NGONYAMA ROAD UPGRADECENTRE – GEOTECHNICAL REPORT

Geotechnical investigation of the Diepsloot Upgrade of Ngonyama Road

(City of Johannesburg)

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Report no: K7964-01
Project no: 7964-GB

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APPENDICES

1. Introduction

This firm was appointed by Mr Adonis Dube of Hlanganani Engineers to do a geotechnical investigation of the proposed Diepsloot Upgrade of the Ngonyama Road pipeline. The area under investigation runs along Ngonyama Road, crosses a prominent drainage feature before is stops at Pulm Street. The aim of the investigation was to study the available geotechnical information, do an in situ inspection and to compile a report on the geotechnical conditions of the site. The assessment was carried out by S P Kok Pr Sci Nat (Engineering Geologist).

The purpose of the investigation is to:

- Determine the geological origin of the material on site.
- Determine the engineering properties of the different material layers.
- Give recommendations regarding the founding of the proposed structures.

2. Site location and description

The site locality is indicated on drawing number 7964-01: Locality Map. The area under investigation is an approximately 1,8 km long pipeline route that runs mostly along Ngonyama Road.

A coordinate at the centre of the investigated area is approximately Lo 29 Y0099131 X2870741.

The area under investigation is developed and the excavations were made in the road reserve where access could be obtained. At the start of the proposed route the area is fully developed with underground services and a tarred road. It was decided not to excavate a test pit as it was likely to cause damage to other services.

Most of the route is on the eastern side of a prominent drainage feature which drains in a south western direction. The route in the east starts at approximately 1440masl and drops to 1380 masl at the drainage feature. The site therefore slopes at approximately 4,8% in a western direction. Storm water drainage follows Ngonyama Road.

3. General geology

The entire site is underlain by the Archaean granite of the Johannesburg Dome (previously the Halfway House Granite). Alluvial deposits are present along the prominent drainage feature in the western part of the site. Some granite rock outcrops are visible in the drainage feature. This was confirmed by the excavation of nine test pits on the site.

4. Groundwater conditions

Four of the nine test pits excavated on site encountered water seepage. The groundwater depth is variable and it is believed that it is a perched groundwater table. A prominent drainage feature is present in the western part of the site and water seepage can be expected in this area. Care must therefore be taken during and after construction to address the shallow perched water table.

5. Available information

Maps

- The published geology map of South Africa (Government Printer) at a scale of 1 : 1 000 000.

Publications

- SACS (Statigraphy of South Africa) Handbook 8, Part 1 Geological Survey (now the Council for Geoscience).
- Brink, A B A (1985). Engineering geology of Southern Africa (Volume 1). Building Publications.

6. Climate

The site lies within the Highveld climatic region, the climate being described as warm temperate with summer rainfall.

The average daily maximum temperature is in the order of 28°C in January and 18°C in July. The rainy season is from October to March, with an average rainfall of about 740mm. Thornwaite's classification indicates sub humid, warm conditions with deficient moisture in all seasons.

The Weinert N-value is in the region of 2,4 which indicates that predominantly chemical decomposition of the underlying rock has taken place.

7. Investigation methods

The available information such as the geology map was studied. Ten test pits were planned, but only nine excavated as the most western test pit was located in an area where there was uncertainty regarding services and it seemed the area contained underground pipes and cables. Nine test pits were excavated by means of a TLB and the soil profiles were described by an engineering geologist. Disturbed soil samples were taken and submitted to a commercial laboratory for testing. Foundation indicator and CBR (Californian Bearing Ratio) tests were done. During the site investigation it rained heavily making sampling and profiling difficult. Water ingress into the test pits occurred as run-off along Ngonyama Road is high.

The soil profile descriptions are attached in Appendix A (soil profiles) and the laboratory test results are included in Appendix B (laboratory test results).

All the available data was used to evaluate the site and to classify the area according to the system proposed by the NHBRC (National Home Builders Registration Council).

