FILLING SERVICE STATION

A PORTION OF PORTION 41 ROOIDRAAI 34JT

ENGINEERING GEOLOGICAL INVESTIGATION

to DETERMINE the POTENTIAL for DEVELOPMENT

of a FILLING STATION and TRUCK STOP,

on a PORTION of PORTION 41 ROOIDRAAI 34JT,

LYDENBURG, MPUMALANGA PROVINCE.

Georeference: 2530AB Lydenburg

GEOSET cc

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REPORT ON THE GEOTECHNICAL INVESTIGATION CONDUCTED FOR A FILLING SERVICE STATION ON A PORTION OF PORTION 41 ROOIDRAAI 34JT, LYDENBURG, MPUMALANGA.

EXECUTIVE SUMMARY

An engineering geological investigation was conducted for the proposed development of a filling station and truck stop on a portion of Portion 41 of the farm Rooidraai 34JT, Lydenburg, Mpumalanga, with the aim to assess aspects such as geology, relief and subsoil conditions which may influence the development of the planned filling station. The site is underlain by greenish fine grained laminated shale and subordinate mudstone with interlayered carbonate layers rare with hornfels in places, of the Lydenburg Member (Vsl), Silverton Formation, Pretoria Group, Transvaal Supergroup. Deposits of quaternary age consist of transported colluvium covering the lithology. The mechanical properties of the soil layers were determined by means of laboratory tests performed on disturbed samples taken during the profiling of trial pits. The obtained site information is evaluated with regard to the development of masonry structures by the application of standard evaluation techniques. Development zonation for township development according to the NHBRC and SAIEG were done, indicating the geotechnical conditions of the site. Zoning of the site revealed one zone classified as CH2, with moderate constraints regarding the slightly collapsible and low to medium and even highly compressible and expansive properties of the sandy clay and the possible limited excavation to 3,0m in depth that may hamper the placement of the storage tanks. **Modified normal and specialized construction** techniques as described must be used to enable proper development. It includes the prewetting of soil within foundations and compaction with a wacker compactor before placement of reinforced steel in slightly enlarged strip foundations and with reinforced masonry. No problems regarding excavatability to 1.5m depth are expected but some problems up to 3,0m can be expected on the site for the placing of the reservoir tanks, and no rock outcrop was encountered. The permeability of the material is slow enough to prevent the rapid percolation of fluids through the filling and soil. The site is suitable for use as a filling service station with a few precautionary measures such as the monitoring of a borehole to ensure the possible detection of any long term contamination.

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1. INTRODUCTION

1.1 GENERAL

On request of Mr Nico Blignaut of Welwyn in Potchefstroom, a geotechnical investigation was conducted for the proposed development of a filling station and truck stop with business centre on the property near Lydenburg.

Our quotation was accepted by the owner of the holding, and communication between us and the abovementioned parties lead to the field work, commencing on 12 August 2020.

The aim of this investigation was to identify any possible engineering geological problems before commencement of proper township proclamation and the development of a filling station and business centre.

This report is based on the visual results of the site visit and other exposed geotechnical properties on site and derived from interpretation of laboratory results.

1.2 LOCALITY

A Portion of Portion 41, Rooidraai 34JT, Lydenburg, approximately 5 hectares in size, was investigated. It is situated adjacent west of the road from Dullstroom to Lydenburg. FIGURE 1 (Appendix A) delineates the site.

1.3 AVAILABLE INFORMATION

The following was consulted during the investigation:

1.3.1 The geological map 2530 Barberton. Scale 1:250 000. The Geological Survey of South Africa.

1.3.2 The topography map 2530AB Lydenburg with a scale of 1:50 000.The Chief Directorate: Surveys and Land Information, Mowbray.

1.3.3 A Google Earth map indicating the satellite image used as base map.

2. SITE DESCRIPTION

2.1 PHYSIOGRAPHY

2.1.1 Topography

The site is located on a shallow slope towards the Doringbergspruit River.

2.1.2 Drainage

Plate flow is the dominant drainage pattern on site, and no prominent drainage channel intersects the site. Drainage occurs in an easterly direction towards the Doringbergspruit River, and later into the Steelpoort River.

2.1.3 Climate

The Lydenburg region is characterized by summer rainfall with thunderstorms, with annual rainfall figures of 758 mm (Lydenburg) recorded at the closest weather station

to the site. Winters are dry with frost common. The warmest months are normally December and January and the coldest months are June and July.

An analysis of the data confirms a Weinert's N-Value in the order of 1.5 for Lydenburg. The chemical decomposition of rocks will therefore be dominant over mechanical disintegration, and deep soil horizons will be expected in areas of poor drainage, underlain by igneous rocks.

Storm water drainage and road pavement design must incorporate the climatic extremes above.

2.1.4 Vegetation

The area is typically characterized by sourish mixed bushveld *veld type* (Acocks, 1988). The site itself is cleared and no vegetation or trees are present on site.

2.2 GEOLOGY

The site is underlain by greenish fine grained laminated shale and subordinate mudstone, interlayered carbonate layers rare with hornfels in places, of the Lydenburg Member (Vsl), Silverton Formation, Pretoria Group, Transvaal Supergroup. A dolerite dyke is present on the site itself.

Deposits of quaternary age consist of transported colluvium covering the lithology.

3. INVESTIGATION METHODS AND TECHNIQUES

3.1 SITE INVESTIGATION

All available information (paragraph 1.3) was studied before and during the site visit.

The investigation commenced with a desk study, where all relevant information is collected and compiled on a base map. The site was divided into land forms, after which the accuracy of the information was checked by means of a field visit.

Test pits were dug and representative disturbed samples were collected and tested. The position of the test pits are represented in FIGURE 4 (Appendix A). The soil profiles were described according to the methods described by Jennings *et al* (Jennings 1973). This method describes each horizon in terms of moisture content, colour, consistency, structure, type of soil and origin of the soil.

Disturbed samples of the soil materials were taken for laboratory analysis. The grading of the soils were determined by sieve and hydrometer analysis, resulting in cumulative grading curves.

The mechanical properties of the soil material are described in terms of the liquid limit and plasticity index (determined by means of the Atterberg Limit tests) and the linear shrinkage. These values can be used to calculate the potential expansiveness of the soils, and to evaluate the materials for use as construction material. The consistency of a soil is described by means of its Atterberg limits, where the effect of a change in the moisture content on the consistency of a cohesive soil is measured. According to Cernica (1982) these tests are useful "mostly for soil identification and classification". It can also be used to determine the mechanical properties of cohesive soil material[1].

The linear shrinkage test to determine the percentage shrinkage that can be expected, is performed by wetting a soil to approximately its liquid limit and drying the resultant paste in a linear shrinkage mould.

The potential expansiveness of a soil depends upon its clay content, the type of clay mineral, its chemical composition and mechanical character. A material is potentially expansive if it exhibits the following properties (Kantey and Brink, 1952):

- a clay content greater than 12 percent,
- a plasticity index of more than 12,
- a liquid limit of more than 30 percent, and
- a linear shrinkage of more than 8 percent.

The potential expansiveness (low, medium, high, very high) is calculated by means of Van der Merwe's method (Van der Merwe, 1964), where the equivalent plasticity index versus the clay content of the material is plotted on a graph divided into heave

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[1] Note that cohesionless soils (i.e. sandy material) cannot be tested for plasticity or collapse potential as this material does not contain enough fines to exhibit consistency. The taking of undisturbed samples is not possible due to disintegration.

categories. If any sample in the study area classifies as potentially expansive, the amount of heave or mobilization in mm measured on the surface will be calculated.

3.2 DYNAMIC CONE PENETROMETER (DCP) TESTS

DCP-tests are usually executed in the vicinity of the trial pits to compare and calibrate the consistency as described in the profiles. The delineation of zones, in particular those affected by collapsible or compressible material, shallow rock or a ferruginized pebble marker, can be simplified by this method.

3.3 LABORATORY TESTS

The disturbed samples taken during the investigation were tested by the laboratory of Specialised Testing Laboratory in Pretoria to determine their physical properties. Indicator tests include a grading analyses, the determination of Atterberg limits and linear shrinkage.

The results are represented in Appendix C.

Several attempts to obtain undisturbed samples were abandoned due to the loose consistency of the soil, as it was difficult to secure a sample for collapse potential tests or laboratory permeability determinations.

4. RESULTS

4.1 SOIL PROFILES

The soil profiles with accompanied plates are represented in Appendix B.

Typical profile on dolerite

Dry to slightly moist, reddish brown, dense to loose, intact, clayey sand. Hillwash.
Dry, reddish brown speckled black, dense to loose, intact, sandy clay. Hillwash.
Slightly moist, kaki speckled black & orange, dense to loose, intact, clayey sand &

gravel of highly weathered dolerite.

