

APPENDIX D

SPECIALIST REPORTS

**BOTANICAL SCOPING REPORT FOR
THE PROPOSED 'ENKANINI HOUSING
DEVELOPMENT' AT ERF RE/18370
AND ERF RE/18332, CITY OF CAPE
TOWN, WESTERN CAPE PROVINCE**



CAPENSIS

GREG NICOLSON

MAY 2021

REPORT PREPARED FOR
SILLITO ENVIRONMENTAL CONSULTING

THE SPECIALIST

I, Gregory Alexander Nicolson, as the appointed specialist hereby declare/affirm the correctness of the information provided or to be provided as part of the application, and that I:

- in terms of the general requirement to be independent:
 - other than fair remuneration for work performed/to be performed in terms of this application, have no business, financial, personal or other interest in the activity or application and that there are no circumstances that may compromise my objectivity;
 - or
- in terms of the remainder of the general requirements for a specialist, am fully aware of and meet all of the requirements and that failure to comply with any the requirements may result in disqualification;
- have disclosed/will disclose, to the applicant all material information that have or may have the potential to influence the decision of the Department or the objectivity of any report, plan or document prepared or to be prepared as part of the application;
- have ensured/will ensure that information containing all relevant facts in respect of the application was/will be distributed or was/will be made available to interested and affected parties and the public and that participation by interested and affected parties was/will be facilitated in such a manner that all interested and affected parties were/will be provided with a reasonable opportunity to participate and to provide comments;
- have ensured/will ensure that the comments of all interested and affected parties were/will be considered, recorded and submitted to the Department in respect of the application;
- have ensured/will ensure the inclusion of inputs and recommendations from the specialist reports in respect of the application, where relevant;
- have kept/will keep a register of all interested and affected parties that participate/d in the public participation process; and
- am aware that a false declaration is an offence in terms of regulation 48 of the 2014 NEMA EIA Regulations.

Note: The terms of reference of the review specialist must be attached.

Signature of the specialist:

A handwritten signature in black ink, appearing to read 'G. Nicolson' with a stylized circular flourish at the beginning.

Date: 22 May 2021

NATIONAL LEGISLATION AND REGULATIONS GOVERNING THIS REPORT

This is a 'specialist report' and is compiled in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended, and the Environmental Impact Assessment Regulations, 2014, as amended.

APPOINTMENT OF SPECIALIST

Capensis Ecological Consulting (Pty) Ltd (Capensis) was appointed by Sillito Environmental Consulting to provide specialist botanical input for the Scoping and Environmental Impact Assessment process for the proposed Enkanini Housing development at Erf RE/18370 and Erf RE/18332, City of Cape Town, Western Cape Province.

CONDITIONS RELATING TO THIS REPORT

The content of this report is based on the authors best scientific and professional knowledge as well as available information. Capensis Ecological Consulting (Pty) Ltd reserves the right to modify the report in any way deemed fit should new, relevant or previously unavailable or undisclosed information become known to the author from on-going research or further work in this field, or pertaining to this investigation.

This report must not be altered or added to without the prior written consent of the authors. This also refers to electronic copies of the report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

DETAILS OF THE SPECIALIST

Gregory Nicolson MSc (Botany) Pr. Sci. Nat.
Capensis Ecological Consulting
156 Main Road
Muizenberg
7945
Mobile: 072 211 9843
e-mail: greg@capenis.co.za

Expertise

- Qualifications: BSc. Hons. (Environmental Science), MSc (Botany)
- Botanist with 8 years' experience in the field of Botanical Surveys
- Has experience in Botanical exploration in South Africa and Namibia
- Has conducted over 200 botanical assessments for the EIA process.