7.1 Soil Profile

The site generally shows variable soil profiles and the depth to refusal varies considerably. A generalized soil profile can be described as follows:

0,0-0,5m	*Rubbish and building rubble; Fill.*
0,5-1,5m	*Moist, orange brown and yellow brown, soft, voided silty clay; residual granite with pockets of clay.*
1,5-1,8m	*Hardpan ferricrete.*

Notes: Water was encountered in from around 0,3m to 2,0m in test pits and sidewall instabilities were noted.

7.2 Laboratory test results

General

Eight disturbed samples were taken from the nine test pits. Four CBR tests with road indicator tests were done and four foundation indicator tests were conducted.

Indicator tests

The results of the samples show the residual granite classify mostly as clayey sand or silty sand, but there are pockets of silt, i.e. according to the Unified Classification System (SC, SM and MH).

From the grading analysis it is evident that the clay or clayey sand has a clay content (minus 0,002mm fraction) of between 3 and 28 percent with an overall average for all the samples of 13,5 percent. The silt fraction (less than 0,075mm) varies between 11 and 51 percent with an average of 25 percent indicating a fine grained material. The grading modulus of the samples varied from 0,83to 2,08 with an average of 1,58 also indicating fine to coarse grained material.

The Atterberg Limits for all the samples are summarised as follows:

Atterberg Limits	Average	Minimum	Maximum
Liquid Limit	32	20	53
Plasticity Index	10	5	16
Linear shrinkage	3.9	0.5	8
PI Whole sample	5.2	2	11

It is evident that the Liquid Limits, Plasticity Indices (PI) and Linear Shrinkage of the samples are generally higher than expected. However, most samples show low activity, with the exception of the sample taken in test pit 9 which indicate medium heave. The material along the drainage channel (alluvium) has a higher heave potential than the residual granite along the remainder of the route.

CBR (Californian Bearing Ratio)

The CBR tests showed that the materials have variable properties i.e. the materials classify from G4 to G8. It is expected that the material along the drainage channel will also be poor. Good quality road building materials are expected in the area between test pits 5, 6 and 7 and reasonable materials i.e. suitable for fill where test pits 1,2 ,3 and 4 was excavated. However, test pit 2 encountered ferricrete at a very shallow depth.

Heave potential

Most of the samples show a low heave potential. However, the material tested in test pit 9 show a medium heave potential. Using van der Merwe's method to determine the heave potential of material, it was calculated that the expected heave can be 5mm to 10mm. Weston's method was also used and the calculated heave was 7,5mm. It is therefore safe to assume that the heave will be less than 10mm.

7.3 <u>Excavatibility</u>

The material is generally easily excavatible and on this site it is soft excavation to a depth of 1,0m and probably deeper than 2,0m if

a 20 ton excavator is used. However, there are hardpan ferricrete and soft rock granite and rock outcrops (in the drainage feature) present which may require pneumatical tools for excavation. Limited blasting and pneumatic breaking may be required.

7.4 Sidewall stability of excavations

In the test pits where water seepage was noted sidewall instabilities occurred. However all excavations deeper than 1,5m must be shored according to Health and Safety requirements.

7.5 Slope stability

The area is fairly flat and no slope stability problems are foreseen.

7.6 Construction materials

The materials inspected in the test pits are generally suitable for use as construction materials for roads. However, the alluvium in TP9 is not suitable and there are also areas where fill is present. Suitable materials will have to be carefully selected.

7.7 Removal of trees

There are no large trees that need to be removed.

7.8 Zonation

The entire southern part of the site is classified according to the NHBRC as **H1, S, R, P (seepage)**. Special care will be required when crossing the drainage feature i.e. softer ground adjacent to rock outcrops are present and water ingress can occur.

8. Foundation design and precautionary measures

The site classification is H1, S, R, P according to the NHBRC soil classification system.

For single and double storey structures the following founding option should be considered:

Modified normal	• Reinforced strip footings • Articulation joints at some internal and all external doors • Light reinforcement in masonry • Site drainage and service / plumbing precautions • Foundations pressure not to exceed 50kPa • Compaction of in situ materials below foundation

- No wet services should be installed below the structures.