End of test pits were executed to refusal of the TLB at depth ranging from 2,2 to 3,0m.

No problems regarding excavatability to a depth of 1,5m can be expected on the site but problems may be encountered to reach the required depth for the installation of reservoirs.

To ensure the stability of excavations, it will need standard sidewall protection in all excavations exceeding 1,5m.

4.2 LABORATORY RESULTS

The tests of the hillwash revealed a sandy or silty clay with a clay percentage of 29%, a linear shrinkage percentage of 10%, plasticity index of 22 and a liquid limit of 48, with a Unified classification of CL as inorganic clay of low to medium plasticity, gravelly, sandy or silty clay, lean clay.

The highly weathered dolerite had a clay percentage of between 51 and 55%, plasticity indexes of 25 to 31, liquid limits of between 51 and 63 and linear shrinkage percentages of 12,5 to 25% indicating the presence of an active clay, probably montmorillonite, with an expected medium to high potential for expansiveness according to the method of heave estimation of Van der Merwe. The Unified classification was MH as inorganic silt, micaceous or fine sandy or silty soil or elastic silt with, and a PRA classification of A-7-5 to A-7-6 as highly compressible silty clay to high volume change plastic fat clay.

The moderately weathered dolerite had a lower clay percentage of 14%, a linear shrinkage percentage of 6,5%, a plastic index of 13 and a liquid limit of 59, with a medium expansive potential, and classified with the Unified system as MH as Inorganic silt, micaceous or fine sandy or silty soil, elastic silt and A-7-5 as highly compressible silty clay with the PRA classification.

The laboratory tests indicated a medium to highly heave potential according to the method of heave estimation of Van der Merwe, 1964. The expected movement measured at surface was calculated to be in excess of 15mm and even more than

30mm measured at surface as heave, resulting in a site class designation of H2 to H3.

Stabilizing of the material with 3 % cement may increase the CBR / UCS values to higher or more acceptable levels.

4.3 DYNAMIC CONE PENETROMETER TESTS

The use of *in situ* dynamic cone penetrometer tests (DCP) concluded the expected adequate bearing capacity of the hillwash.

The dry to slightly moist profile as described can change dramatically according to the moisture variations, and lower values are expected during the wet summer months.

A derived CBR (Californian Bearing Capacity Ratio) of less than 10 indicates that the bearing capacities of the soil are not sufficient and to ensure adequate foundation support, at least compaction techniques will be necessary to ensure safe building construction.

4.4 GROUND WATER

No ground water even in the form of seepage was intersected during the investigation. According to the neighbor, the water table is possibly in excess of 25m deep according to the water rest level in the borehole. Normal water tightening techniques such as damp course on foundation levels are required due to the presence of the slightly moist profile in some areas.

The Doringbergspruit River is distanced far enough to prevent a sudden spillage reaching and polluting this river, and sealed fuel tanks with sampling points near them can be used to detect and prevent this possibility of pollution. Tanks should be dipped daily and reconciliation against the volume used to ensure no loss due to leakages occurred. Periodic monitoring of a borehole will also ensure the possible detection of any long term spillage.

No water samples were retrieved to enable the physical and chemical

characterization of existing ground water, although it is possible to monitor the quality of the water should it become necessary in future when the system should be opened and sampled.

In order to evaluate the quality and suitability of the water in respect of its use as domestic potable watering purposes, physical and chemical parameters, appropriate to each of these uses, must be selected. Selection of these parameters are guided by the South African Water Quality Guidelines for Domestic and Agricultural Use (DWA&F 1993), as well as by the determinants (= parameters) given in the SABS 241 - 1999 Specification for Water for Domestic Supplies (SABS 1999). The SABS standard lays down both a recommended concentration limit as well as a maximum allowable concentration limit for drinking water parameters. The recommended concentration of each parameter relevant to drinking water quality is shown and comments on the suitability of the water for a particular use will be made with reference to the information in the South African Water Quality Guidelines. In addition to the customary physical and chemical parameters for domestic use, a microbiological examination of the water in the area should be undertaken, enabling the following bacteriological tests:

- The Standard Plate Count or heterotrophic bacteria refers to all the micro-organisms which produce visible colonies on a non-selective medium after incubation for 48 hours. It is an indicator of the general microbiological quality of the water. Total Coliform Bacteria counts are used to evaluate the general hygienic or sanitary quality of water, since they include bacteria of faecal origin, as well as several other bacterial groups. However, some coliform bacteria have their origin in the aquatic environment.

- Faecal Coliform Bacteria counts should be made, since they are considered to be much more closely associated with faecal (sewage) pollution. Faecal coliforms are bacteria which normally inhabit the indigestive system of all warm-blooded animals or human. They are the most commonly used bacterial indicator of faecal pollution. The latter are therefore used to evaluate the level of faecal contamination in effluents, rivers and other water resources to be used for drinking water supply.

Domestic water refers to water that is used for drinking, cooking, bathing and personal hygiene and laundry purposes. The concentration of any domestic water quality parameter exceeding the recommended limit is indicated by highlighting the

relevant block and indicated if it is within the recommended limits laid down by the SABS 241 - 1999 specification for domestic water supplies.

Bacterial counts including heterotrophic plate count and total coliform count is indicative of water of poor hygienic or sanitary quality, and indications of any trace of faecal coliforms will be detected.

Furthermore, according to the South African Water Quality Guidelines for Domestic Use (see Department of Water Affairs & Forestry, 1996) water containing total coli counts greater than 100 in 100 ml presents a significant and increasing risk of infectious disease transmission the greater the count.

The water tested must be evaluated according to the allowable limits for its microbiological content and comment must be made on their fitment for human consumption unless it is submitted to a treatment process. This may include ultrafiltration, ozone treatment, chlorination, chlorine gas or chlorine dioxide as treatment, especially if the Standard Plate Count Bacteria or the Total coliform colonies exceed the maximum allowable values of 10 colonies per ml and colonies per 100ml respectively.

Typical Analyses of Water Samples

Determinants mg/l	**Class 0 Ideal**	**Class I Acceptable**	**Class II Maximum Allowable**
pH value	6-9	5-9.5	4-10
@ Temperature Deg C			
Electrical conductivity mS/m	<70	70-150	150-370
TC Temperature			
Total dissolved solids @EC 6,5	<450	450-1000	1000-2400
Total dissolved solids @EC 7			
Total dissolved Solids	n.s.	n.s.	n.s.
TDS Summation	n.s.	n.s.	n.s.
P alkalinity	n.s.	n.s.	n.s.
Total alkalinity as CaCO3	n.s.	n.s.	n.s.
Calcium Ca	<30	80-150	150-300
Potassium K	<25	25-150	150-300
Magnesium Mg	<30	30-70	70-100
Sodium Na	<100	100-200	200-400
Silikon Si	n.s.	n.s.	n.s.
Fluoride	<0.7	0.7-1.0	1.0-1.5
Chloride	<100	100-200	200-600
Nitrate	<6	6-10	10-20
Phosphate	n.s.	n.s.	n.s.
Sulphate	<200	200-400	400-600
Standard plate count Bacteria colonies/1ml	0	1	10
Total coliforms colonies/100ml	0	1	10
Faecal coliforms cfu/100ml	0	1	10

5. SITE EVALUATION

During the engineering geological investigation it is essential to determine and quantify the extent of potential problems associated with the area (addressed in bold below), before proper township proclamation. The ideal conditions for urban development may be listed as follows:

* A smooth surface gradient with slopes less than 12°. Accessibility should not be restricted by topography (plateau areas).
* No potential for slope instability features - landslides, mud flows.
* Easy excavation for foundations and installation of services (normal depth of 1,5 m required).
* Foundations above the ground water level or perched water table, with not too low permeability.
* Development above the 1:50 year flood line.
* Adequate surface and subsurface drainage conditions, with minimal erosion potential.
* No presence of problematic soils, for example **heaving clays, compressible clays**, sand with some collapse potential, or dispersive soils, that will require expensive remedial measures.
* No potential for surface subsidence due to the presence of dolomite (sinkholes) or undermining.
* No damaging differential subsidence or movement (less than 5mm total movement at the surface allowed).

Further conditions or core parameters to suit the development for the placement of a filling service station:

- Placement of site with reference to development – on busy roads or intersections, out of sight and downwind from the town and far enough from water extraction points or production boreholes.
- Deep soil profile with **excavatability depth** of at least 2,0m, preferably 3,0m for the placement of the reservoir tanks.
- The permeability of the underlain material of between 10^{-4} and 10^{-5} cm/s for sufficient slow movement and decay of leach.
- A buffer zone of at least 1,5m to 2,0m between the top of the groundwater level.
- No drainage channels near or through the site.
- Canalizing of runoff storm water.
- A **borehole situated downstream** should be drilled to serve as a reference for sampling and monitoring the levels of possible contamination.

