PRELIMINARY GEOTECHNICAL INVESTIGATION FOR

THE GREATER GRABOUW HOUSING PROJECT - ERF 313

Report No MD1483-2/1

NOVEMBER 2024

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1. INTRODUCTION

Melis & Du Plessis Consulting Engineers (Pty) Ltd (hereafter referred to as MDP) were appointed by Engineering Advice and Services to conduct the Preliminary Geotechnical Investigation for the Greater Grabouw Housing Project - Erf 313, Theewaterskloof Municipality.

2. SCOPE OF WORKS

The Preliminary Geotechnical Investigation is a desktop study following the requirements as set out in The National Housing Code in Chapter 3 of Part 3 as stipulated in the GFSH-2 manual – Generic Specification (September 2002).

The Preliminary Geotechnical Investigation aims to ensure that potential geotechnical risks are identified, to assess the requirements for specialist geotechnical processes and investigations during the latter stages of the project. As such, the expected subsoil conditions beneath the site are described and comment is made on slope stability, earthworks, foundations, excavatibility etc. in accordance with the requirements of the Theewaterskloof Local Municipality, South African National Standards (SANS 10400) and the National Home Builders Registration Council (NHBRC).

The recommendations provided in this report are preliminary, and subject to change based on a Detailed Geotechnical Investigation which needs to be carried out prior to design and development/construction.

3. INFORMATION SUPPLIED

The following information was provided by Engineering Advice and Services, for use as part of this study:

- SRK Consulting Report titled, “Gypsy Queen Erf 563 Grabouw Phase 1 Geotechnical Investigation (November 2022)”, (Report No. 587360/1).
- Mark Berry Environmental Consultants Botanical Status Quo Report titled, “Portion 9 of Farm Oude Brug 313, Erf 4233 & Erf 8078, Grabouw (August 2022)”.
- Google Earth files (kmz/kml) demarcating site boundaries and Global Positioning System (GPS) coordinates of the study area, and
- Photographs across the study area.

The 1:250 000 Geological Map titled “3319 Worcester” as published by the Geological Survey, was also used by MDP.

4. SITE DESCRIPTION

The study area is located in the Grabouw area, situated approximately 70km southeast of Cape Town CBD, within the Theewaterskloof Municipality, at latitude S34º 09' 53" and longitude E18º 59' 53". The locality of the site is indicated in **FIGURE 1**.

The site which spans across Erf 313, is approximately 19.2ha in extent and is accessed via the N2 Freeway in the south. The study area is mainly characterised by densely populated informal and some formal dwellings with a network of gravel access roads. Topographically, the study area generally slopes gently to moderately from Northwest to Southeast, with localised areas in which surface outcrop is exposed (particularly in the southern portion).

General views across the study area as shown in Plate 1 and Plate 2 below.

Plate 1

Plate 2

5. GEOLOGY AND SUBSOILS

According to published geological maps and literature, the site is primarily underlain by quartzitic sandstone (with minor shale layers) of the Nardouw Subgroup – Table Mountain Group. Sandstone bedrock is anticipated to occur at depths generally less than 1.5 metres below existing ground level (EGL) across most of study area with areas of rock outcrop present to the west. The sandstone bedrock weathers to form fine to coarse gritty sand with much of the overburden consisting of transported colluvium/hillwash.

The soil profile encountered is expected to comprise a light grey to greyish brown, fine grained, silty SAND (colluvium/hillwash transported soils) which overlies a yellowish brown/light brown to khaki brown fine to coarse grained gravelly SAND to sandy GRAVEL (residuum), in turn overlying weathered fine to coarse grained gritty sandstone bedrock.

The inferred boundaries of the lithological units are indicated in **FIGURE 2.**

6. GROUNDWATER OCCURRENCE

Shallow groundwater seepage can be anticipated along the low-lying areas and along drainage lines and valley head areas. A perched groundwater table can be anticipated at shallow depths (generally less

than 1.5 metres below EGL- perched on the shallow bedrock) both during and after periods of rainfall and/or during the high rainfall season.

