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GEOTECHNICAL INVESTIGATION REPORT FOR WESSELSBRON TOWNSHIP

REPORT NO.: HCE/19/01

CONDUCTED FOR:

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Phase 2 - Geotechnical site Investigation for Wesselsbron

Contents

Annexures

Annexure A- Test Pit Profiles and Pictures

Annexure B- DCP Results

Annexure C- Laboratory Results

1. Introduction

1.1 General

Mocha Labs conducted a geotechnical site investigation for Wesselsbron, in the Free State Province within the Free State Province of South Africa. This investigation was undertaken in order to assess the engineering geological character of the area, focusing on the geotechnical properties which will affect the overall development potential of the site.

1.2 Terms of Reference

Mocha Labs was appointed by Hoxana Consulting Engineers as confirmed by means of an appointment letter.

1.3 Scope of the investigation

The purpose of this investigation was:

- To recommend development of practices based on the outcome of Laboratory tests
- To propose certain recommendations regarding the founding of the Structures;
- To identify other factors possibly influencing the development of the area
- To Characterize site in terms of typical nature and variation of geology and subsoil Drainage

2. SITE DESCRIPTION

2.1 Site Location

The area under discussion is situated approximately 55 km north west of Welkom**.** The total area investigated is approximately 49 Ha in size (19 Ha, Vergenoeg and 30 Ha, Khali Nkomo).

The proposed parcel of land is located at roughly the following coordinates:
Latitude: 27°49'26.51"S **Longitude:** 26°22'52.05"E

2.2 Accessibility and Trafficability

The site was easily accessible to the Technicians performing the geotechnical investigations. All vehicles were able to traverse within the investigated area. A gravel road provided access to the site.

2.3 Climate and Weather Conditions

Welkom is influenced by the local steppe climate. During the year there is little rainfall. The climate here is classified as BSk by the Köppen-Geiger system. The average annual temperature is 16.8 °C in Welkom. Precipitation here averages 557 mm.

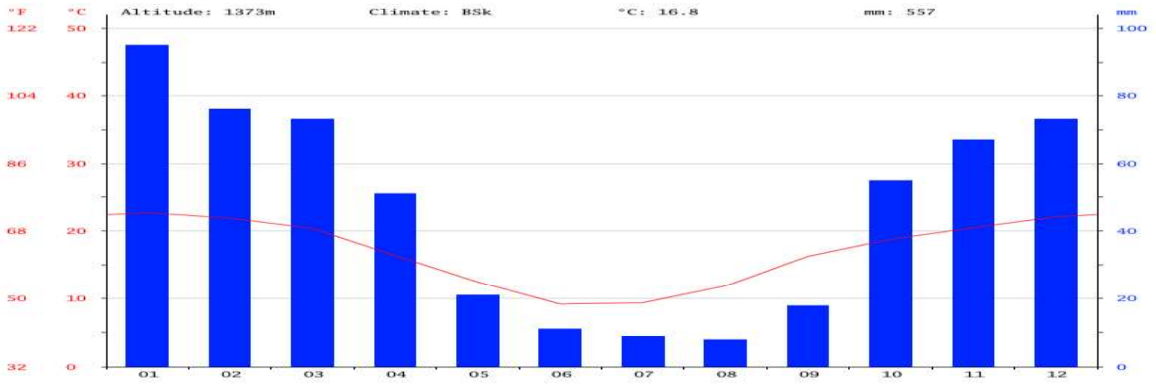

Figure 1 Weather and Climatic Conditions

The warmest month of the year is January, with an average temperature of 22.7 °C. June is the coldest month, with temperatures averaging 9.2 °C. The difference in precipitation between the driest month and the wettest month is 87 mm. Throughout the year, temperatures vary by 13.5 °C

2.4 Current Land Use

The investigated area was found to be an open space, undeveloped area and informal settlements. Settlement were identified near TP03, TP04, and TP09 (Vergenoeg) and a railway line has been identified about 300m from TP03 (Khali Nkomo)