5.1 EVALUATION FOR URBAN DEVELOPMENT

Seepage and the presence of perennial fluctuations of ground water were not encountered on site.

Special care must be taken to ensure adequate surface drainage to prevent the accumulation of water next to structures, and the excessive erosion of this clayey silty sand (with a lack of cohesion between the sand) material must be prohibited,.

The site contains moderate to highly compressible and expansive soils relevant to variable moisture content and foundations will need specialized treatment.

Some problems regarding excavatability to 1.5m depth can be expected on the site, but no rock outcrop was encountered.

The permeability of the material is slow enough to prevent the rapid percolation of fluids through the soil, and it more than doubles with soil compaction and stabilization with three percent cement.

Retaining walls as well as slope stabilization measures are recommended on all constructed embankments exceeding 1,5m. Storm water diversion measures such as ponding pools are recommended to control peak flows during thunderstorms. All embankments must be adequately compacted and planted with grass to stop any excessive erosion and scouring of the landscape.

5.2 ZONATION FOR URBAN DEVELOPMENT

By grouping together all the land facets with the same geotechnical characteristics, the site can be divided into development zones, this being the main objective or result of a phase 2 engineering geological investigation. Each zone can therefore be defined as a grouping of areas with specific geotechnical properties placing similar constraints upon development. With the above-mentioned criteria in mind, the study area can be divided into typical development zones for single storey residential development (NHBRC 1995):

Land suitable for development: Standard foundation techniques and normal

construction with normal site drainage and standard building practice will be adequate for development.

Land suitable for development with precaution or risk: A few precautionary measures for problematic soils in this zone are necessary before urban development can be initiated, with a higher than normal cost implication to overcome geotechnical constraints. The risk of restricted excavatability for the placing of services induce a higher cost for development.

Land not suitable for development typically comprises of the drainage features that are susceptible to annual flooding below the 1:50 year flood line, and is also associated with perched water tables. Land in close proximity of unstable ground such as a potential slope failure or mud flow induced by rainfall is also not suitable for development.

On account of the field observations, laboratory results, previous experience and engineering properties of the soil, it is zoned as follows (SAIEG, 1997- See tabular explanation of classification in Appendix E):

5.2.1 Zonation

Geotechnical Zonation
Special Development:
Site Class C1H1H2:
The upper soft open textured clayey sand represents this zone with slight compressible and collapsible material, underlain by moderately to slightly weathered dolerite with medium to highly expansive properties. There is a risk of limited excavatability, as we expected and the use of pneumatic tools, a competent TLB or even blasting may be required to reach the required depth of 3,0m for the placing of services and especially the reservoir tanks to enable proper development, with increased cost, but alternatively can it be placed partially below ground level. Special construction such as soil replacement with a soil raft with material of G5 quality or better, deep strip foundations and proper compaction within lightly reinforced strip footings and light reinforcement in masonry will be required, and drainage provision will be required. It was classified as CH1H2 in terms of the NHBRC.

The geotechnical problems encountered will require specialized foundation techniques and modified normal to special construction and it includes prewetted standard compaction techniques and drainage for the development.

5.3 FOUNDATION DESIGN AND BUILDING PROCEDURES

5.3.1 *Consolidation or collapse settlement*

Site Class C (Estimated total Settlement of less than 5mm):

Normal Construction:
Minor collapse settlement requires normal construction (strip footing and slab on the ground) with compaction in foundation trenches and good site drainage.

5.3.2 *Expansive soil*

Site Class H (Estimated total heave of less than 7.5mm):

Soil tested as medium expansive with a clay layer thickness of up to 0,3m from surface

Normal construction:
Minor heave requires normal construction (strip footing and slab on the ground) with site drainage and service/plumbing precautions recommended.

Site Class H1 (Estimated total heave of between 7.5 and 15mm):

Tested as medium expansive with a clay layer thickness of between 0,45 to 0,85m from surface,
or a highly expansive clay layer of between 0,3 and 0,4m in thickness from surface
or a clay layer with a very high expansive potential of up to 0.3m.

Modified normal:
Lightly reinforced strip footings.
Articulation joints at all internal/external doors and openings
Light reinforcement in masonry.
Site drainage and plumbing/service precautions.

Or soil raft:
Remove all or part of expansive horizon to 1,0m beyond the perimeter of the construction and replace with inert backfill compacted to 93% MOD AASHTO density at -1% to 2% of optimum moisture content.
Normal construction with lightly reinforced strip footings and masonry.
Site drainage and plumbing/service precautions.

Site Class H2 (Estimated total heave of between 15 and 30mm):

Tested as medium expansive with a clay layer thickness of between 0,85 to 2,0m,
or highly expansive of between 0,4 and 0,85m in thickness measured from surface,
or a clay layer with a very high expansive potential of between 0.3 and 0.4m.

Soil raft:
See H1.

Stiffened or cellular raft:
Articulation joints or solid lightly reinforced masonry.
Site drainage and plumbing/service precautions.

Piled construction:
Piled foundation with suspended floor slabs with or without ground beams.
Site drainage and plumbing/service precautions.

Split construction:

Combination of reinforced brickwork/blockwork and full movement joints.
Suspended floors or fabric reinforced ground slabs.
Site drainage and plumbing/service precautions.

Site Class H3 (Estimated total heave of more than 30mm):

Soil tested as medium expansive with a clay layer thickness of more than 2,0m (>2,0m thick), or highly expansive of more than 0,85m (0,85m or more in thickness), or a clay layer with a very high expansive potential of more than 0.4m in thickness. Foundations require special design by structural engineer of the following:

Soil raft:
As for H1.

Stiffened or cellular raft:
As for H2.

Piled construction:
As for H2.

5.4 CONSTRUCTION MATERIALS

Due to the level of development surrounding the area, the likelihood for the development of borrow pits are low.

The material tested is not suitable for bedding of the tanks and pipes due to the clayey nature.

All road building and construction materials will be sourced from established commercial activities in and around Lydenburg.

6. CONCLUSIONS

1. A site of approximately 5 hectares, on a portion of Portion 41 of the farm Rooidraai 34JT, Lydenburg, Mpumalanga, was investigated to determine the engineering geological properties that will influence township proclamation and the development of a filling service station with truck stop and business centre.

2. The site is underlain by greenish fine grained laminated shale and subordinate mudstone, interlayered carbonate layers rare with hornfels in places, of the Lydenburg Member (Vsl), Silverton Formation, Pretoria Group, Transvaal Supergroup, with a dolerite dyke on site. Deposits of quaternary age consist of transported hillwash covering the lithology.

3. No problems are foreseen regarding excavatability to 1,5m, although a large excavator may be required to reach 3,0m during the installation of the reservoirs.

4. The permeability of the soil material is slow enough to prevent the rapid percolation of fluids through the soil, and it will increase with soil compaction and stabilization with two to three percent cement.

5. Zoning of the site revealed a zone with moderate constraints regarding the medium to highly **consolidation and expansiveness** of the material, and it was zoned as follows:

Geotechnical Zonation

Modified Normal to Special Development:

Site Class CH2: The hillwash comprising soft open textured clayey sand with slightly collapsible and compressible or medium expansive material, underlain by a pebble marker and moderately to slightly weathered dolerite with medium to highly expansive properties, with up to 30mm of movement measured at surface as heave. No problems are foreseen regarding the excavations to 1,5m for the foundations but the use of pneumatic tools, a competent TLB or even blasting may be required to reach the required depth of 3,0m for the placing of some services and especially the reservoir tanks to enable proper development, with increased cost, but alternatively can it be placed at shallower depths partially below ground level. Special construction such as soil replacement with a soil raft with material of G5 quality or better, deep strip foundations and proper compaction within lightly reinforced strip footings and light reinforcement in masonry will be required, and drainage provision will be required. It was classified as CH2 in terms of the NHBRC.

6. **Modified normal and specialized construction** techniques as described must be used to enable proper development.

7. The site is suitable for use as a filling station and business centre, and regular monitoring of a borehole regarding water resting depth and quality will also ensure the possible detection and prevention of any long term spillage.