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1. INTRODUCTION

An application is underway for a housing development in Enkanini. The proposed development site is located on parts of two erven: Erf RE/18370 and RE/18332 (referred to as the 'study area' or the 'site' in this report). The study area had been earmarked for future conservation by the City of Cape Town. However, as the land (approximately 50%) has become illegally occupied over the past three years the intention is now to use the land for housing. A biodiversity offset is proposed by the client for the loss of habitat associated with the development. Sillito Environmental Consulting has been appointed as the Environmental Assessment Practitioner (EAP) for the project. Capensis Ecological Consulting (Pty) Ltd (Capensis) was commissioned by Sillito to carry out a botanical assessment for the proposed development and to provide the necessary information to inform the offset study. The project will go through a Scoping Phase and an Impact Assessment Phase. The Scoping Phase is required to (a) determine the baseline information, (b) identify potentially developable versus No Go areas, (c) and apply the mitigation hierarchy prior to applying the offset option anticipated in the Impact Assessment Phase. Once the mitigation hierarchy has been applied it should be determined whether an offset is the best available option.

2. PROTOCOL FOR DETERMINING LEVEL OF REPORTING

The sensitivity of the site was predetermined using the Department of Environmental Affairs (DEA) Screening Tool (<https://screening.environment.gov.za/screeningtool/>). The entire study area is rated as Very high for terrestrial biodiversity sensitivity (Figure 1). This level of sensitivity requires a Terrestrial Biodiversity Impact Assessment to be submitted as part of the application for Environmental Authorisation (EA). This botanical impact assessment forms part of this input as required in the Protocol for the assessment and reporting of environmental impacts on terrestrial biodiversity (Government Gazette, 2020a).

The relative plant species theme sensitivity for the site is rated as 'Medium'. "An applicant intending to undertake an activity identified in the scope of this protocol, on a site identified by the screening tool as being of "medium sensitivity" for terrestrial plant species, must submit either a **Terrestrial Plant Species Specialist Assessment Report** or a **Terrestrial Plant**

Species Compliance Statement, depending on the outcome of a site inspection undertaken in accordance with paragraph 4” (Government Gazette 2020b). Plants listed as Species of Conservation Concern (SCC) have been identified at this site and therefore a Terrestrial Plant Species Specialist Assessment Report is included in Appendix 4 of this report. [SEP]