2.4 Vegetation

Vegetation with swampy surroundings was observed near TP 07, 08 and 09 (Vergenoeg), with soil mounds identified near TP02 (Khali Nkomo)

3 GEOLOGY AND GROUNDWATER

3.1 Geological Description

According to the available geological information (1: 250 000 geological series map 2726 Kroonstad); the study area is underlain by Sedimentary, Volcanic and Intrusive rocks from the Quaternary and Jurassic Era. The available lithology of the area as read from the map is **Qs** (Aeolian Sand) and **Jd** (Dolerite), There's also a sign of a mine production of **St** (Stone, Aggregate and Gravel) nearby.

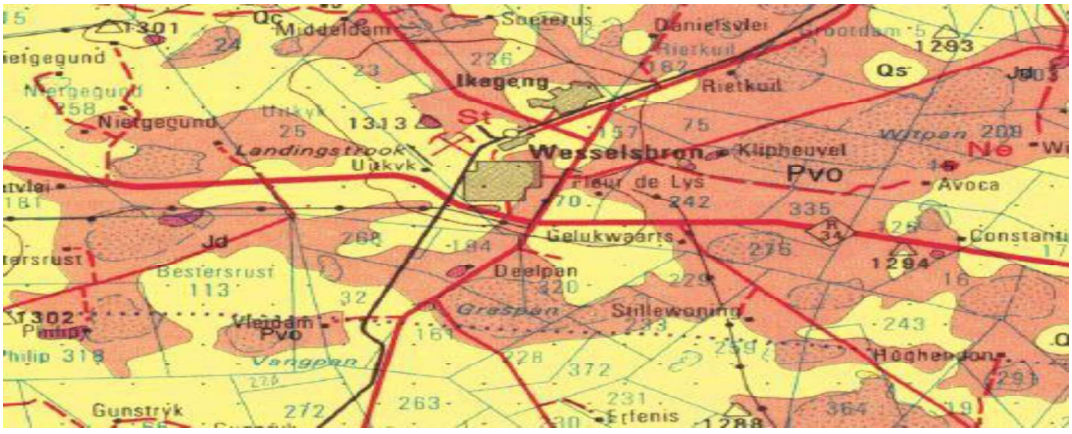

Figure 2 1:250 000 geological series map 2726 Kroonstad

3.2 Groundwater

- There was no ground water encountered within any of the test pit excavations. A sewage pipe was damaged by the TLB at Test Pit 01 in Vergenoeg.

4 Description of Field and Laboratory Investigations

4.1 Trial Holes

As instructed by the Client, a total of nine-teen (19) trial holes and nine-teen (19) DCP's were conducted ensuring sufficient coverage of the investigated area (8 in Khali Nkomo and 11 in Vergenoeg). The trial holes were excavated, inspected, profiled and sampled and backfilled. Some of the profiles were done on the service trenches. The trial holes were excavated with the aid of a Volvo BL71 TLB type excavator.

The test pits were profiled by a geologist according to the guidelines of SAICE and SAIEG. For the benefit of the non-geotechnical reader, these guidelines are summarized in the Table 2 below. The profiles and test pits pictures may be found in Annexure A, whereas DCP results are found in Annexure B of this report. Profile descriptions as per the test pits reflect the impressions created by the pedological conditions and may sometimes be in slight variance with the results of the soil testing.