It is recommended that the excavations (for foundations and underground services) be inspected on the site during construction. This should ensure that conditions at variance to that described can be noted and the necessary adjustments made.

9. Conclusions and recommendations

The regional geology map shows that the site is underlain by Archaean Granite of the Johannesburg Dome.

The area under investigation falls mostly in the Ngonyama Road reserve and crosses a prominent drainage feature near the western extent of the route.

It is calculated that the maximum amount of movement due to heave is less than 10mm if a foundation / pipe is placed at approximately 0,5m below ground level.

According to the NHBRC the site is classified as **H1, S, R P (seepage).**

For single and double storey structures the following founding options can be considered:

Modified normal	• Reinforced strip footings • Articulation joints at some internal and all external doors • Light reinforcement in masonry • Site drainage and service / plumbing precautions • Foundations pressure not to exceed 50kPa • Compaction of in situ materials below foundation

Any other foundation design by a registered engineer can be considered.

The precautionary measures to reduce water ingress must be implemented as changes in moisture content can cause ground movement.

Excavations (for foundations and underground services) must be inspected on the site during construction.

The in situ materials are generally considered suitable for use in layer works. However, this will require some selection as the materials are fairly variable.

It is recommended that all construction materials should be imported.

Only limited excavation problems are foreseen if a large excavator is used. Some hardpan ferricrete and weathered granite rock is present close to surface. Some granite rock outcrops are visible in the drainage feature. Limited blasting and pneumatic breaking may be required. All excavations deeper than 1,5m must be shored.

10. Report provisions

The aim of the investigation was to estimate through site investigation; professional judgment and past experience the geotechnical conditions of the site, different soil horizons with their different geotechnical properties, areas subject to a perched water table, and areas of poor drainage, areas underlain by hard

rock and to estimate their distribution. However, it is impossible to guarantee that isolated zones of different geotechnical conditions, foundation materials, blanketing layers or any other geotechnical problems have not been missed.

For this reason detailed foundation inspections should be carried out at the time of construction to identify such variances and adjust foundation designs accordingly if need be.

11. References

11.1 GEOLOGICAL MAP

Number and title: Geology Map of South Africa

Scale: 1:1 000 000

Date of publication: 1973

Source: Government Printer

11.2 Jennings, JE, Brink, ABA and Williams, AAB (1973). **Revised guide to soil profiling for Civil Engineering Purposes in SA.** Trans SAICE, Vol 5, No 1, pp 3-12.

11.3 Van der Merwe, DH (1964). **The prediction of heave from the plasticity index and the percentage clay fraction.** Trans SAIC Vol 6, No 6, pp 103-7.

11.4 Brink, ABA, (1979). **Engineering Geology of South Africa.** Vol. 1 published Building Publications, Silverton.

11.5 Burland, JB (1961), **A simplified colour chart for soil identification.** Trans SAICE Vol.3, No.8.

11.6 Jennings, JE & Kerrich, JE (1962). **The heaving of buildings and the associated Economic consequences, with particular reference to the Orange/Free State Gold Fields.** The Civil Engineer in SA. Vol4, No. 11.

11.7 Jennings, DE and Robertson, A Mac G (1974). **Settlement and collapse potential.** Reply to ABA Brink in SAICE Div. Soil Mech. And Found Eng. Newsletter No.2 pp 1-5.

11.8 South African Institute of Civil Engineers/Institution of Structural Engineers (1995). **Code of Practice P: Foundation and Superstructures for Single Storey Residential Buildings of Masonry Construction.** Joint Structural Division, Johannesburg.

11.9 Partridge, TC Wood, KC and Brink, ABA (1993). **Priorities for urban expansion within The PWV metropolitan region. The primacy of geotechnical constraints.** South African Geographical Journal, Vol 75, pp 9-13.

11.10 National Home Builders Registration Council (1999). **Home builders manual Parts 1 and 2.** Revision no. 1 February 1999.

11.11 SAIEG/SAICE (1996). **Guidelines for Urban Engineering Geological Investigations.**

Appendix A: Soil Profile Descriptions

Appendix B: Laboratory Test Results

Appendix C: Drawings