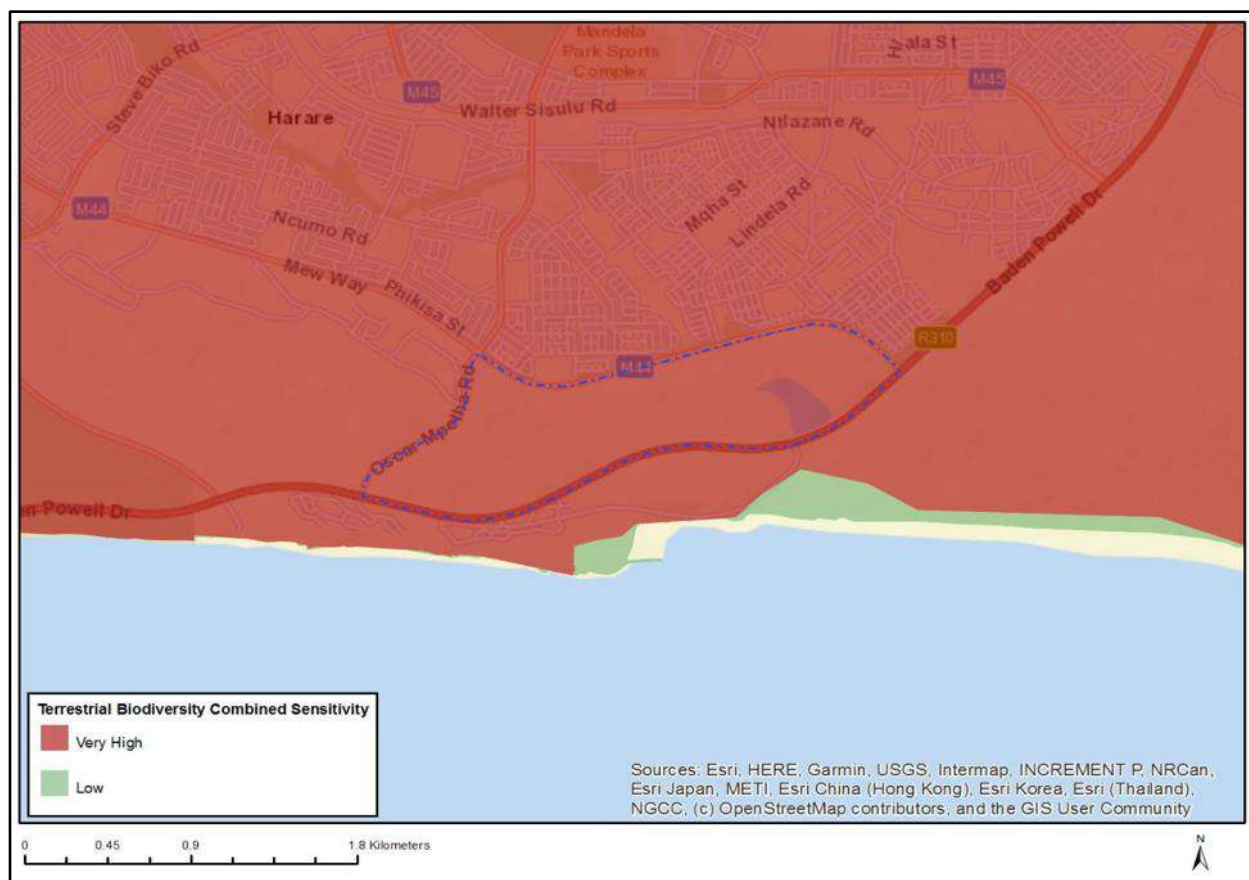


Figure 1. Map of relative terrestrial biodiversity theme sensitivity generated from the DEA Screening Tool (<https://screening.environment.gov.za>). The Study area is marked by the blue dashed line.

3. TERMS OF REFERENCE

3.1. GENERAL

Botanical assessments must follow guidelines set out in the following documents:

- Department of Environmental Affairs and Development Planning (DEA&DP) Guidelines for Involving Biodiversity Specialists in the EIA Process (Brownlie, 2005).

- Ecosystem Guidelines for Environmental Assessment in the Western Cape (Cadman et al., 2016).
- The requirements of CapeNature for providing comments on agricultural, environmental, mine planning and water-use related applications (Turner, 2013).
- Protocol for the Assessment and Reporting of Environmental Impacts on Terrestrial Biodiversity (Government Gazette, 2020).
- Protocol for the Assessment and Reporting of Environmental Impacts on Terrestrial Biodiversity (Government Gazette 43855, 2020). Terrestrial Plants Species Specialist Assessment Report.

3.2. SPECIFIC

The specific terms of reference followed for this assessment are as follows:

- Identify and describe biodiversity patterns at community and ecosystem level (main vegetation type, plant communities in the vicinity and threatened/vulnerable ecosystems), at species level (threatened Red List species, presence of alien species) and in terms of significant landscape features;
- Assess the local and regional importance of the vegetation communities and plant species within the affected areas based on the relevant biodiversity plans, bioregional planning documents and Environmental Management Frameworks.
- Determine the implications that the proposed project has for the relevant fine-scale biodiversity plan (in this case the, 2017 City of Cape Town Biodiversity Network).
- Describe the sensitivity of the site and its environs and map these resources.
- Identify any areas not suitable for construction activities (No-Go Areas) and related buffers that should be observed.
- Describe the direct, indirect and cumulative botanical impacts (both before and after mitigation) and provide an assessment of the significance of the impacts.
- Describe the measures to mitigate any impacts, and an indication of whether or not the measures (if implemented) would change the significance of the impact.
- On the basis of the impact assessment findings provide an authorisation opinion regarding whether or not the proposed activity should proceed.

