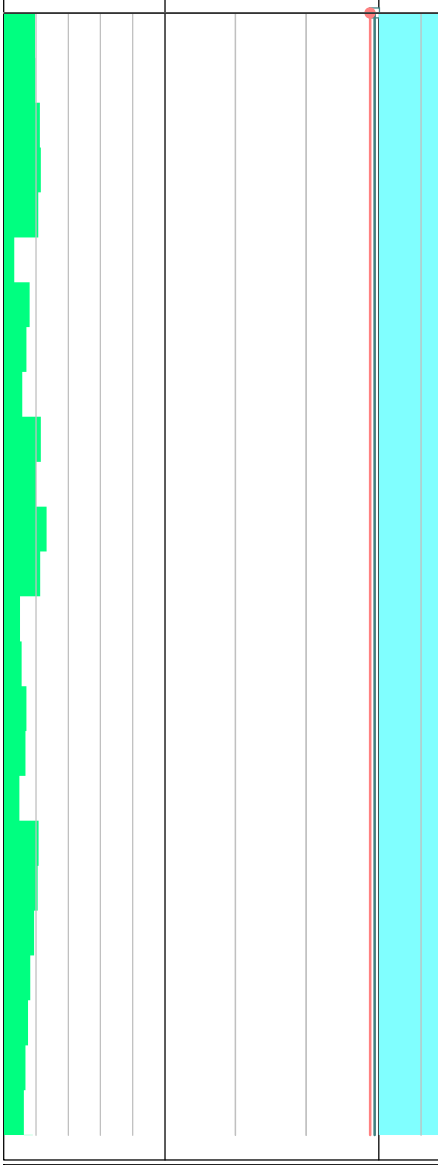
PERCUSSION BOREHOLE LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW
PROJECT NO: PJ096KJP

HOLE NO: MW04
X COORD: 2,941,676
Y COORD: WGS27 -96,959
ELEVATION:



Description
Ground Surface
Sandy SILT Brown, with traces of brown ferricrete nodules and pale orange brown ferruginous shale fragments. Colluvium.
Slightly sandy SILT Pale orange brown, with traces of mauve, highly weathered, ferruginous, shale fragments. Residual shale (Ecca Group, Karoo Supergroup).
SILT Pale creamy orange to khaki, with occasional pale khaki, highly weathered, mudrock fragments. Residual mudrock (Ecca Group, Karoo Supergroup).
Silty SAND Pale brown, with traces of beige, highly weathered, sandstone fragments. Residual sandstone (Ecca Group, Karoo Supergroup).
Sandy SILT Pale orange to pale orange beige, with traces of beige, highly weathered mudrock fragments and some beige, highly weathered sandstone fragments. Residual mudrock (with sandstone lenses) (Ecca Group, Karoo Supergroup)

NOTES 1: Hammer Action: 0 = none, 1=v.irregular, 2=irregular, 3=regular
2: Groundwater strike at 21m during drilling operations
3: Clay cutter used between 6 and 12m
4:
5:
6:

CONTRACTOR: J.K. Developments CC
INCLINATION: Vertical
DIAM/COMP: 165mm
MACHINE: Thor (18 Bar)
HAMMER TYPE:
FILE REF:

DATE DRILLED: 15/02/2012
DATE LOGGED: 25-26/02/2012
LOGGED BY: Ed Shedden
PROF. REG.:

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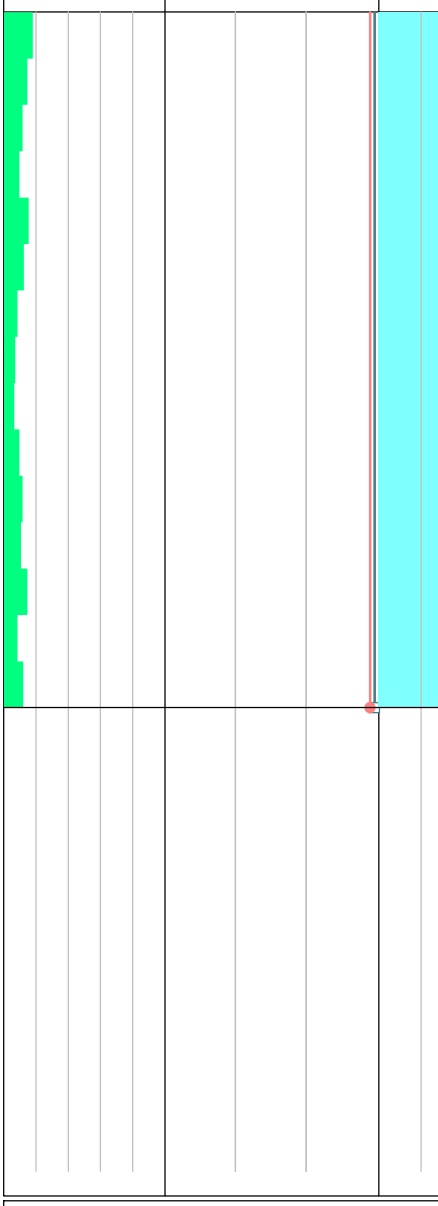
PERCUSSION BOREHOLE LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW
PROJECT NO: PJ096KJP

HOLE NO: MW04
X COORD: 2,941,676
Y COORD: WGS27 -96,959
ELEVATION:



Description

Sandy SILT
Pale greyish brown, with minor, dark grey, highly weathered to weathered, carbonaceous shale fragments, some beige mudrock fragments (contamination?). Residual carbonaceous shale (Ecca Group, Karoo Supergroup)
Minor beige, highly weathered sandstone fragments at 23 - 25m (Interpreted as sandstone lens within shale)

Very soft rock, carbonaceous SHALE
Grey, weathered. (Ecca Group, Karoo Supergroup)

COAL BEDS
Black, non-vitreous coal fragments, beige sandstone and occasional shale fragments in a trace matrix of dark grey, silty sand. Interpreted as coal beds (Ecca Group, Karoo Supergroup)

Carbonaceous SANDSTONE
Grey, weathered, with black non-vitreous coal and some gritstone fragments in a trace matrix of grey silty sand.
Interpreted as sandstone, with intercalated coal lenses (Ecca Group, Karoo Supergroup)

COAL
Black, non-vitreous, with subordinate grey, carbonaceous sandstone fragments.
Interpreted as coal, with occasional lenses of sandstone (Ecca Group, Karoo Supergroup)

NOTES 1: Hammer Action: 0 = none, 1=v.irregular, 2=irregular, 3=regular
2: Groundwater strike at 21m during drilling operations
3: Clay cutter used between 6 and 12m
4:
5:
6:

CONTRACTOR: J.K. Developments CC
INCLINATION: Vertical
DIAM/COMP: 165mm
MACHINE: Thor (18 Bar)
HAMMER TYPE:

DATE DRILLED: 15/02/2012
DATE LOGGED: 25-26/02/2012
LOGGED BY: Ed Shedden
PROF. REG.:

FILE REF:

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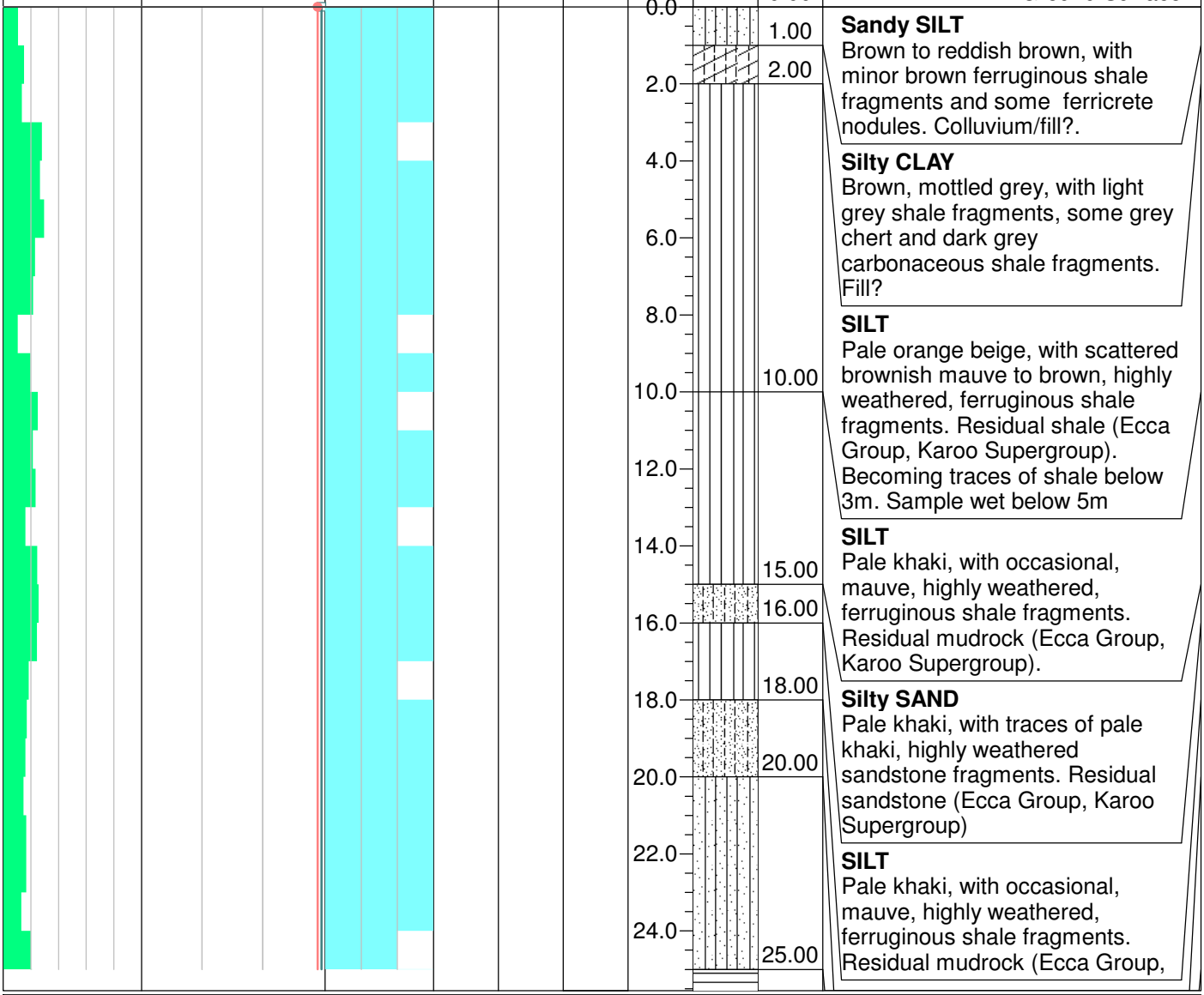
PERCUSSION BOREHOLE LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW
PROJECT NO: PJ096KJP

HOLE NO: MW05
X COORD: 2,941,770
Y COORD: WGS27 -96,936
ELEVATION:



Description
Ground Surface
Sandy SILT Brown to reddish brown, with minor brown ferruginous shale fragments and some ferricrete nodules. Colluvium/fill?.
Silty CLAY Brown, mottled grey, with light grey shale fragments, some grey chert and dark grey carbonaceous shale fragments. Fill?
SILT Pale orange beige, with scattered brownish mauve to brown, highly weathered, ferruginous shale fragments. Residual shale (Ecca Group, Karoo Supergroup). Becoming traces of shale below 3m. Sample wet below 5m
SILT Pale khaki, with occasional, mauve, highly weathered, ferruginous shale fragments. Residual mudrock (Ecca Group, Karoo Supergroup).
Silty SAND Pale khaki, with traces of pale khaki, highly weathered sandstone fragments. Residual sandstone (Ecca Group, Karoo Supergroup)
SILT Pale khaki, with occasional, mauve, highly weathered, ferruginous shale fragments. Residual mudrock (Ecca Group,

NOTES 1: Hammer Action: 0 = none, 1=v.irregular, 2=irregular, 3=regular
2: Groundwater strike at 9.0m during drilling operations
3: Clay cutter used between 9 and 16m
4:
5:
6:

CONTRACTOR: J.K. Developments CC
INCLINATION: Vertical
DIAM/COMP: 165mm
MACHINE: Thor (18 Bar)
HAMMER TYPE:

DATE DRILLED: 15/02/2012
DATE LOGGED: 25-26/02/2012
LOGGED BY: Ed Shedden
PROF. REG.:

FILE REF:

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PERCUSSION BOREHOLE LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW
PROJECT NO: PJ096KJP

HOLE NO: MW05
X COORD: 2,941,770
Y COORD: WGS27 -96,936
ELEVATION:

Penetration Rate (min/m) 1 2 3 4	Sample Recovery 33 66 / Air Return 33 66	Hammer Action *see note 1 2	Chip Size (max)	Chip Size (ave)	Scale	Symbol	Depth	Description
					27.0			**Silty SAND** Pale khaki, with traces of pale khaki, highly weathered, sandstone fragments. Residual sandstone (Ecca Group, Karoo Supergroup)
					29.0			**Sandy SILT** Pale greyish brown, with grey, highly weathered, carbonaceous sandstone fragments, some dark grey siltstone fragments and beige sandstone fragments. Residual sandstone (Ecca Group, Karoo Supergroup).
					31.0			
					33.0			
					35.0			**Very soft rock, carbonaceous SHALE** Grey to dark grey, weathered, with intercalated lenses of dark grey, carbonaceous siltstone. (Ecca Group, Karoo Supergroup) Tends to very poor quality coal in places below 32m. Some beige sandstone lenses between 37 - 40m
					37.0			
					39.0			
							40.00	
					41.0			**COAL** Black, non-vitreous, with subordinate grey, carbonaceous shale fragments. Interpreted as coal, with occasional lenses of shale (Ecca Group, Karoo Supergroup)
					43.0			
					45.0		45.00	**Hole stopped at required depth** No dolomitic sediments encountered
					47.0			
					49.0			End of Log

NOTES 1: Hammer Action: 0 = none, 1=v.irregular, 2=irregular, 3=regular
2: Groundwater strike at 9.0m during drilling operations
3: Clay cutter used between 9 and 16m
4:
5:
6:

CONTRACTOR: J.K. Developments CC
INCLINATION: Vertical
DIAM/COMP: 165mm
MACHINE: Thor (18 Bar)
HAMMER TYPE:

DATE DRILLED: 15/02/2012
DATE LOGGED: 25-26/02/2012
LOGGED BY: Ed Shedden
PROF. REG.:

FILE REF:

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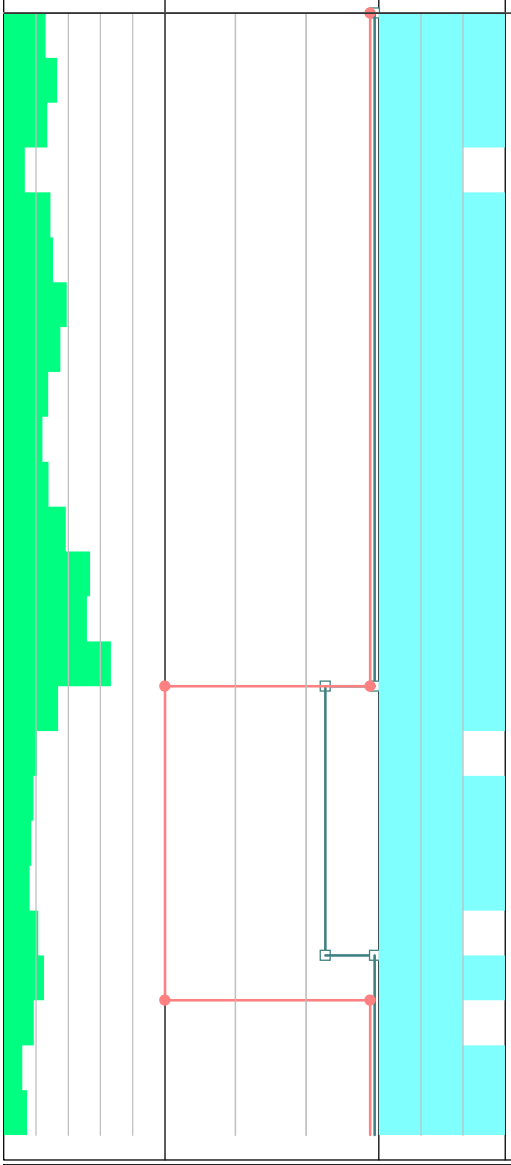
PERCUSSION BOREHOLE LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW
PROJECT NO: PJ096KJP