8. **This investigation was done to reveal the geotechnical properties on site with the techniques as described to form our opinion. Although every possible factor during the investigation was dealt with, it is possible to encounter variable local conditions. This will require the inspection of foundations by a competent person to verify expected problems.**

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APPENDICES

APPENDIX A: FIGURES

APPENDIX B: SOIL PROFILES

Profiles with photographs

APPENDIX C: LABORATORY RESULTS

Indicator tests

APPENDIX D: TABULAR EXPLANATION OF ZONING

APPENDIX A: FIGURES

GEOSET cc

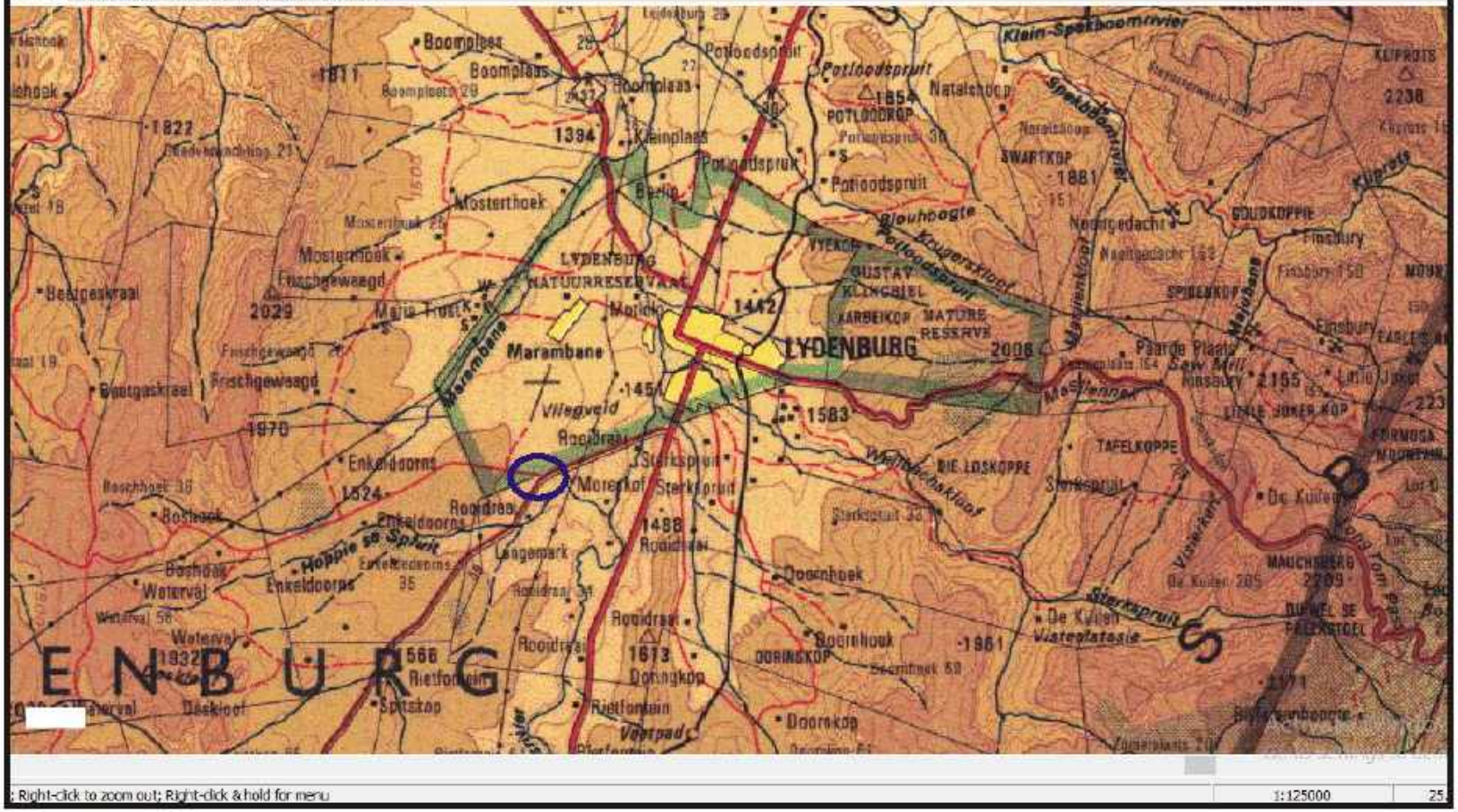
David S. van der Merwe

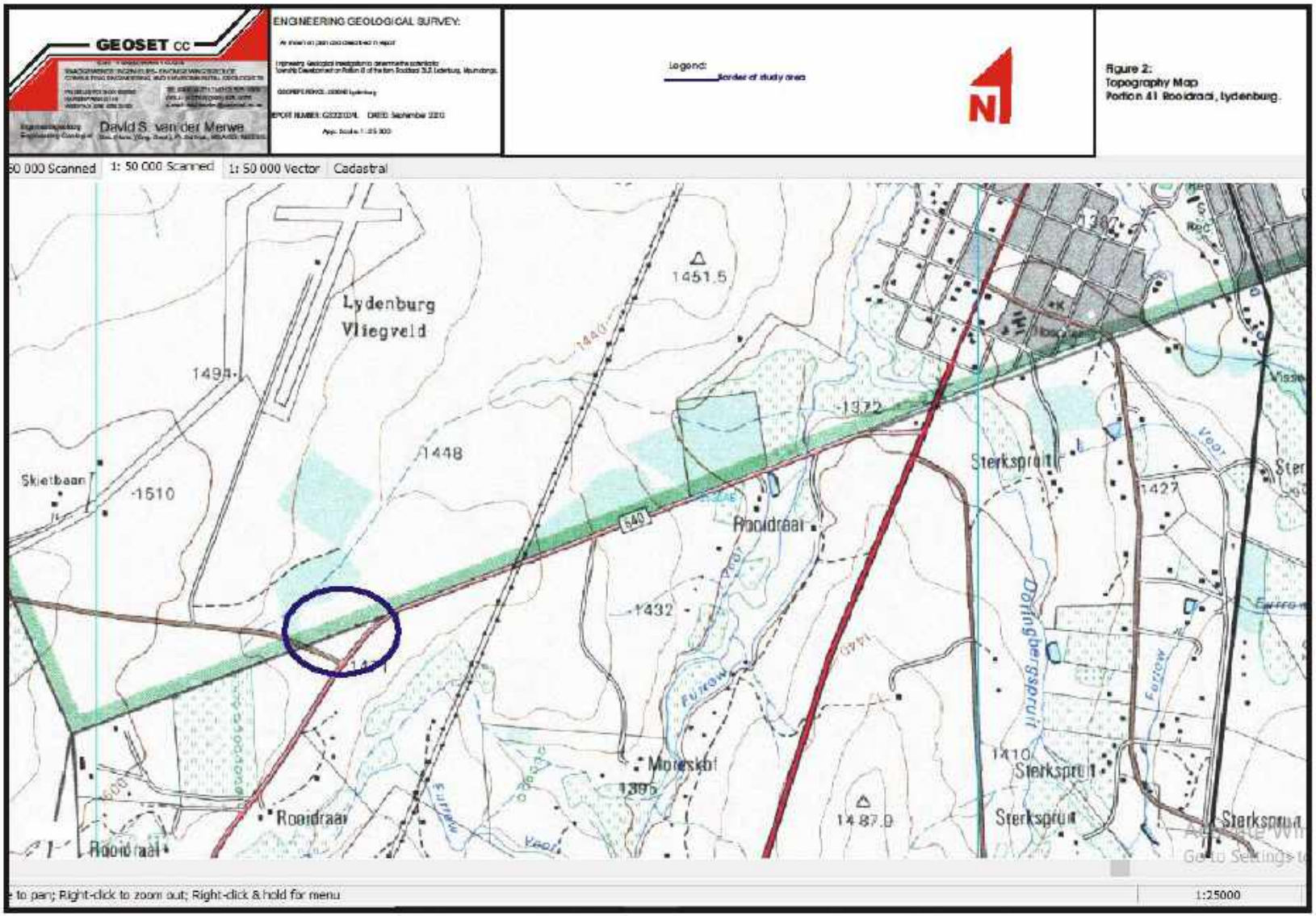
ENGINEERING GEOLOGICAL SURVEY:

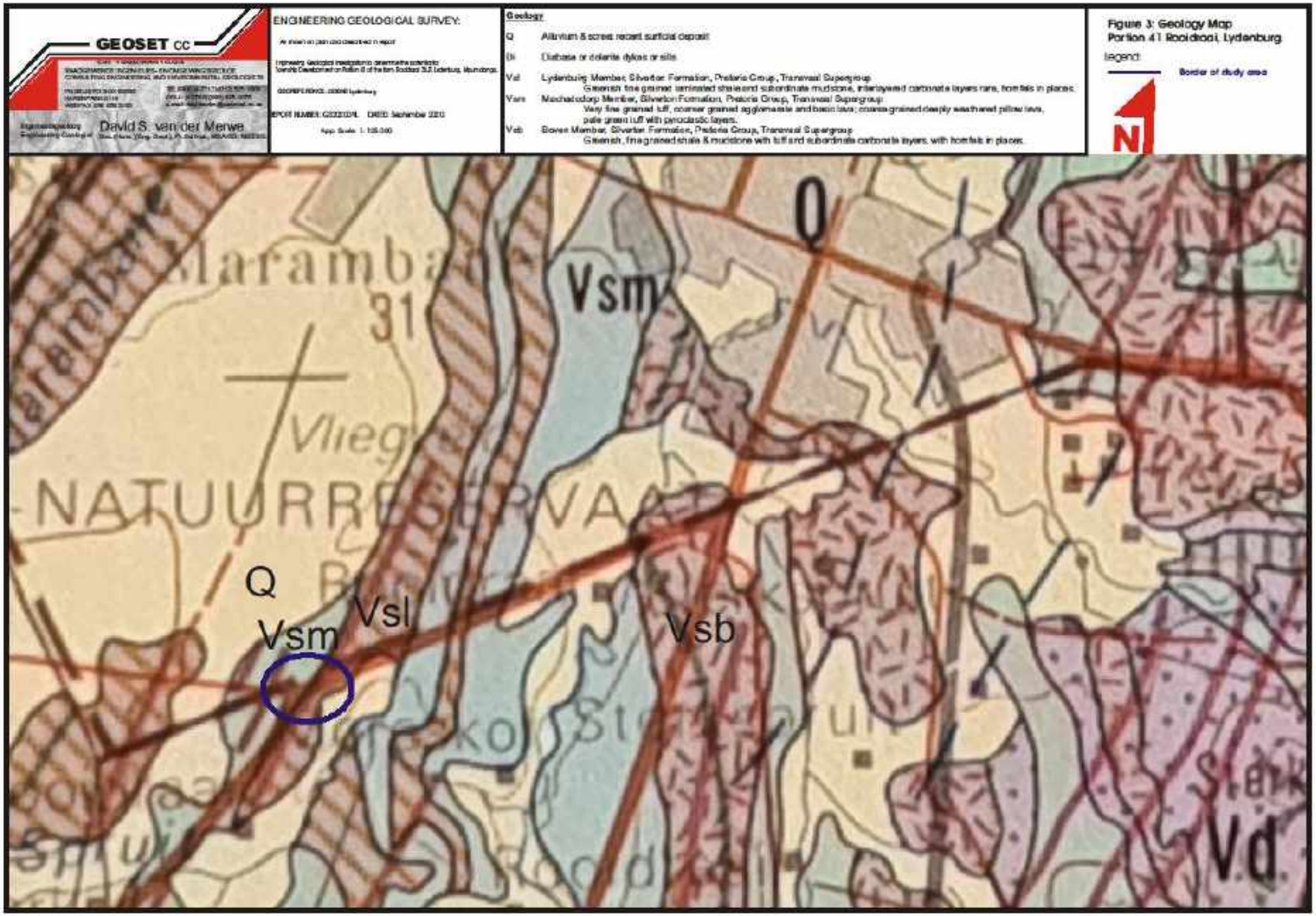
Legend:

Border of study area

Figure 1: Regional Locality Map
Portion 41 Rooidraai, Lydenburg.




GEOSET cc
David S. van der Merwe
ENGINEERING GEOLOGICAL SURVEY:
Legend:
Border of study area
N
Figure 2:
Topography Map
Portion 41 Rooidraai, Lydenburg.
50 000 Scanned
1: 50 000 Scanned
1: 50 000 Vector
Cadastral
Lydenburg
Vliegveld
1451.5
1498
1448
1510
1372
1440
Skietbaan
548
Rooidraai
Sterkspruit
1427
1432
Morelsbl
1395
1487.0
1410
Sterkspruit
Rooidraai
Rooidraai
Sterkspruit
to pan; Right-click to zoom out; Right-click & hold for menu
1:25000


GEOSET cc
David S. van der Merwe
ENGINEERING GEOLOGICAL SURVEY:
Geology
Q Alluvium & scree; recent surficial deposit
Db Diabase or dolerite dykes or sills
Vsl Lydenburg Member, Silverton Formation, Pretoria Group, Transvaal Supergroup
Greenish fine grained laminated shale and subordinate mudstone, interlayered carbonate layers rare, hornfels in places.
Vsm Machadodorp Member, Silverton Formation, Pretoria Group, Transvaal Supergroup
Very fine grained tuff, coarser grained agglomerate and basin lava; coarse grained deeply weathered pillow lava, pale green tuff with pyroclastic layers.
Vsb Boven Member, Silverton Formation, Pretoria Group, Transvaal Supergroup
Greenish, fine grained shale & mudstone with tuff and subordinate carbonate layers, with hornfels in places.
Figure 3: Geology Map
Portion 41 Rooidraai, Lydenburg
legend:
Border of study area
N
Q
Vsm
Vsl
Vsb
Vd
31

GEOSET CC

David S. van der Merwe

ENGINEERING GEOLOGICAL SURVEY:

As shown on plan and described in report

Engineering Geological Investigation to determine the potential for Township Development on Portion 41 of the farm Rooidraai 35 JT, Lydenburg, Mpumalanga.

GEOREFERENCE: Lydenburg

REPORT NUMBER: GEO2009. DATED: September 2020

Approx. Scale: 1:100 000

Geology

The area is underlain by basaltic amygdaloidal lava, agglomerate & tuff of the Alanridge Formation (Ra), and amygdaloidal lava & tuff of the Reigat Formation (Rr), Platberg Group, of the Ventersdorp Supergroup, and the site itself is covered by Kalahari sand and calcrete.

Geotechnical Zonation

Modified Normal to Special Development:
Site Class CH2:
The hillwash comprising soft open textured clayey sand with slightly collapsible and compressible or medium expansive material, underlain by a pebble marker and moderately to slightly weathered dolerite with medium to highly expansive properties, with up to 30mm of movement measured at surface as heave. No problems are foreseen regarding the excavations to 1,5m for the foundations but the use of pneumatic tools, a competent TLB or even blasting may be required to reach the required depth of 3,0m for the placing of some services and especially the reservoir tanks to enable proper development, with increased cost, but alternatively can it be placed at shallower depths partially below ground level. Special construction such as soil replacement with a soil raft with material of G5 quality or better, deep strip foundations and proper compaction within lightly reinforced strip footings and light reinforcement in masonry will be required, and drainage provision will be required. It was classified as CH2 in terms of the NHBRC.

Figure 4:
Engineering Geological Zone Map
Portion 41 Rooidraai, Lydenburg.

APPENDIX B: SOIL PROFILES

Profiles with photographs

Soil Profile Nr: L1

DATE: 12 August 2020

JOB NR: GS202009L

PROJECT NAME: Ptn 41 Rooidraai

Town: Lydenburg

CLIENT: Eben

TLB Contractor:

TLB Machine: Bell 315SK 4X4

TLB Operator: Shandoor

GEOSET CC

Consulting Engineering & Environmental Geologists

Raadgewende Ingenieurs- en Omgewingsgeoloë

P.O. Box / Posbus 60995 **Tel:** 012 525 1004

KARENPARK 0118 **Webfax:** 086 658 3190

e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075

Engineering Geologist: David S. van der Merwe.

Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2		L1-0,3	Dry, dark reddish brown, soft, open textured, sand. Hillwash.
0.3		●	
0.4			
0.5			Abundant, small & medium, angular sub to well rounded, dolerite & quartzite pebbles
0.6			& boulders. Pebble marker.
0.7			
0.8			
0.9		L1-1,0	
1.0		●	
1.1			Slightly moist, dark reddish brown, soft, shattered, silty sandy clay.
1.2			Highly weathered dolerite.
1.3			
1.4			
1.5			
1.6			
1.7			
1.8			
1.9			
2.0			Slightly moist, yellow speckled black, dense, intact, sandy clay.
2.1			Moderately weathered dolerite.
2.2			

Notes:

1. Difficult excavation & refusal on dolerite.
2. No groundwater was intersected.
3. ● Disturbed samples L1-0,3 & 1,0.

Lat/long	X Coord:	25˚07'34,94" S
WGS84 datum	Y Coord:	30˚24'49,11" E

Soil Profile Nr: L2

DATE: 12 August 2020

JOB NR: GS202009L

PROJECT NAME: Ptn 41 Rooidraai

Town: Lydenburg

CLIENT: Eben

TLB Contractor: Eben

TLB Machine: Bell 315SK 4X4

TLB Operator: Shandoor

GEOSET CC

Consulting Engineering & Environmental Geologists

Raadgewende Ingenieurs- en Omgewingsgeoloë

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e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075

Engineering Geologist: David S. van der Merwe.

Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1	I:I:I:I:I:I:I:I		
0.2	I:I:I:I:I:I:I:I		Abundant, small & medium, angular sub to well rounded, dolerite & quartzite pebbles
0.3	I:I:I:I:I:I:I:I		& boulders. Pebble marker.
0.4	I:I:I:I:I:I:I:I		
0.5	I:I:I:I:I:I:I:I		
0.6	I:I:I:I:I:I:I:I		
0.7	I:I:I:I:I:I:I:I		
0.8	I:I:I:I:I:I:I:I		
0.9	I:I:I:I:I:I:I:I		
1.0	I:I:I:I:I:I:I:I		
1.1	I:I:I:I:I:I:I:I		
1.2	I:I:I:I:I:I:I:I		
1.3	I:I:I:I:I:I:I:I		
1.4	I:I:I:I:I:I:I:I		
1.5	I:I:I:I:I:I:I:I		Slightly moist, yellow & purple, soft becoming dense, laminated, silty clay.
1.6	I:I:I:I:I:I:I:I		Highly weathered shale.
1.7	I:I:I:I:I:I:I:I		
1.8	I:I:I:I:I:I:I:I		
1.9	I:I:I:I:I:I:I:I		
2.0	I:I:I:I:I:I:I:I		
2.1	I:I:I:I:I:I:I:I		
2.2	I:I:I:I:I:I:I:I		
2.3	I:I:I:I:I:I:I:I		
2.4	I:I:I:I:I:I:I:I		
2.5	I:I:I:I:I:I:I:I		
2.6	I:I:I:I:I:I:I:I		
2.7	I:I:I:I:I:I:I:I		

Notes:

1. Difficult excavation & near refusal on shale.
2. No groundwater was intersected.
3. No sample.

Lat/long	X Coord:	25°07'32,14" S
WGS84 datum	Y Coord:	30°24'43,85" E

Soil Profile Nr: L2

Soil Profile Nr: L3

DATE: 12 August 2020

JOB NR: GS202009L

PROJECT NAME: Ptn 41 Rooidraai

Town: Lydenburg

CLIENT: Eben

TLB Contractor:

TLB Machine: Bell 315SK 4X4

TLB Operator: Shandoor

GEOSET CC

Consulting Engineering & Environmental Geologists

Raadgewende Ingenieurs- en Omgewingsgeoloë

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e-mail: davidsvdm@webmail.co.za **Cell:** 082 925 4075

Engineering Geologist: David S. van der Merwe.

Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			Dry, dark reddish brown, soft, open textured, sand. Hillwash.
0.3			
0.4			
0.5			Abundant, small & medium, angular sub to well rounded, dolerite & quartzite pebbles
0.6			& boulders. Pebble marker.
0.7			
0.8		●	
0.9		L3-0,8	
1.0			
1.1			Slightly moist, dark reddish brown, soft, shattered, silty sandy clay.
1.2			Highly weathered dolerite.
1.3			
1.4			
1.5			
1.6			
1.7			
1.8			
1.9			
2.0			Slightly moist, yellow speckled black, dense, intact, sandy clay.
2.1			Moderately weathered dolerite.
2.2			
2.3			
2.4			
2.5			
2.6			

Notes:

1. Difficult excavation & refusal on dolerite.
2. No groundwater was intersected.
3. ● Disturbed samples L3-0,8.

Lat/long	X Coord:	25˚07'34,94" S
WGS84 datum	Y Coord:	30˚24'49,11" E

Soil Profile Nr: L3

Soil Profile Nr: L4

DATE: 12 August 2020

JOB NR: GS202009L

PROJECT NAME: Ptn 41 Rooidraai

Town: Lydenburg

CLIENT: Eben

TLB Contractor:

TLB Machine: Bell 315SK 4X4

TLB Operator: Shandoor

GEOSET CC

Consulting Engineering & Environmental Geologists

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Engineering Geologist: David S. van der Merwe.

Ingenieursgeoloog: Pr. Sci. Nat., MSAIEG.

Depth bngl (m)	Soil Profile Symbol	Sample Nr Symbols	Description of soil and properties
0.1			
0.2			Dry, dark reddish brown, soft, open textured, sand. Hillwash.
0.3			
0.4			
0.5		L4-0,6	Abundant, small & medium, angular sub to well rounded, dolerite & quartzite pebbles
0.6		●	& boulders. Pebble marker.
0.7			
0.8			
0.9			
1.0			
1.1			Slightly moist, dark reddish brown, soft, shattered, silty sandy clay.
1.2			Highly weathered dolerite.
1.3			
1.4			
1.5			
1.6			
1.7			
1.8			
1.9		L4-2,0	
2.0		●	
2.1			
2.2			Slightly moist, yellow speckled black, dense, intact, sandy clay.
2.3			Moderately weathered dolerite.
2.4			
2.5			
2.6			
2.7			
2.8			
2.9			
3.0			

Notes:

1. Difficult excavation & refusal on dolerite.
2. No groundwater was intersected.
3. ● Disturbed samples L4-0,6 & 2,0.

Lat/long	X Coord:	25°07'34,94" S
WGS84 datum	Y Coord:	30°24'52,16" E

Soil Profile Nr: L4

APPENDIX C: LABORATORY RESULTS

Indicator tests

Table A Summary of Laboratory Results

Stats		Depth	Material Description	Origin		Classification		% Linear	Plasticity	Liquid	Expan-
5	Nr	m			Clay %	Unified	PRA	Shrinkage	Index	Limit	siveness
1	L1	0,3	Silty sandy clay	Hillwash	29	CL	A-7-6	10	22	48	M
2	L1	1,0	Silty clay	Highly weathered dolerite	55	CH	A-7-5	15	30	62	M
3	L3	0,8	Silty clay	Highly weathered dolerite	51	CH	A-7-6	12,5	25	51	M
4	L4	0,6	Silty clay	Highly weathered dolerite	54	CH	A-7-5	25	31	63	H
5	L4	2,0	Sandy silt	Moderately weathered dolerite	14	MH	A-7-5	6,5	13	59	M
Material possibly expansive if value:					>12%			>8%	>12	>30	Exp?

Table A Legend

Unified

5 According to the revised ASTM-Standard on the "Unified Soil Classification System" (Weinert).

1 MH: Inorganic silt, micaceous or fine sandy or silty soil, elastic silt.

1 CL: Inorganic clay of low to medium plasticity, gravelly, sandy or silty clay, lean clay.

3 CH: Inorganic clay of high plasticity, fat clay.

PRA / AASHTO

5 "Public Roads Classification" (Brink, Partridge & Williams).

3 A-7-5: High compressibility silty clay.

2 A-7-6: High compressibility high volume change clay.

5 Expansiveness according to Van der Merwe's method (Brink, Partridge & Williams).

0 L: Low

0 L/M: Low to medium expansiveness

4 M: Medium

1 H: High

A clayey material is potentially expansive if it exhibits the following properties (Kantey and Brink, 1952):

5 a clay content greater than 12 percent,

4 a linear shrinkage of more than 8 percent,

5 a plasticity index of more than 12, and

5 a liquid limit of more than 30 percent

0 NP: Not plastic: sandy material with no cohesion

0 SP: Slightly plastic: material with little cohesion

0 ND: not determined

Specialised Testing Laboratory (Pty) Ltd
Quality | Excellence | On Time

Client Name: Geoset
Project Name: Lydenburg
Job Number: DVM-124
Date: 14-Sep-20
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	L1	L1	L3	L4	L4			
Depth (m)	0.3	1.0	0.8	0.6	2.0			
Lab No	DVM-124-1195	DVM-124-1196	DVM-124-1197	DVM-124-1198	DVM-124-1199			
53.0	100	100	100	100	100			
37.5	100	100	100	100	100			
26.5	100	100	100	100	100			
19.0	100	100	100	100	100			
13.2	100	100	100	100	100			
9.5	100	100	100	100	100			
6.7	100	100	99	100	100			
4.75	100	99	99	100	100			
2.00	99	95	94	99	99			
1.00	96	91	89	97	98			
0.425	95	90	87	97	98			
0.250	91	88	85	95	95			
0.150	86	87	83	94	89			
0.075	78	84	81	91	76			
0.060	66	81	78	87	69			
0.050	62	79	76	86	65			
0.035	55	77	72	83	58			
0.020	50	74	69	77	48			
0.006	38	64	60	64	25			
0.002	29	55	51	54	14			
GM	0.28	0.31	0.38	0.13	0.27			