7. DISCUSSION

7.1. Proposed Development

It is envisaged that single storey free standing housing units are proposed to be constructed across the study area, with each unit being approximately 40m^2 in extent. Foundation loads for each unit are anticipated to be less than 50kPa.

7.2. General Stability

The study area is considered to be for the most part stable; however, good stormwater management is essential to ensure long term stability. Thus, it is recommended developmental practice, to maintain stability includes:

i. Careful planning of the development in order to obviate large cuts and fills and ensure good site drainage.

ii. Provision of stormwater control facilities such as retention structures, interceptors and similar such measures to reduce concentrated overland flows.

iii. It is recommended that the development be focussed along gently to moderately sloping landform (generally less than 15^o gradient). It is anticipated that higher housing densities can generally be achieved across most of the site.

iv. It is recommended that the development is not planned along any steep/very steep slopes (generally greater than 15^o gradient) and in/close proximity to natural drainage areas where groundwater seepage is shallow and/or surface water activity is imminent, particularly after periods of heavy rain.

v. It is recommended that all necessary floodline studies (1 in 50 and 1 in 100 year), environmental and wetland delineation studies be carried out by a registered professional to determine the limits of development in the study area.

7.3. Earthworks

All earthworks should be carried out in a manner to promote stable development of the site. It is recommended that earthworks be carried out along the guidelines given in SANS 1200 (current version).

<u>In terms of cuttings and natural slopes:</u>

i. Cut slopes in soils should be formed to batters of 1 vertical to 1.5 horizontal (34 degrees) and to a height not greater than 1.5m where retaining walls are not provided or where slope stability assessments have been undertaken on the proposed slope. Cuts in weathered bedrock should not exceed gradients of 1 vertical to 1 horizontal (45 degrees).

ii. Inspection of cuts by a competent Engineering Geologist or Geotechnical Engineer may indicate that the angle of cut batter slopes need to be varied locally to ensure stability of the site.

In terms of embankment slopes and platforms:

i. Where natural ground slopes are steeper than 1 vertical to 6 horizontal (6 degrees), the fill must be benched into the slope. Benches should be 0.5m deep and 2.0m wide.

ii. Placement of fill should be undertaken in layers not exceeding 200mm thick when placed loose and compacted using suitable compaction plant to achieve minimum 93% Modified AASHTO maximum dry density.

iii. Terraces should be graded to direct water away from the fill edges, and small earth bunds should be constructed along the crests of fills, to prevent overtopping and erosion of fill embankment slopes. These bunds should be a minimum 450mm wide and 300mm high.

iv. Quality assurance, namely density control of any placed fill material should be undertaken at regular intervals during fill construction.

v. Boulders larger than 200mm diameter or $^1/_3$ of the layer thickness when loose should be removed from the fill material as these could complicate the compaction works, and also cause piping within fills. Furthermore, large boulders in fills could cause later problems during construction of foundations.

vi. Engineered fill slopes should be formed to batters of 1 vertical to 1.5 horizontal provided that the edge of fills are over constructed and thereafter trimmed back to the required position.

7.4. Excavatability and Rippability

It is anticipated that the subsoils from 0.0 to 1.5 metres depth will be easily excavatable. These materials classify as soft in terms of SANS 1200DA criteria which can easily be removed by hand tools or a tractor loader backhoe (TLB) of flywheel power approximately 0.10kW per millimetre of tined bucket width.

It is anticipated that excavations from 1.5 - 2.5 metres in the soil to upper weathered rock layers will classify as intermediate, which can be efficiently ripped by a bulldozer of mass approximately 35t, fitted with a single-tine ripper suitable for heavy ripping, and of flywheel power approximately 220kW. In addition, consideration can also be given to use of a tracked excavator of flywheel power exceeding 0.10kW per millimetre of tined bucket width.