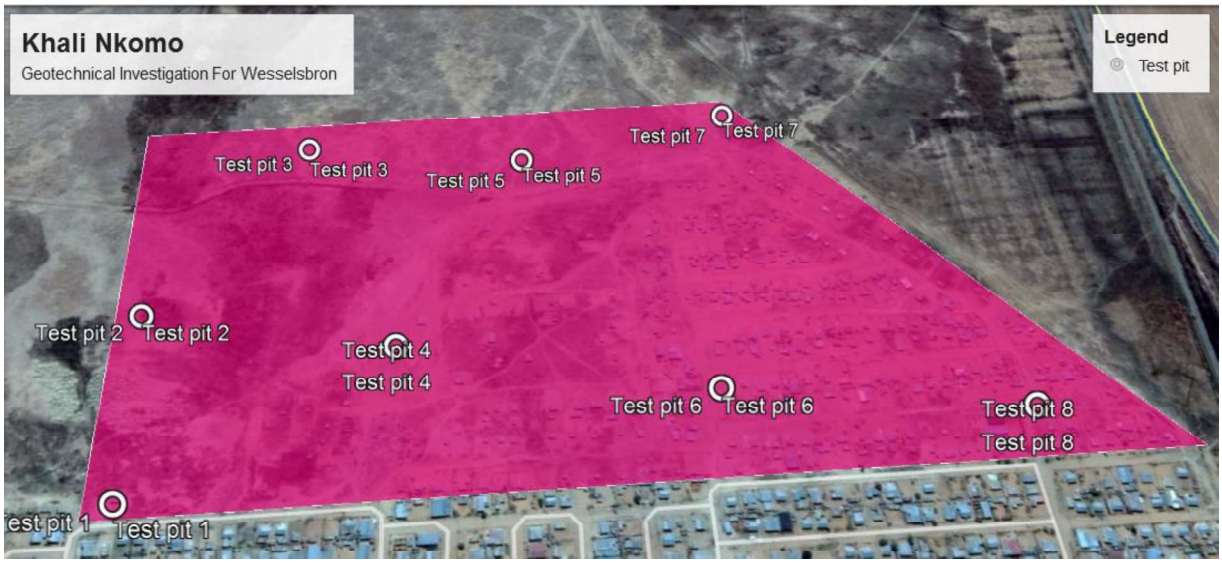

Figure 3 Test Pit and DCP Layout for Khali Nkomo

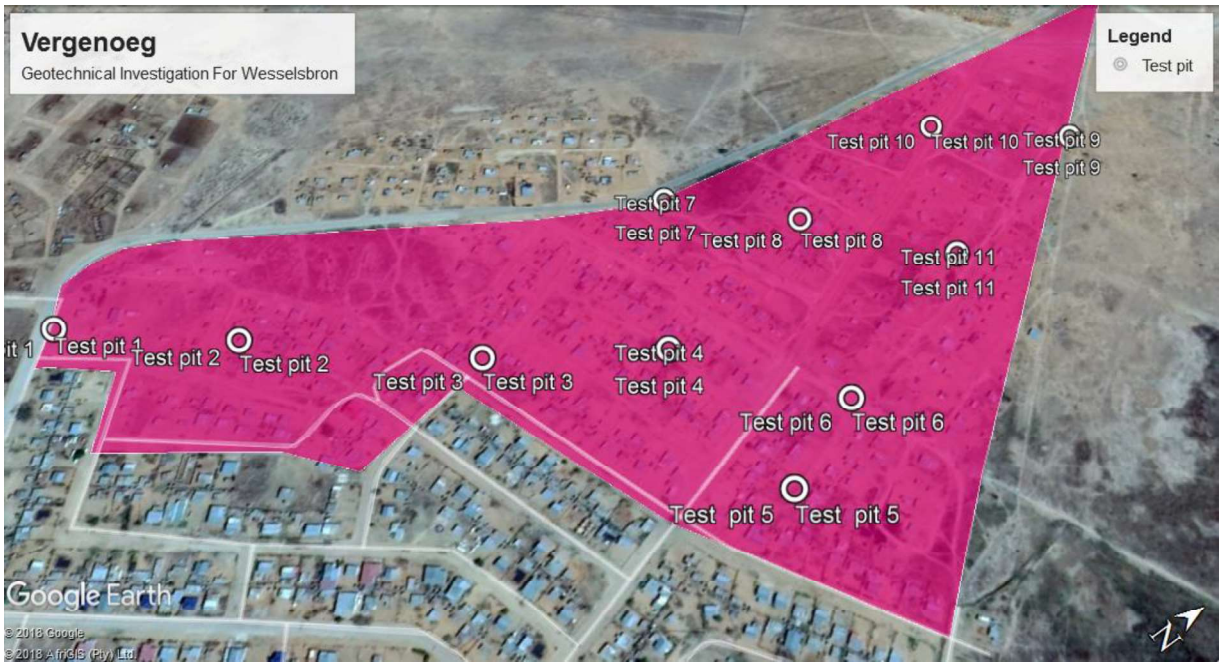

Figure 4 TestPit and DCP layout for Vergenoeg

4.2 TEST PROCEDURES

Soil testing was performed by Mocha Labs Civil Laboratory at 28 Chroom Street, Furura, Polokwane. The following test procedures were performed:

Table 1 List of Test Procedures

Method Code	Description
TMH5 MA2	Sampling from a sampling Pit in a natural Gravel, Soil and Sand
TMH5 MD-1	Division of a sample using a riffler
TMH5 MD-2	Division of a sample by quartering
SANS 3001-GR1	Wet preparation and particle size analysis
SANS 3001-GR3	Particle size analysis of material smaller than 2 mm (hydrometer method)
SANS 3001-GR10	Determination of the one-point liquid limit, plastic limit, plasticity index and linear shrinkage
SANS 3001-GR11	Determination of the liquid limit with the two point method
SANS 3001-GR20	Determination of moisture content by oven drying
SANS 3001-GR30	Determination of maximum dry density and optimum moisture content
SANS 3001-GR40	Determination of California Bearing Ratio
TMH 6 ST6	Dynamic Cone Penetrometer Test
SANS 6240	Electric conductivity of fine aggregate
TMH 1 MA20	Electrometric determination of the pH value of soil suspension

The Unified, COLTO and UNIFIED classification were awarded, the results of the soil testing may be found in Annexure C to this report. However, for easy reference the most important results are summarized in Table 3 below.

TABLE 2 SOIL PROFILING PARAMETERS