HOLE NO: MW07
X COORD: 2,941,781
Y COORD: WGS27 -96,857
ELEVATION:



Chip Size (max)	Chip Size (ave)	Scale	Symbol	Depth	Description
				0.00	Ground Surface
		0.0			**Silty SAND** Brown, with minor orange brown and brown, ferricrete nodules and ferruginous concretions. Colluvium (possibly as ferricrete in places).
		2.0		3.00	
		4.0		5.00	**Sandy SILT** Brown to light brown, with traces of brown and orange brown ferricrete concretions. Colluvium?
		6.0			
		8.0			**SILT** Pale orange khaki to khaki, with widely scattered pale khaki, completely weathered, mudrock fragments and some brown, fine ferricrete nodules. Residual mudrock (Ecca Group, Karoo Supergroup). Sample wet below 7m
		10.0			
		12.0			
		14.0		15.00	
		16.0			**NO SAMPLE**
		18.0			
		20.0			
		22.0		22.00	**SILT** Khaki, with scattered, dark grey, weathered, carbonaceous shale fragments. Residual mudrock (with carbonaceous shale
		24.0			

NOTES 1: Hammer Action: 0 = none, 1=v.irregular, 2=irregular, 3=regular
2: Groundwater strike at 23m during drilling operations
3: Clay cutter used between 0 and 22m
4: Water added between 1m and 15m
5:
6:

CONTRACTOR: J.K. Developments CC
INCLINATION: Vertical
DIAM/COMP: 165mm
MACHINE: Thor (18 Bar)
HAMMER TYPE:
FILE REF:

DATE DRILLED: 15/02/2012
DATE LOGGED: 25-26/02/2012
LOGGED BY: Ed Shedden
PROF. REG.:

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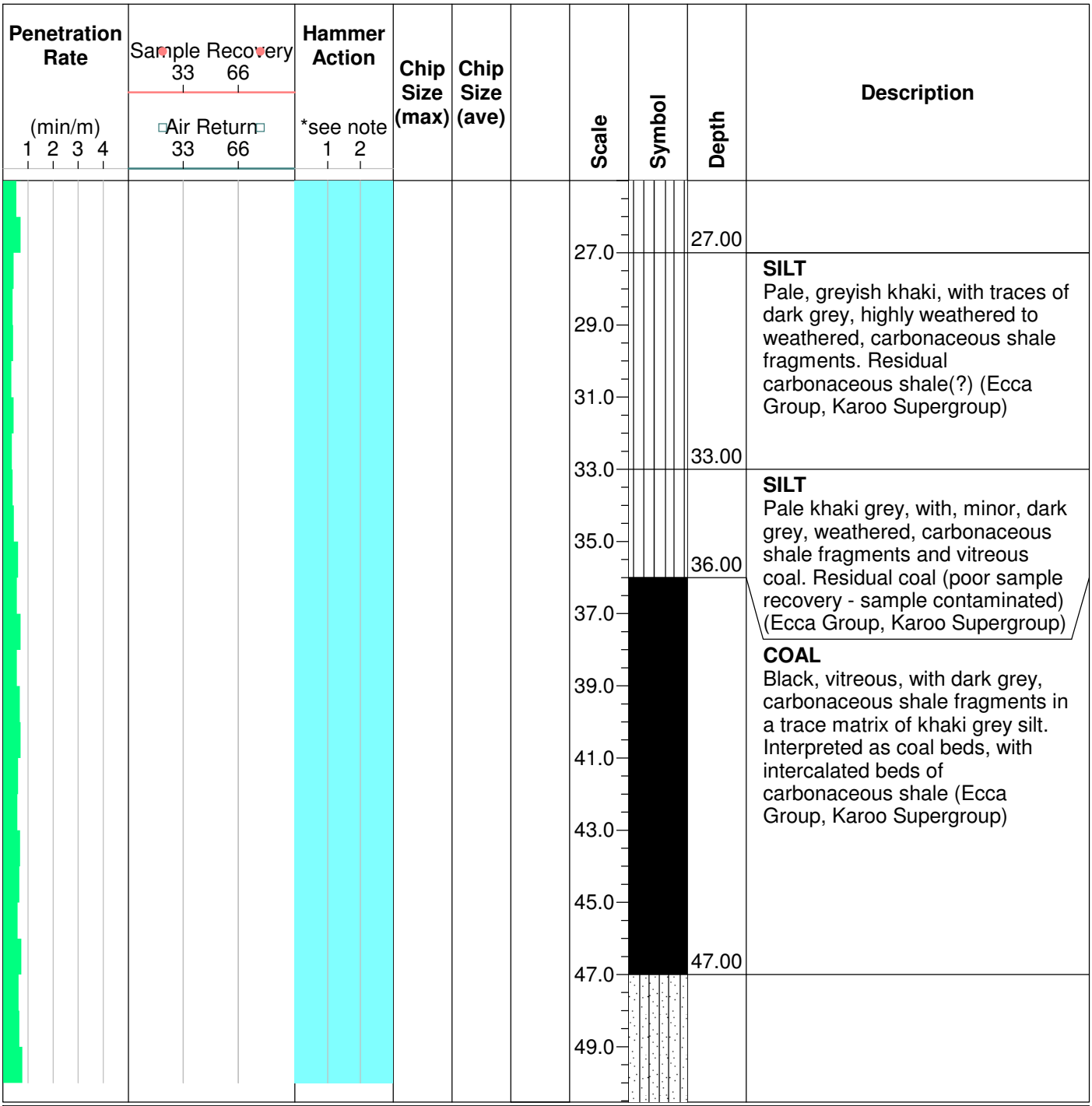
PERCUSSION BOREHOLE LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW
PROJECT NO: PJ096KJP

HOLE NO: MW07
X COORD: 2,941,781
Y COORD: WGS27 -96,857
ELEVATION:



SILT
Pale, greyish khaki, with traces of dark grey, highly weathered to weathered, carbonaceous shale fragments. Residual carbonaceous shale(?) (Ecca Group, Karoo Supergroup)

SILT
Pale khaki grey, with, minor, dark grey, weathered, carbonaceous shale fragments and vitreous coal. Residual coal (poor sample recovery - sample contaminated) (Ecca Group, Karoo Supergroup)

COAL
Black, vitreous, with dark grey, carbonaceous shale fragments in a trace matrix of khaki grey silt. Interpreted as coal beds, with intercalated beds of carbonaceous shale (Ecca Group, Karoo Supergroup)

NOTES 1: Hammer Action: 0 = none, 1=v.irregular, 2=irregular, 3=regular
2: Groundwater strike at 23m during drilling operations
3: Clay cutter used between 0 and 22m
4: Water added between 1m and 15m
5:
6:

CONTRACTOR: J.K. Developments CC
INCLINATION: Vertical
DIAM/COMP: 165mm
MACHINE: Thor (18 Bar)
HAMMER TYPE:
FILE REF:

DATE DRILLED: 15/02/2012
DATE LOGGED: 25-26/02/2012
LOGGED BY: Ed Shedden
PROF. REG.:

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PERCUSSION BOREHOLE LOG

CLIENT: MSA Group Environmental
PROJECT: Meyerton WWTW
PROJECT NO: PJ096KJP

HOLE NO: MW07
X COORD: 2,941,781
Y COORD: WGS27 -96,857
ELEVATION:

Penetration Rate (min/m) 1 2 3 4	Sample Recovery 33 66 / Air Return 33 66	Hammer Action *see note 1 2	Chip Size (max)	Chip Size (ave)	Scale	Symbol	Depth	Description
					52.0 54.0 56.0 58.0 60.0 62.0 64.0 66.0 68.0 70.0 72.0 74.0		60.00	**Slightly sandy SILT** Pale greyish brown, with traces of dark grey, weathered, carbonaceous shale and grey, weathered sandstone fragments. Residual carbonaceous sandstone, with intercalated lenses of carbonaceous shale (Ecca Group, Karoo Supergroup). Scattered grey, chert fragments below 56m suggests diamictite (very poor sample recovery below 55m - pale grey slurry with a few clasts)
								Hole stopped at required depth No dolomitic sediments encountered

End of Log

NOTES 1: Hammer Action: 0 = none, 1=v.irregular, 2=irregular, 3=regular
2: Groundwater strike at 23m during drilling operations
3: Clay cutter used between 0 and 22m
4: Water added between 1m and 15m
5:
6:

CONTRACTOR: J.K. Developments CC
INCLINATION: Vertical
DIAM/COMP: 165mm
MACHINE: Thor (18 Bar)
HAMMER TYPE:
FILE REF:

DATE DRILLED: 15/02/2012
DATE LOGGED: 25-26/02/2012
LOGGED BY: Ed Shedden
PROF. REG.:

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Consulting Engineers
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Appendix

F

Council for Geoscience:
Letter of comment

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Fax: +27 (0)12 841 1221
email: info@geoscience.org.za
website: www.geoscience.org.za

Council for Geoscience

Our Reference: F4021.1
Meyerton WWTW upgrade
Your Reference: PJ096/KJP/2012/03/2371
Enquiries : S Richardson
Tel: 012 841 1150
Fax: 086 676 9546
No. of Pages: 4

16 April 2012

Vela VKE Consulting Engineers
230 Albertus Street,
La Montagne,
0184

Attention: E Odendaal

Fax: +27 (12) 803 7943
Email: OdendaalE@velavke.co.za

Dear Sir/ Madam,

MEYERTON WASTE WATER TREATMENT WORKS UPGRADE

Your firm, Vela VKE Consulting Engineers submitted a report "Geotechnical report for Meyerton WWTW upgrade, Gauteng", dated March 2012 to this office for comment on 2 March 2012.

The Meyerton Waste Water Treatment Works (WWTW) is situated about 2km west of the R59, and just east of a brick factory and clay mine within an industrial area, in the South west of Meyerton CBD, located within the Midvaal Local Municipality. The WWTW comprises buildings, sludge ponds, drying beds, effluent dam and a clarifier tank to the north, with irrigation fields covering the southern part of the site. An aeration/balancing pond, with a settling plant, is located about 260m south-east of the site, connected to the rest of the plant by an underground channel, with an additional water and sludge pipeline. The surrounding area is undeveloped.

According to the geological map, the entire site is underlain by sandstone, shale and coal of the Ecca Group, Karoo Supergroup. These Karoo sediments were deposited onto the underlying dolomite. Boreholes in the vicinity of the site show the dolomite to be covered by 6m - >50m of Ecca Sediments, the shallow dolomite being approximately 400m to the south east.

Vela VKE indicates that several old sinkholes have been recorded in the area south of the site.

Four percussion boreholes were drilled across the site. The site is situated in the Lower Klip River north Groundwater Compartment. The water table is expected between 40m and 60m below surface (DWA). Water levels recorded in the boreholes drilled on site were in the order of 25m-27m below surface, and perched water was encountered in Test pit MW1.

Having reviewed the report;

- The four percussion boreholes were drilled to between 40m and 60m encountering Karoo sediments and coal beds. No dolomite was encountered in any of the boreholes.

- Vela VKE has classified the site as Inherent Hazard Class (IHC) 1 and assigned a Dolomite Area Designation of D2. Vela VKE concludes that the site is "dolomitic", but is covered by significantly thick Karoo Sediments.

This office is in broad agreement that the boreholes drilled on site represent low hazard conditions and the D designation is supported.

Therefore this office has no objection to the upgrading of the Meyerton Waste Water Treatment Plant from a dolomite stability perspective, conditional to the following;

a) An audit of wet services shall be carried out on the entire site and this shall be reported to the Local Authority. Any shortcomings identified shall be rectified to the satisfaction of the Local Authority.

b) The Builder must inform the professional team when the service/foundation trenches are open for inspection takes place. The results of these inspections and quality control must be recorded in a construction report (copy to the Local Authority and this Office).