4. METHODOLOGY, LIMITATIONS AND ASSUMPTIONS

The study area was visited on the 1st and 2nd of May 2021 and surveyed on foot. Sample waypoint positions were obtained using a Garmin GPS map 62. Photographs were taken and georeferenced using a Olympus TG-5 Camera with built-in GPS.

The following sources have been used to inform this study:

Vegetation map: A product of *The Vegetation of South Africa, Lesotho and Swaziland* (VEGMAP) (Mucina & Rutherford, 2006). The South African National Biodiversity Institute (SANBI) has updated the VEGMAP (2018). These latest shapefiles were used.

Ecosystem threat status: Informed by (1) The National List of Ecosystems that are Threatened and in Need of Protection (Government Gazette, 2011), (2) The Western Cape State of Biodiversity 2017 Report (Turner, 2017), (3) The City of Cape Town Biodiversity Network (Purves and Holmes, 2016) and (4) The National Biodiversity Assessment 2018 (SANBI, 2019).

Biodiversity planning: The City of Cape Town Biodiversity Network (BioNet) GIS (Geographical Information System) shapefiles (City of Cape Town, 2017) is important for determining the conservation importance of the designated habitat. Ground-truthing is an essential component in terms of determining the habitat condition. The BioNet forms part of the 2017 Western Cape Biodiversity Spatial Plan (CapeNature, 2017).

Important species: The presence or absence of threatened (i.e. species of conservation concern) and ecologically important species informs the ecological condition and sensitivity of the site. The latest conservation status of species is checked in the Red List of South African Plants (Raimondo et al. 2009) (www.redlist.sanbi.org).

Previous studies: Previous botanical studies at a local scale, if available, are consulted to provide additional information regarding the botanical attributes of the site.

Site boundary: these and other resource layers were used to define the site boundary and to compile several maps. This information is available on the CapeFarmMapper website (Department of Agriculture: gis.elsenberg.com).

The site visit was carried out over a two days (1 May for the whole day and 2 May as a follow-up for an hour) during the autumn period, which extends from March to May. During this period most geophytes (bulbs), annuals and shrubs in the region are not in flower. The timing of the

survey is therefore regarded as sub-optimal in terms of accurately assessing the flora of the region. This seasonal constraint limits the accuracy of the assessment to a certain degree and it is likely that certain species have been overlooked. Furthermore, approximately 50% the site has been illegally occupied housing over the past three years. This has consisted of clearing of vegetation, levelling of sites and introduction of fill material for the construction of informal houses, construction of informal roads and animal pens. This limited the access to certain parts of the site, as well as made safety in parts of the site a concern. An additional issue is that the mapping of the site using available aerial imagery to determine the extent of the land invasion and the habitat condition is limited to the latest available satellite image from Google Earth (26 February 2021). However, despite these limitations, the overall condition of the vegetation at the time of the survey was determined with a high level of confidence.

5. STUDY AREA

5.1. LOCALITY

The study area is located on the Cape Flats in close proximity to the False Bay coastline (Figure 2). The site is located adjacent to Baden Powell Drive to the south, Oscar Mpetha Road to the west and Mew Way to the north and east (Figure 3). The proposed project layout is provided in Figure 4.