Atterberg Limits

LL (%)	48	62	51	63	59			
PI (%)	22	30	25	31	13			
LS (%)	10.0	15.0	12.5	25.0	6.5			

pH & Conductivity

pH								
EC (S/m)								

MDD / OMC

MDD (kg/m³)								
OMC (%)								

CBR

100%								
98%								
97%								
95%								
93%								
90%								
Swell (%)								

UCS (MPa)

100%								
97%								
90%								

COLTO Classification

Remarks:

Specialised Testing Laboratory

Quality | Excellence | On Time

Client Name:	Geoset
Project Name:	Lydenburg
Job Number:	DVM-124
Date:	2020-09-14
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	L1	L1	L3	Sample	L1	L1	L3
Depth (m)	0.3	1.0	0.8	Depth (m)	0.3	1.0	0.8
Lab No	DVM-124-1195	DVM-124-1196	DVM-124-1197	Lab No	DVM-124-1195	DVM-124-1196	DVM-124-1197
53.0	100	100	100	Liquid Limit (%)	48	62	51
37.5	100	100	100	Plastic Limit (%)	26	32	26
26.5	100	100	100	Plasticity Index (%)	22	30	25
19.0	100	100	100	Linear Shrinkage (%)	10.0	15.0	12.5
13.2	100	100	100	PI of whole sample	21	27	22
9.5	100	100	100				
6.7	100	100	99	% Gravel	1	5	6
4.75	100	99	99	% Sand	33	14	16
2.00	99	95	94	% Silt	37	26	27
1.00	96	91	89	% Clay	29	55	51
0.425	95	90	87	Activity	0.8	0.6	0.5
0.250	91	88	85				
0.150	86	87	83	% Soil Mortar	99	95	94
0.075	78	84	81				
0.060	66	81	78	Grading Modulus	0.28	0.31	0.38
0.050	62	79	76	Moisture Content (%)	N / T	N / T	N / T
0.035	55	77	72	Relative Density (SG)*	2.65	2.65	2.65
0.020	50	74	69				
0.006	38	64	60	Unified (ASTM D2487)	CL	CH	CH
0.002	29	55	51	AASHTO (M145-91)	A - 7 - 6	A - 7 - 5	A - 7 - 6

Remarks: *: Assumed

N / T: Not Tested

Specialised Testing Laboratory

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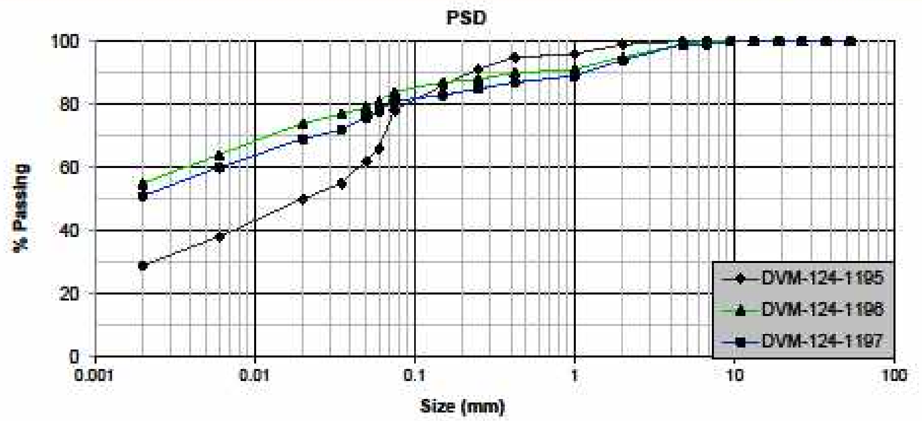
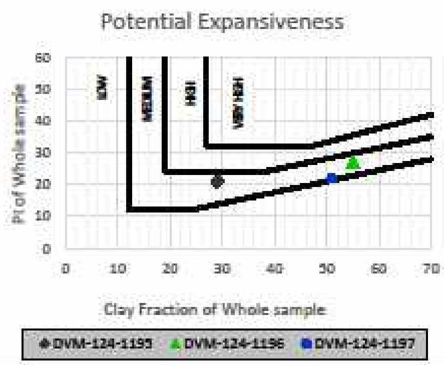
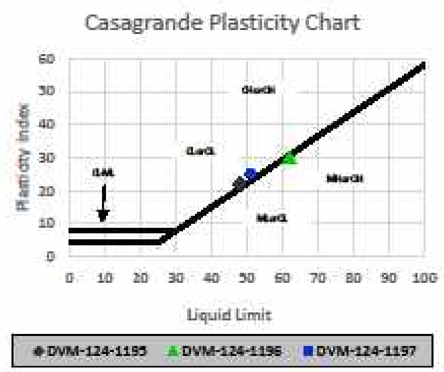
Client Name: Geoset
Project Name: Lydenburg
Job Number: DVM-124
Date: 2020-09-14
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR	Sheet Reference: R-STL-011 Rev02







Specialised Testing Laboratory

Quality | Excellence | On Time

Client Name: Geoset
Project Name: Lydenburg
Job Number: DVM-124
Date: 2020-09-14
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)

Sample	L4	L4	
Depth (m)	0.6	2.0	
Lab No	DVM-124-1198	DVM-124-1199	
53.0	100	100	
37.5	100	100	
26.5	100	100	
19.0	100	100	
13.2	100	100	
9.5	100	100	
6.7	100	100	
4.75	100	100	
2.00	99	99	
1.00	97	98	
0.425	97	98	
0.250	95	95	
0.150	94	89	
0.075	91	76	
0.060	87	69	
0.050	86	65	
0.035	83	58	
0.020	77	48	
0.006	64	25	
0.002	54	14	

Atterberg Limits & Classification

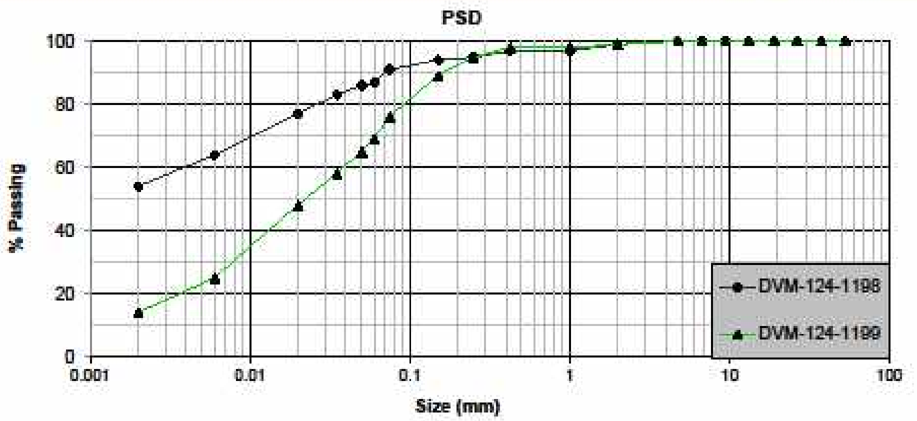
Sample	L4	L4	
Depth (m)	0.6	2.0	
Lab No	DVM-124-1198	DVM-124-1199	
Liquid Limit (%)	63	59	
Plastic Limit (%)	32	46	
Plasticity Index (%)	31	13	
Linear Shrinkage (%)	25.0	6.5	
PI of whole sample	30	13	
% Gravel	1	1	
% Sand	12	30	
% Silt	33	55	
% Clay	54	14	
Activity	0.6	0.9	
% Soil Mortar	99	99	
Grading Modulus	0.13	0.27	
Moisture Content (%)	N / T	N / T	
Relative Density (SG)*	2.65	2.65	
Unified (ASTM D2487)	CH	MH	
AASHTO (M145-91)	A - 7 - 5	A - 7 - 5	

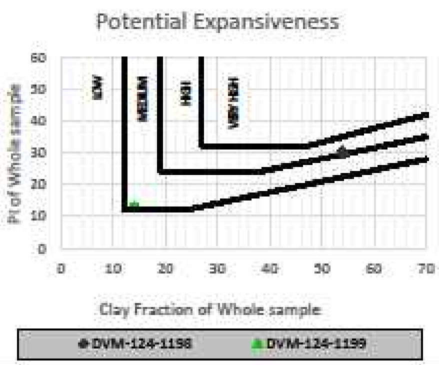
Remarks: *: Assumed
N / T: Not Tested

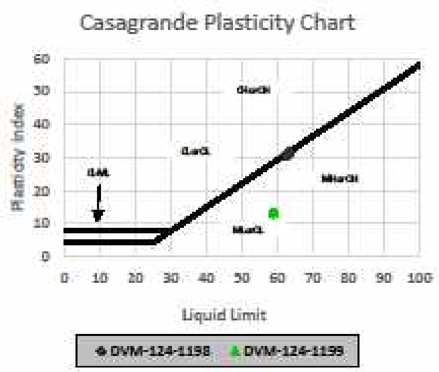
Client Name: Geoset
Project Name: Lydenburg
Job Number: DVM-124
Date: 2020-09-14
Method: SANS 3001 GR1, GR3, GR10 GR12 & BS 1377 (where applicable)