CONSISTENCY: GRANULAR SOILS **CONSISTENCY: COHESIVE SOILS**

SPT N	**GRAVELS & SANDS Generally free draining soils**		**DRY DENSITY (kg/m3)**	**SPT N**	**SILTS & CLAYS and combination with SANDS Slow draining soils**		**UCS**
4	Very Loose	Crumbles very easily when scraped with geological pick. Requires power tools for excavation.	< 1450>	<2	Very Soft	Pick point easily in 100mm Easily moulded by fingers	**<0>**
4-10	Loose	Small resistance to penetration	1450-1600	2-4	Soft	Pick point easily pushed in 30mm to 40mm Moulded by fingers with some pressure	**50-125**
10-30	Medium Dense	Considerable resistance to penetration by sharp pick point	1600-1750	4-8	Firm	Pick point penetrate to 10mm Very difficult to mould with fingers	**125-250**
30-50	Dense	Very high resistance to penetration by sharp pick point. Requires many blows by pick point for excavation.	1750-1925	8-15	Stiff	Slight indentation by pick point Cannot be moulded by fingers. Penetrated by thumbnail	**250-500**
>50	Very dense	High resistance to repeated blows of geological pick. Requires power tools for excavation.	>1925	15-30	Very stiff	Slight indentation by blow of pick point. Requires power tools for excavation	**500-1000**

SOIL TYPE

SOIL TYPE	PARTICLE SIZE (mm)
Clay	<0,002
Silt	0,002
Sand	0,06 -2,0
Gravel	2,0 – 60,0
Cobbles	60,0 – 200,0
Boulders	>200,0

MOISTURE

Dry	No water detectable
Slightly moist	Water just discernable
Moist	Water easily discernable
Very moist	Water can be squeezed out
Wet	Generally below water table