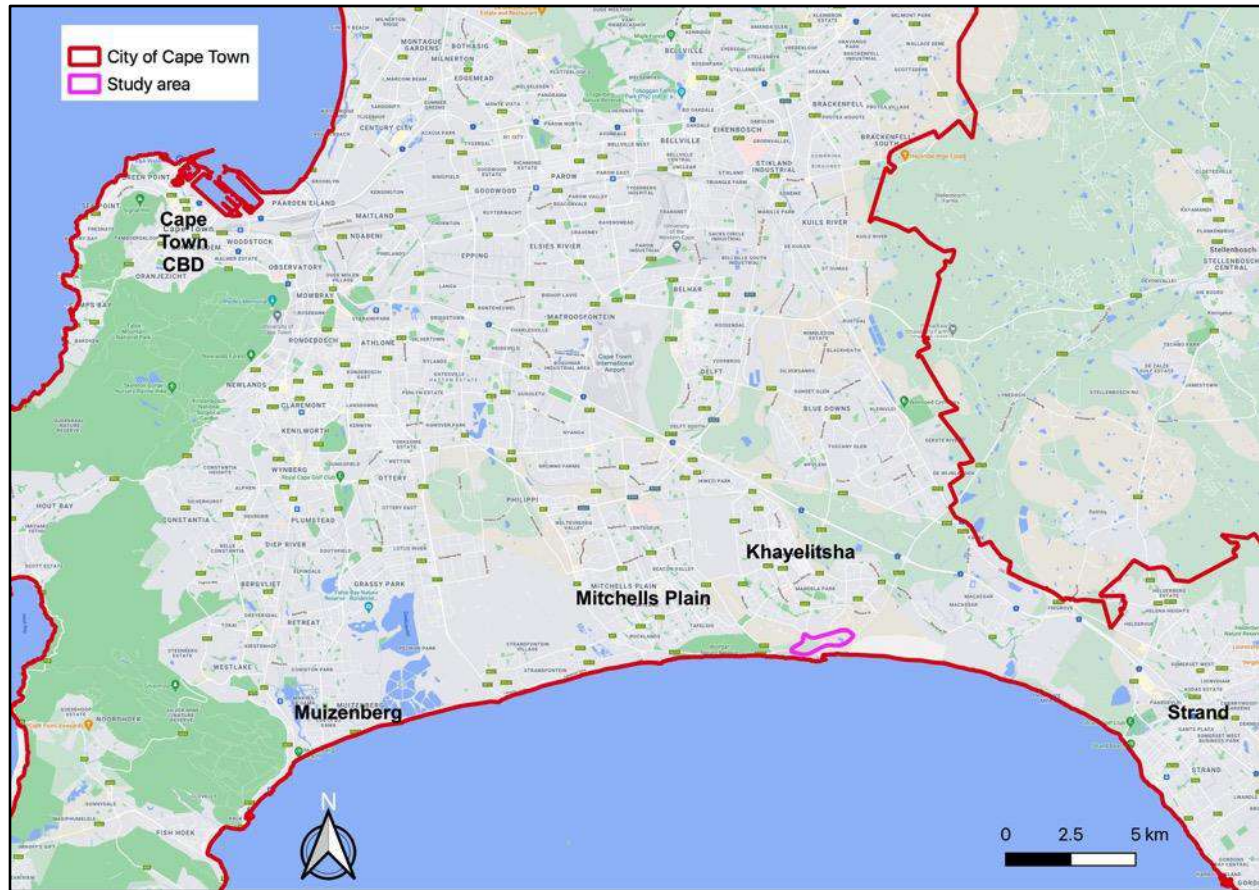


Figure 2. The study area in relation to the City of Cape Town municipal boundary and the closest suburbs overlaid on a Google Maps™ image.



Figure 3. The study area and its immediate surroundings overlaid on a Google TM Streetmap.



Figure 4. The proposed layout of the project (image supplied by Sillito Environmental Consulting).

5.2. LANDSCAPE AND GEOLOGY

The study area is characterized by stabilized dune fields with several prominent dunes traversing the site in a north-west to south-east direction. These comprise calcareous sands of marine origin that overlie meta-sediments of the Tygerberg Formation (Rebelo *et al.* in Mucina & Rutherford, 2006). The dunes systems are shaped by the prevailing southeast winds.

6. VEGETATION DESCRIPTION

6.1. NATIONAL VEGETATION TYPE

According to the Vegetation Map of South Africa, Lesotho and Swaziland (VEGMAP) the vegetation type occurring in the study area is Cape Flats Dune Strandveld (South African National Biodiversity Institute, 2018) (Figure 5). The landscape and vegetation of the Cape Flats Dune Strandveld is described by Rebelo *et al.* (in Mucina and Rutherford, 2006): *“Flat to slightly undulating (dune fields) landscape covered by tall, evergreen, hard-leaved shrubland with abundant grasses and annual herbs in gaps”*.