Excavations below 2.5 metres (and where bedrock is present at or near surface level) classify as hard and will require the use of pneumatic tools and possibly blasting.

7.5. Material Classification and Usage for Subgrade Treatment for Roads, Parking Areas and Surface Beds

The following comments for the study area have relevance in this regard:

i. The gravelly/sandy residual subsoils and sandstone bedrock are anticipated to classify between a G7 to G9 quality material in terms of TRH14, 1985 (generally good to fair subgrade

materials). Where gravelly/sandy soils of G9 quality (or better) are encountered, the materials should be ripped to the depths specified by the Engineer and re-compacted to 95% Modified AASHTO maximum dry density. A design CBR of 8 - 10 can be used in this instance.

ii. The sandy colluvium/hillwash (transported soils) subsoils on site are anticipated to not satisfy the criteria for a G9 quality material.

The above information is inferred and is subject to a Detailed Geotechnical Investigation which will include Laboratory testing for final confirmation.

7.6. Suitability of Insitu Materials for Use as Trench Backfill

Materials classifying as Selected Granular Materials i.e. “Bedding Sands” and Select Backfill in terms of SANS 1200LB definitions are anticipated to not be present on site. Accordingly, allowances for importing suitable sands for support and covering of pipes in service trenches should be made.

However, the materials on site can be used as general trench backfill above pipes.

The above information is inferred and is subject to a Detailed Geotechnical Investigation which will include Laboratory testing and pipe details for final confirmation.

7.7. NHBRC Classification of the Study Area

According to the guidelines provided by the NHBRC, it is anticipated that the site classifies as **C/C1-R** – Study area underlain by compressible and potentially collapsible sandy/gravelly soils with areas of shallow bedrock occurring generally less than 1.5 metre below EGL.

The inferred NHBRC classification boundaries are indicated in **FIGURE 2**.

The specifications following the NHBRC guidelines, together with the foundation recommendations, are listed below in **Tables 1 and 2**.

Table 1: Residential site class designations (from NHBRC)

TYPICAL FOUNDING MATERIAL	CHARACTER OF FOUNDING MATERIAL	EXPECTED RANGE OF TOTAL SOIL MOVEMENTS (mm)	ASSUMED DIFFERENTIAL MOVEMENT (% OF TOTAL)	SITE CLASS
Silty sands, sands, sandy and gravelly soils	COMPRESSIBLE AND POTENTIALLY COLLAPSIBLE SOILS	<5 5.0 – 10	75% 75%	C C1
Rock (excluding mudrocks which may exhibit swelling to some depth)	STABLE	NEGLIGIBLE	-	R

Table 2: Foundation design, building procedures and precautionary measures for single storey residential structures founded on collapsible soil horizons (from NHBRC Part 1)

SITE CLASS	ESTIMATED TOTAL SETTLEMENT (mm)	CONSTRUCTION TYPE	FOUNDATION DESIGN AND BUILDING PROCEDURES (Expected damage limited to Category 1)
C	< 5	Normal	• Normal construction (strip footing or slab on the ground foundations) • Good site drainage
C1	5 – 10	Modified Normal	• Reinforced strip footings. • Articulation joints at all internal / external doors and openings. • Light reinforcement in masonry. • Site drainage and plumbing / service precautions.
		Compaction of in situ soils below individual footings	• Remove in situ material below foundation to a depth of 1.5m times the foundation width or to a competent horizon and replace with material compacted to 93 % MOD ASSHTO density at -1% to +2% of optimum moisture content. • Normal construction with lightly reinforced strip foundation and light reinforcement in masonry.
		Deep strip foundations	• Normal construction with drainage requirements • Founding on a competent horizon below the problem horizon
		Soil Raft	• Remove all necessary parts of expansive horizon to 1,0 m beyond the perimeter of the building 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 light reinforcement in masonry if residual movements are <7,5 mm, or construction type appropriate to residual movements. • Site drainage and plumbing / service precautions.