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

d) A Dolomite Risk Management Plan must be implemented for the site.

e) Wet services should be laid exactly where indicated on the drawings presented to the Local Authority. The Builder or his appointed professional team should certify that they have been placed as indicated. The Owner/responsible person must also have a copy of the exact plan presented to this Office.

f) Adequate paving around the structures should always exist and all storm water must be discharged in the municipal storm water system. Roof water may thus not cascade off the apron and directly into the soil. The property should be landscaped in a way that the storm water is channelled away from the structures and in principle as shown on the drawings

submitted. The Competent Person should, during the first year after completion of construction, visit the site after heavy rain storms to check that the storm water control system works effectively and should implement changes as deemed necessary.

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

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

Yours faithfully,

G J HEATH
ENGINEERING GEOSCIENCE UNIT

Appendix

Company Profile:
Geotechnical Services

VELAVKE

www.velavke.co.za

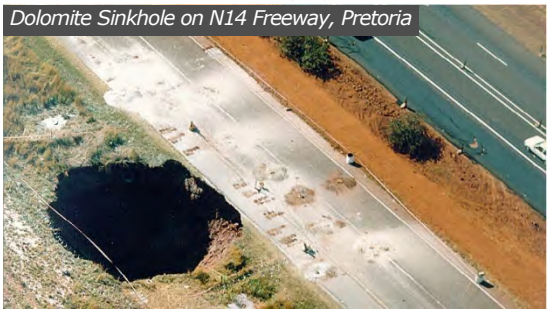
Geotechnical Services

OVERVIEW

Variable or unknown ground conditions can pose a considerable technical and financial risk to a project. The failure to carry out adequate site investigations and geotechnical designs often has had dramatic and expensive consequences on projects.

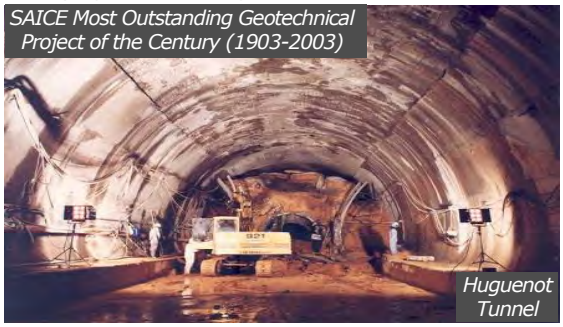

Mbabane - Manzini Highway

This risk can only be mitigated through thorough investigations and analysis by competent specialists. For this reason, the involvement of geotechnical specialists in all project stages, particularly the conceptualisation and planning stages, will optimise the cost-effectiveness of projects.


Dolomite Sinkhole on N14 Freeway, Pretoria

GEOTECHNICAL EXCELLENCE

The Geotechnical Division of the Firm offers a full range of geotechnical services to all branches of engineering and related disciplines. These services are offered throughout Sub-Saharan Africa by geotechnical engineers, engineering geologists and qualified technicians who have gained extensive experience of local, national and regional conditions through working on a vast number of projects in the region.


SAICE Most Outstanding Geotechnical Project of the Century (1903-2003)

Huguenot Tunnel


Gautrain Viaducts – South

Our personnel are experienced in working within multi-disciplinary teams where an integrated and holistic approach to a project is required. As part of a team, our geotechnical specialists add value to the design process. Emphasis is always placed on providing the Client with the required information in a directly useable format.

FIELDS OF EXPERTISE


N4 Nelspruit Bypass Investigations and Foundations

The expertise available within the Geotechnical Division is wide-ranging, and includes those fields where specialist advice is often sought by civil and structural engineers, architects, planners, developers and homeowners, as follows:

- Dolomite
- Bridges
- Undermining
- Earth Dams
- Tunnels
- Townships
- Buildings
- Roads
- Waste Disposal, including Tailings Dams


Slope Stabilisation and Walls N1-Makado, Limpopo