Cape Flats Dune Strandveld has been further divided into two sub-types: False Bay and West Coast Cape Flats Dune Strandveld (Holmes *et al.* 2012). The site falls within the False Bay sub-type. The False Bay sub-type has been impacted by human activities and has lost a considerable area to urbanisation (formal and informal), sand mining and other activities (Holmes *et al.* 2012).

Ecological drivers

According Cadman *et al.* (2016) the key ecological drivers in **strandveld** ecosystems include: (1) variation in soil type, (2) variations the amount and seasonality of rainfall, (3) dispersal of berries and seed by frugivorous bird species (4) fire, (5) drainage patterns and (6) corridors for faunal movement.

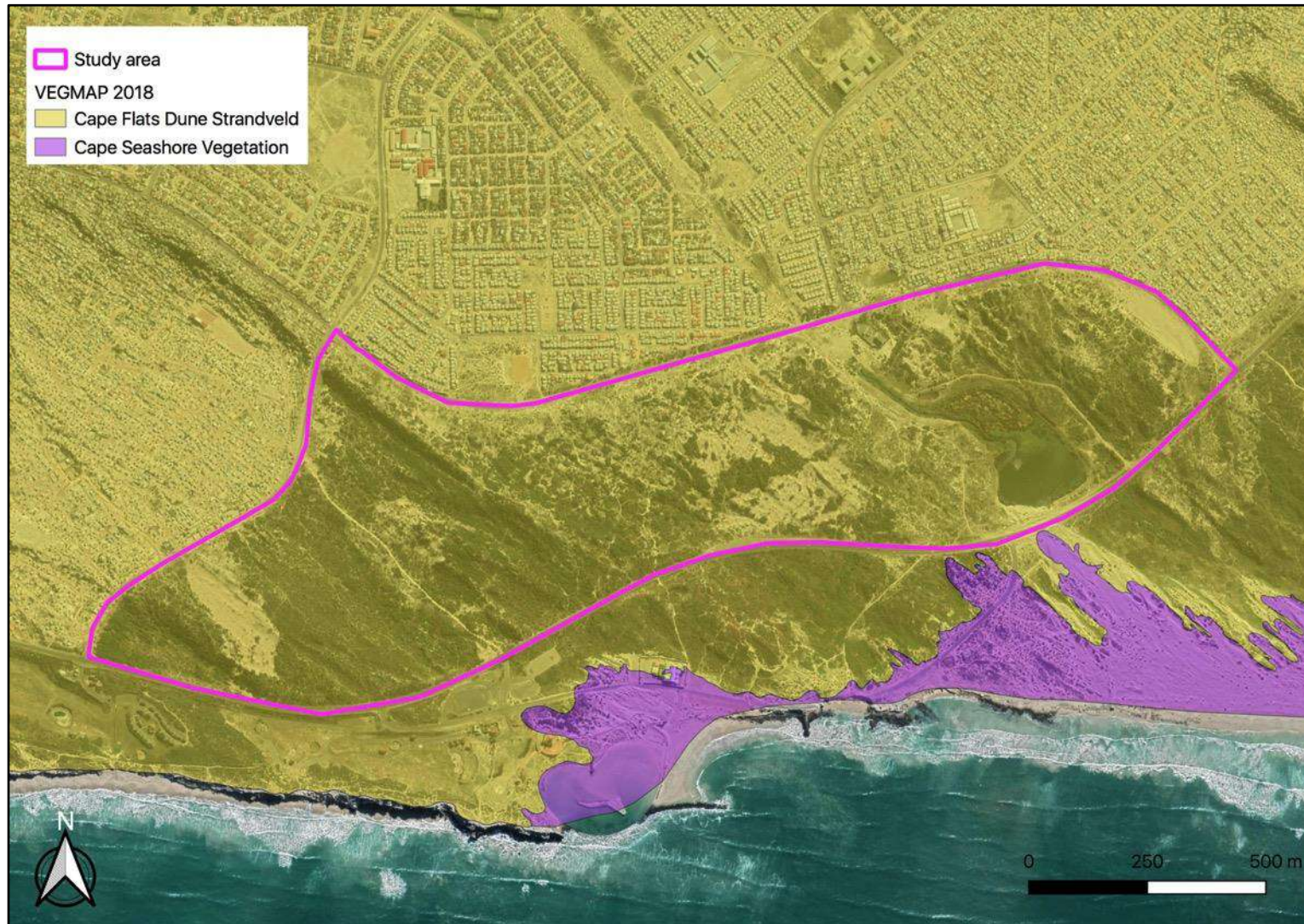


Figure 5. VEGETATION MAP: The study area superimposed on a portion of *The Vegetation Map of South Africa, Lesotho and Swaziland* (SANBI, 2018) overlaid on a Google Earth™ aerial image.

6.2. ECOSYSTEM THREAT STATUS

Ecosystem threat status is derived from four sources (Table 1). These include the following:

1. The National List of Ecosystems that are Threatened and in Need of Protection (Government Gazette, 2011).
2. The City of Cape Town BioNet (Pugnalin and Holmes 2016)
3. The Western Cape State of Biodiversity (WCSB) Report (Turner, 2017).
4. The National Biodiversity Assessment 2018 (NBA) (SANBI 2019).

Cape Flats Dune Strandveld ecosystem is listed as **Endangered (D1)** in the National List of Ecosystems that are Threatened and in Need of Protection (Government Gazette 2011). The vegetation type is also listed as Endangered in the City of Cape Town Biodiversity Network (Homes and Pugnalin, 2016), Western Cape State of Biodiversity Report (Turner 2017) and the National Biodiversity Assessment 2018 (SANBI 2019) under the following categories:

B1 – Extent of a minimum convex polygon (km²) enclosing all occurrences (EOO) and an observed or inferred continuing decline in spatial extent.

B2 – The number of 10x10 km grid cells occupied (AOO) and an observed or inferred continuing decline in spatial extent.