7.8. Foundation Recommendations

Considering the topography of the site and the soils encountered, several founding systems may be adopted. The type of foundation system selected will depend on the structure type, the soil type and the thickness of the soil cover over a competent founding layer. Various foundation options are discussed below.

7.8.1. Raft Foundation

In adopting the raft founding solution on this project the following recommendations have relevance.

i. The stiffened raft foundation should comprise a grillage of reinforced concrete beams cast integrally with the floor slab. The stiffness of the raft should be sufficient to reduce the differential movements in the supporting soil to a level than can be tolerated by the structure. In practice, it is often uneconomical to provide a raft stiff enough to allow the use of solid brickwork without movement joints, and articulated brickwork is therefore, recommended.

ii. Additionally, the employment of pads keyed into competent bedrock would further enable the raft design to be optimised to counteract against differential settlements. This is particularly important where the structure straddles the cut/fill line on any given platform.

iii. In the construction of the structures an allowable ground bearing pressure of 75kPa can be adopted for founding purposes for structures located at a depth of 0.5m and placed on at least medium dense residual gravelly/sandy soils. A maximum allowable ground bearing pressure of 150kPa can be considered for structures located in weathered bedrock; structures located on fill need to be supported off pads founded onto the intact bedrock.

7.8.2. Reinforced Concrete (R.C.) Strip Footings

Alternatively reinforced concrete (R.C.) strip footings and ground beams on mass concrete pads can be considered. The economic use of a founding solution comprising strip footing and R.C. ground beam on pad bases is also likely to prove feasible over the site where approved founding materials (rock) occur within 1.5 metres of finished platform level.

An allowable ground bearing pressure of 75kPa can be adopted for founding purposes for structures located at a depth of 0.5m medium dense residual gravelly/sandy soils. A maximum allowable ground bearing pressure of 150kPa can be considered for structures located in weathered bedrock

Furthermore, by virtue of its relative simplicity, this founding solution lends itself to adoption by emerging subcontractors under the guidance of a main housing contractor as part of a labour-based contract.

The site will be classified during the Detailed Geotechnical Investigation in accordance with the guidelines provided by the National Home Builders Registration Council (NHBRC).

8. STORMWATER MANAGEMENT

The use of soakpits to dispose of stormwater runoff is not recommended due to the likely occurrence of a perched water table over the majority portion of the study area (note, the presence of shallow depth to bedrock is a clear indication of a perched water table during rainy periods).

It is important that the design of the stormwater management system allow for the drainage of accumulated surface water. It is recommended that all surface water be suitably directed by use of surface drains and controlled release to low points (drainage lines or streams).

Both during and after construction, the site should be well graded to permit water to readily drain away and to prevent ponding of water anywhere on the surface of the ground. All terraces and earthworks in general should be sloped to a gradient to prevent ponding and ingress of water into the subsurface soils.

9. RECOMMENDED ADDITIONAL WORK

It must be appreciated that the above recommendations have been based solely on the desktop study of the site. In order to provide more accurate recommendations for design purposes, the following additional geotechnical work is required for this site:

i. Machine excavated test pits for the logging/profiling and sampling of soil and bedrock horizons. This will provide a visual assessment of the soil and bedrock strata, variation in depths to bedrock and an assessment of the excavation requirements, which is essential for budgeting and construction costs;

ii. CBR Dynamic Cone Penetrometer (DCP) tests to gauge the in-situ relative densities of the subsoils with depth; and

iii. Laboratory tests on soil and bedrock samples to allow for more accurate material classification and recommendations for use in earthworks, foundations, roads etc.

10. CONCLUSION

This report details the results of a Preliminary Geotechnical Investigation for the "Greater Grabouw Housing Development - Rooidakke (on Erf 313), Theewaterskloof Municipality".

The soil profile encountered is expected to comprise a light grey to greyish brown, fine grained, silty SAND (colluvium/hillwash transported soils) which overlies a yellowish brown/light brown to khaki brown fine to coarse grained gravelly SAND to sandy GRAVEL (residuum), in turn overlying weathered fine to coarse grained gritty sandstone bedrock.