FOUNDATION INDICATOR

Sheet Reference: R-STL-011 Rev02







APPENDIX E: TABULAR EXPLANATION OF ZONING

Table1. Categories of Urban Engineering Geological Investigation

Table 2. Geotechnical CLASSIFICATION FOR Urban Development: Partridge, Wood & Brink (1993)

Table 3. Residential Site Class Designations: SAICE, SAIEG & NHBRC (1995)

Table 1. CATEGORIES OF URBAN ENGINEERING GEOLOGICAL INVESTIGATION

Type	Planning Investigations		Urban Development Investigations		Specialised Investigations
Description	**Regional Engineering Geological Mapping (REGM)**	**Mapping for Urban Planning**	**Urban Development Investigation**	**Urban Development Investigation**	**Specialised Geotechnical Investigation**
Size of study area **and field work**	More than 1000 ha. Walk-over survey and limited test pits and soil sampling.	Less than 1000 ha. Walk-over survey.	Less than 10 ha. Test pits, trial holes and soil sampling.	More than 10 ha. Walk-over survey with trial pits and test holes and soil sampling.	Not relevant. Specific to type of specialised investigation.
Suggested number of test pits	A minimum of 3 test pits per land facet type.	None suggested. However, a limited number of test pits may be required at the discretion of the consultant.	Between 6 and 10 test pits.*	Between 1 and 6 test pits per 10 ha. depending on the size and variability of the a[ea to as much as 1 test pit per hectare for highly variable sites.*	Dependent on the type of specialised investigation performed.
Mapping unit	Land systems and land facets.	Terrain types: 1 - most favourable 2 - intermediate 3 - least favourable	Soil classes: C, H, Sand P and other (e.g. excavation, drainage features)	Soil classes: C, H, Sand P and other (e.g. excavation, drainage features)	Not applicable.
Reference	Brink, Partridge and Williams (1982)	Partridge, Wood and Brink (1993)	SAICE Code of Practice (1995)	SAICE Code of Practice (1995)	Not relevant.
Consultants	Engineering geologists.	Engineering geologists and to a lesser extent geotechnical engineers.	Both engineering geologists and geotechnical engineers.	Both engineering geologists and geotechnical engineers.	Geotechnical engineers And to a lesser extent engineering geologists.

* Note that these figures are not intended to be absolute and should serve only as a guideline.

Table 2. GEOTECHNICAL CLASSIFICATION FOR URBAN DEVELOPMENT (after Partridge, Wood and Brink 1993)

CONSTRAINT		Most favourable (1)	Intermediate (2)	Least favourable (3)
A	Collapsible Soil	Any collapsible horizon or consecutive horizons totalling a depth of less than 750 mm in thickness.*	Any collapsible horizon or consecutive horizons with a depth of more than 750 mm in thickness.	A least favourable situation for this constraint does not occur.
B	Seepage	Permanent or perched water table more than 1,5 m below ground surface.	Permanent or perched water table less than 1,5 m below ground surface.	Swamps and marshes.
C	Active soil	Low soil-heave potential predicted. *	Moderate soil heave potential predicted.	High soil-heave potential predicted.
0	Highly compressible soil	Low soil compressibility expected.*	Moderate soil compressibility expected.	High soil compressibility expected.
E	Erodability of soil	Low.	Intermediate.	High.
F	Difficulty of excavation to 1,5 m depth	Scattered or occasional boulders less than 10% of the total volume.	Rock or hardpan pedocretes between 10 and 40 % of the total volume.	Rock or hardpan pedocretes more than 40 % of the total volume.
G	Undermined ground	Undermining at a depth greater than 100 m below surface (except where total extraction mining has not occurred.)	Old undermined areas to a depth of 100 m below surface where stope closure has ceased. -	Mining within less than 100 m of surface or where total extraction mining has taken place.
H	Instability in areas of soluble rock	Possibly unstable.	Probably unstable.	Known sinkholes and dolines.
I	Steep slopes	Between 2 and 6 degrees (all regions).	Slopes between 6 and 18 degrees and less than 2 degrees (Natal and Western Cape). Slopes between 6 and 12 degrees and less than 2 degrees (all other regions).	More than 18 degrees (Natal and Western Cape). More than 12 degrees (all other regions).
J	Areas of unstable natural slopes	Low risk.	Intermediate risk.	High risk (especially in areas subject to seismic activity).
K	Areas subject to seismic activity	10% probability of an event less than 100 cm/s^2 within 50 years.	Mining-induced seismic activity more 100 cm/s^2.	Natural seismic activity more than 100 cm/s^2•
L	Areas subject to flooding	A "most favourable" situation for this constraint does not occur.	Areas adjacent to a known drainage channel or floodplain with slope less than 1%.	Areas .within a known drainage channel or floodplain.

Table 3. **RESIDENTIAL SITE CLASS DESIGNATIONS** (SAICE, 1995)

TYPICAL FOUNDATION MATERIAL	CHARACTER OF FOUNDING MATERIAL	EXPECTED RANGE OF TOTAL SOIL MOVEMENTS (mm)	ASSUMED DIFFERENTIAL MOVEMENT (% OF TOTAL)	SITE CLASS
Rock (excluding mud rocks which exhibit swelling to some depth)	STABLE	NEGLIGIBLE	-	R
Fine-grained soils with moderate to very high plasticity (clays, silty clays, clayey silts and sandy clays)	EXPANSIVE SOILS	< 7,5 7,5 - 15 15 - 30 > 30	50% 50% 50% 50%	H H1 H2 H3
Silty sands, sands, sandy and gravelly soils	COMPRESSIBLE AND POTENTIALLY COLLAPSIBLE SOILS	< 5.0 5,0 - 10 > 10	75% 75% 75%	C C1 C2
Fine-grained soils (clayey silts and clayey sands of low plasticity), sands, sandy and gravelly soils	COMPRESSIBLE SOIL	< 10 10 - 20 > 20	50% 50% 50%	S S1 S2
Contaminated soils Controlled fill Dolomitic areas Land fill Marshy areas Mine waste fill Mining subsidence Reclaimed areas Very soft silt/silty clays Uncontrolled fill	VARIABLE	VARIABLE		P

NOTES:

1. The classifications C,H,R and S are not intended for dolomitic area sites unless specific investigations are carried out to assess the stability (risk of sinkholes and doline formation) of the dolomites. Where this risk is found to be acceptable, the site shall be designated as Class P (dolomitic areas).
2. Site classes are based on the assumption that differential movements, experienced by single-storey residential buildings, expressed as a percentage of the total soil movements are equal to about 50% for soils that exhibit expansive or compressive characteristics and 75% for soils that exhibit both compressible and collapse characteristics. Where this assumption is incorrect or inappropriate, the total soil movements must be adjusted so that the resultant different movement implied by the table is equal to that which is expected in the field.
3. In some instances, it may be more appropriate to use a composite description to describe a site more fully e.g. C1/H2 or S1 and/or H2. Composite Site Classes may lead to higher differential movements and result in design solutions appropriate to a higher range of differential movement e.g. a Class R/S 1 site. Alternatively, a further site investigation may be necessary since the final design solution may depend on the location of the building on a particular site.
4. Where it is not possible to provide a single site designation and a composite description is inappropriate, sites may be given multiple descriptions to indicate the range of possible conditions e.g. H-H1-H2 or C1-C2.
5. Soft silts and clays usually exhibit high consolidation and low bearing characteristics. Structures founded on these horizons may experience high settlements and such sites should be designated as Class S1 or S2 a as relevant and appropriate.
6. Sites containing contaminated soils include those associated with reclaimed mine land, land down-slope of mine tailings and old land fills.
7. Where a site is designated as Class P, full particulars relating to the founding conditions on the site must be provided.
8. Where sites are designated as being Class P, the reason for such classification shall be placed in brackets immediately after the suffix - i.e. P(contaminated soils). Under certain circumstances, composite description may be more appropriate - e.g. P(dolomite areas)-C1.
9. Certain fills may contain contaminates which present a health risk. The nature of such fill should be evaluated and should be clearly demarcated as such.