COLOUR

Spackled	Very small patches of colour <2mm
Mottled	Irregular patches of colour 2-5mm
Blocked	Large irregular patches 6-20mm
Bandad	Approximately paraffel bands of varying colours
Streaked	Randomly orientated streaks of colour
Stained	Local colour variations : Associated with discontinuity surfaces

SOIL STRUCTURE

Intact	No structure present
Fissured	Presence of discontinues , possibly cemented
Stickenskled	Very smooth , glossy , often solated discontinuity planes.
Shattered	Presence of open. Soil break into gravel size blocks
Micro shattered	Small scale shattering, very closely spaced open tissues. Soil breaks into sand size crumbs
Residual structures	Residual bedding laminations ,locations etc.

ORIGIN

Transported	Alluvium, deltas, floodplains ,colluvium etc.
Residual	Weathered from parent rock , e.g. residual granite
Pedocretes	Silcrete,calcrete etc.

DEGREE OF CEMENTATION OF PEDOCRETES

TERM	DESCRIPTION	UCS (MPa)
Very weakly cemented	Some material can be crumbled between finger and thumb. Disintegrates under knife blade to a fiable stale	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 fight hammer blows disintegrate to a state	0,5-2,0
Cemented	Material crumbles under firm blows of sharp pick point. Grains can be dislodged with some difficulty by a knife blade	2,0-5,0
Strongly cemented	Firm blows of sharp pick point on hand-held specimen show 1-3mm .Grains cannot be dislodged by knife blade	5,0-10,0
Very strongly cemented	Hand-held specimen can be broken by single firm blow of hammer head. Similar appearance to concrete	10,0-25

5. Interpretive Data

5.1 Laboratory Test Results

Table 3 Summary of laboratory test results (Vergenoeg)

TEST PIT NO	DEPTH (mm)	SOIL TYPE	SOIL CLASS		MDD	OMC	PI	LS	CBR			COLTO
			PRA	UNIFIED	Kg/m^3	%			93	95	98	
TP01 L01	0-1200	Clayey SAND	A-6	SC	1898	10.3	16	6.84	2	2	2	<G9
TP02 L01	600-1100	Silty SAND	A-2-4	SM	1946	9.8	S/P	1.20	3	4	4	<G9
TP02 L02	1100-2000	Silty SAND	A-2-4	SM	1993	7.9	S/P	0.93	1	1	1	<G9
TP03 L01	700-2100	Clayey SAND	A-2-4	SC	1981	9.2	SC	1.17	3	3	3	<G9
TP04 L01	200-900	Silty Clayey SAND	A-2-4	SM-SC	1856	10.2	6	2.34	8	11	17	G9
TP04 L02	900-1700	Clayey SAND	A-2-4	SC	1973	9.6	7	1.92	3	3	4	<G9
TP05 L01	0-900	Silty SAND	A-2-4	SM	1993	9.1	S/P	0.46	9	10	13	G9
TP05 L02	900-1800	Silty Clayey SAND	A-4	SM-SC	1973	8.5	5	1.30	3	3	3	<G9
TP06 L01	200-1800	Silty SAND	A-2-4	SM	1977	9.5	S/P	0.83	-1	5	15	<G9
TP06 L02	1800-2200	Clayey SAND	A-2-4	SC	1996	8.8	9	2.34	5	6	7	<G9
TP07 L01	300-1600	Silty SAND	A-4	SM	1991	9.5	S/P	0.96	10	11	12	<G9
TP07 L02	300-1600	Clayey SAND	A-4	SC	1977	9.7	8	3.06	5	6	6	<G9
TP08 L01	200-1600	Silty Clayey SAND	A-2-4	SM-SC	2001	9.5	4	1.99	13	15	19	G8
TP09 L01	300-1000	Silty SAND	A-2-4	SM	1962	8.2	S/P	0.85	9	12	16	G9
TP09 L02	1000-140	Silty Clayey SAND	A-4	SM-SC	1934	10.5	6	1.32	3	4	4	<G9
TP10 L01	300-1900	Silty Clayey SAND	A-4	SM-SC	1993	8.6	6	2.56	8	9	11	G9
TP10 L02	1900-2400	Clayey SAND	A-2-6	SC	1988	9.5	11	5.13	5	5	6	<G9
TP11 L01	200-500	Silty SAND	A-2-4	SM	1970	8.4	S/P	0.90	8	10	13	G9
TP11 L02	500-1400	Clayey SAND	A-2-4	SC	1934	9.0	10	1.78	2	3	3	<G9