The most important factor in the stable development of the site is the control and removal of both surface and groundwater from the site.

Shallow groundwater seepage can be anticipated along the low-lying areas and along drainage lines and valley head areas. A perched groundwater table can be anticipated at shallow depths (generally less than 1.5 metres below EGL, perched on the shallow bedrock) both during and after periods of rainfall and/or during the high rainfall season.

A detailed geotechnical investigation will be required to determine the limits of slope stability across the site. Development is not recommended in seepage areas where shallow groundwater seepage and/or surface water activity is imminent, particularly after periods of heavy rain.

The gravelly/sandy subsoils and sandstone bedrock are anticipated to classify between a G7 to G9 quality material in terms of TRH14, 1985 (generally good to fair subgrade materials). The sandy colluvium/hillwash (transported soils) subsoils on site are anticipated to not satisfy the criteria for a G9 quality material.
Materials classifying as Selected Granular Materials i.e. "Bedding Sands" and Select Backfill in terms of SANS 1200LB definitions are anticipated to not be present on site. However, the materials on site can be used as general trench backfill above pipes.

According to the guidelines provided by the NHBRC, it is anticipated that the site classifies as **C/C1-R** – Study area underlain by compressible and potentially collapsible sandy/gravelly soils with areas of shallow

bedrock occurring generally less than 1.5 metre below EGL.

The use of soakpits to dispose of stormwater runoff is not recommended due to the likely occurrence of a perched water table over the majority portion of the study area (note, the presence of shallow depth to bedrock is a clear indication of a perched water table during rainy periods).

A raft foundation can be selected across most of the area/s to support the proposed structures. Cognisance of the requirement of pad supports to the raft beneath the fill portion of the layout with pads keyed into bedrock should be made.

The economic use of comprising strip footing and R.C. ground beam on pad bases is also likely to prove feasible over the site where approved founding materials occur within 1.5m of finished platform levels.

Taking all the factors into account it is considered that the site is suitable for the proposed development, subject to the findings of a detailed geotechnical investigation.

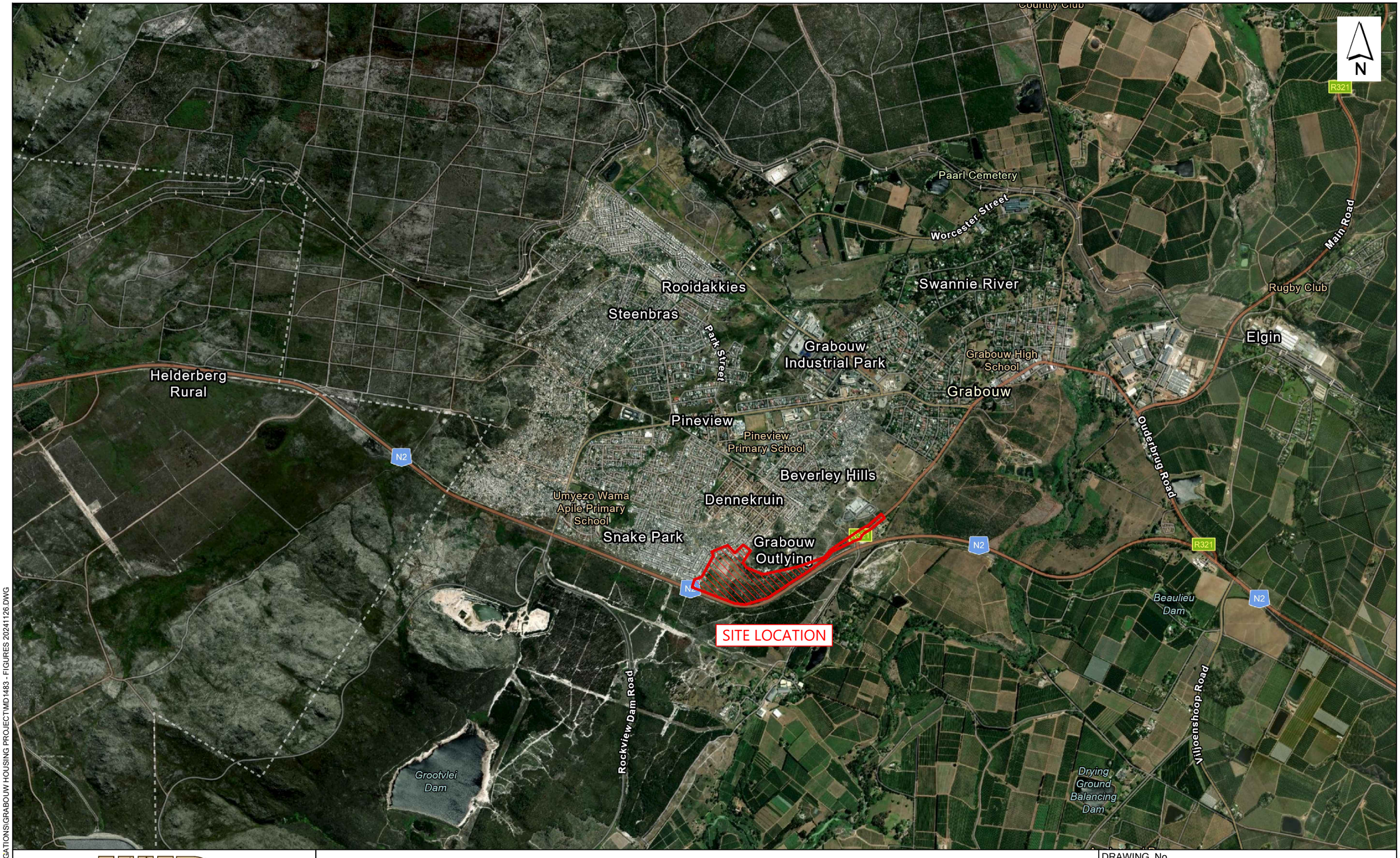
This report has been based solely on a desktop study. To provide more accurate recommendations, it is recommended that a Detailed Phase 1 Geotechnical Investigation be carried out across the study area (comprising inspection pits, CBR Dynamic Cone Penetrometer tests, laboratory sampling etc.) prior to engineering design and construction. As such, MDP would be able to assist in this regard.

Y. Hansa

for MELIS & DU PLESSIS CONSULTING ENGINEERS (Pty) Ltd

FIGURE 1

Locality Plan



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GREATER GRABOUW HOUSING PROJECT - ERF 313 : GEOTECHNICAL DESKTOP STUDY