Table 4 Summary of laboratory test results (Khali Nkomo)

TEST PIT NO	DEPTH (mm)	SOIL TYPE	SOIL CLASS		MDD	OMC	PI	LS	CBR			COLTO
			PRA	UNIFIED	Kg/m^3	%			93	95	98	
TP01 L01	400-2100	Clayey SAND	A-6	SC	1873	8.7	11	7.02	2	2	2	<G9
TP02 L01	450-850	Clayey SAND	A-4	SC	1894	8.6	10	3.94	1	1	2	<G9
TP02 L02	850-2400	Silty Clayey SAND	A-2-4	SM-SC	1961	8.4	6	2.88	1	1	1	<G9
TP03 L01	400-900	Silty Clayey SAND	A-2-4	SM-SC	1863	10.6	6	3.33	1	1	1	<G9
TP03 L02	900-2300	Clayey SAND	A-2-4	SC	1942	9.9	8	2.82	2	2	2	<G9
TP04 L01	300-2200	Clayey SAND	A-6	SC	2006	9.5	17	6.17	1	2	2	<G9
TP05 L01	600-2200	Clayey SAND	A-6	SC	1893	12.6	12	6.05	2	3	3	<G9
TP06L01	400-2400	Clayey SAND	A-4	SC	1958	9.9	8	2.52	2	2	2	<G9
TP07 L01	800-2200	Silty Clayey SAND	A-2-4	SM-SC	1974	9.8	6	1.18	2	3	3	<G9
TP08 L01	300-1100	Silty Clayey SAND	A-2-4	SM-SC	1939	10.7	4	1.47	4	4	5	<G9
TP08 L02	850-2400	Clayey SAND	A-2-4	SC	1824	12.5	10	5.24	2	2	2	<G9

MDD=Maximum Dry Density, OMC=Optimum Moisture Content, PL=Plastic Limit, LL=Liquid limit, CBR=California Bearing Ratio

6. RECOMMENDATIONS

6.1 Geotechnical Zoning and Foundations

The following are the geotechnical characteristics of the area under investigation, and has been categorized into two main zones.

6.1.1 Soil Zone A

Zone A is classifies as Site Class “P” (contaminated soils) according to the National Home Builders Registration Council (NHBRC) standards and guidelines of 1999. This area may either be excluded from development or be reinstated in terms of recognized engineering standards, followed by foundation designs suitable for reinstated areas.

For ease of identification, illegal dumping may be observed near TP03 and TP06 (Vergenoeg). Cattle Farm, dry swamps and illegal dump sites can be observed near TP 01, TP04 and TP07

6.1.2 Soil Zone B

Zone B is predominantly composed of a fine grained soils and classifies as Site Class “H1, C1” according to the National Home Builders Registration Council (NHBRC) standards and guidelines of 1999.

It must be noted that the Geotechnical zones described above is based on observation during profiling and test pit excavations (Predominance of material). Although all efforts have been made to ensure that the descriptions are accurately plotted in a geotechnical site layout, some minor characteristics of other zones may co-exist in other zones.

7. References

The following sources of information were utilized:

- Brandl G, *et.al,* 1986, , 1: 250 000 geological series map 2726 Kroonstad; Department of Minerals and Energy, Pretoria
- SAICE Geotechnical Division. Site investigation code of practice. January, 2010
- *National Home Builders Registration Council,* 2015, Home builders manual and guide, ISBN: 978-0-620-68292-3, Johannesburg