FIGURE 1: LOCALITY PLAN

DRAWING No.	MD1483-24/11-3
PROJECT No.	REVISION No.
MD1483-2	0
DATE	SCALE
26-11-2024	1:25 000

FIGURE 2

Geology & NHBRC Classification

LEGEND

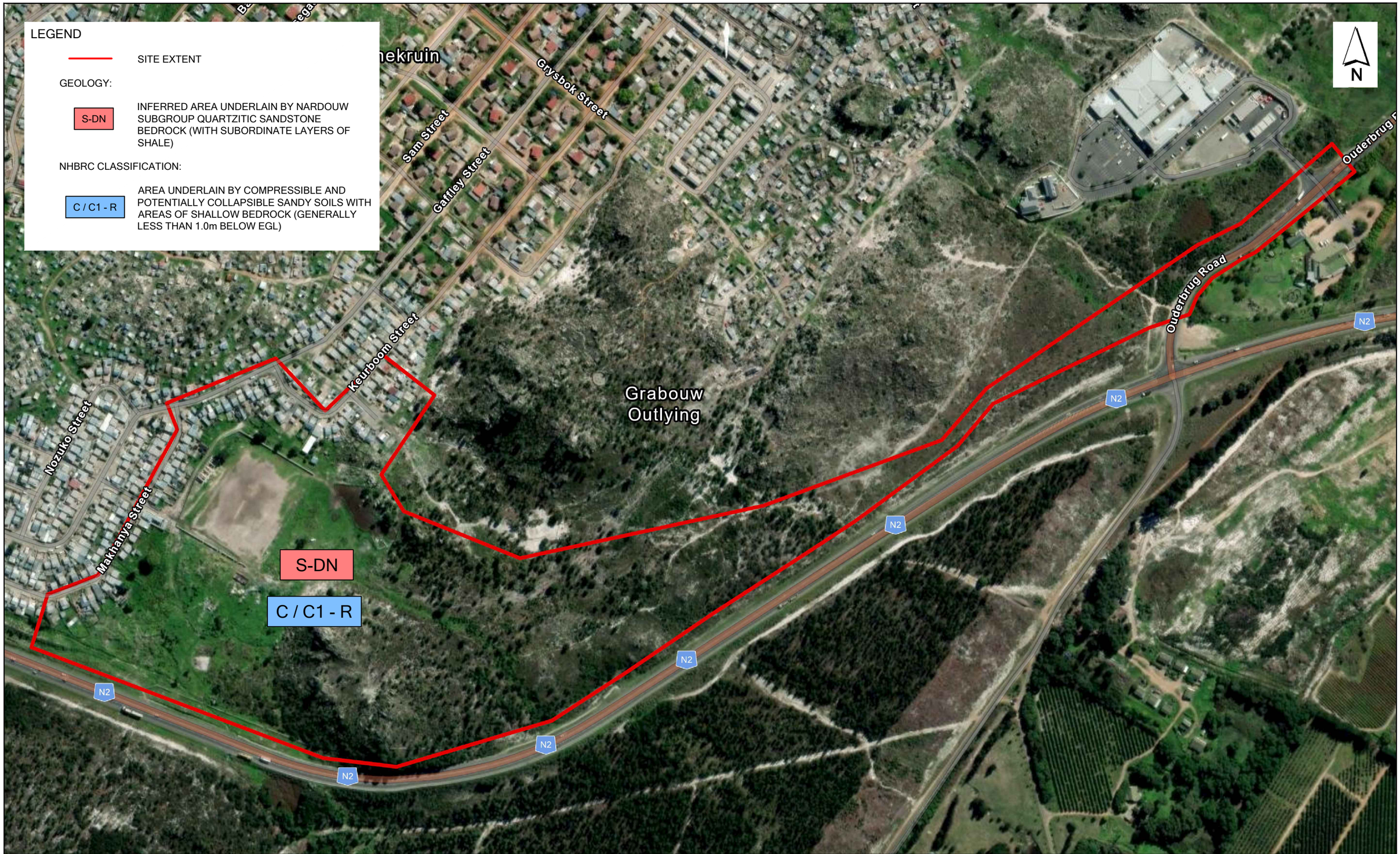
SITE EXTENT

GEOLOGY:

S-DN — INFERRED AREA UNDERLAIN BY NARDOUW SUBGROUP QUARTZITIC SANDSTONE BEDROCK (WITH SUBORDINATE LAYERS OF SHALE)

NHBRC CLASSIFICATION:

C / C1 - R — AREA UNDERLAIN BY COMPRESSIBLE AND POTENTIALLY COLLAPSIBLE SANDY SOILS WITH AREAS OF SHALLOW BEDROCK (GENERALLY LESS THAN 1.0m BELOW EGL)



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GREATER GRABOUW HOUSING PROJECT - ERF 313 : GEOTECHNICAL DESKTOP STUDY

FIGURE 2: GEOLOGY & NHBRC CLASSIFICATION

DRAWING No.	MD1483-24/11-4
PROJECT No.	MD1483-2
REVISION No.	0
DATE	26-11-2024
SCALE	1:3000