B1thrsp_inv – limited extent ecosystems at risk of collapse due to invasive species

Within the False Bay sub-type only 25.3% of the original Strandveld remains, close to the minimum national target of 24%, resulting in the vegetation type approaching a status of Critically Endangered (Holmes *et al.* 2012).

Table 1. Ecosystem threat status derived from available information sources

Ecosystem threat status	The National List of Threatened Terrestrial Ecosystems	The Western Cape State of Biodiversity	The National Biodiversity Assessment	City of Cape Town BioNet
Cape Flats Dune Strandveld	ENDANGERED (D1)	ENDANGERED (A1 & D1)	ENDANGERED	ENDANGERED
Reason	Threatened species associations.	Irreversible loss of habitat & Threatened species associations.	B1, B2, B1_thrsp_inv (see above).	Irreversible loss of habitat.
Remaining % of ecosystem	43%	42.6%	56%	28.4% of the False Bay subtype
Conservation target	24%	27%	27%	24%
Species of special concern	66 Threatened species and one endemic species.			

6.3. CONSERVATION PLANS

The conservation importance of all areas within the City of Cape Town have been mapped in the BioNet (Holmes and Pugnalin, 2017). The BioNet map units are selected for conserving important habitats and biodiversity processes. The habitat categories are selected for various reasons and may include degraded or low quality vegetation, since they may serve as important biodiversity corridors between ecologically intact habitats. It is therefore important to ground-truth these areas and interpret the findings in relation to the objectives of the BioNet (City of Cape Town, 2017).

According to the BioNet (Holmes & Pugnalin 2017) almost the entire study area is a CBA 1b site. One small area is classified as an Other Ecological Support Area (OESA) and two small sections are excluded based on the transformation of habitat in those sites (Figure 6). The description of this BioNet category and the recommended actions and compatible activities is provided in Table 2. Note that according to the BioNet CBA1b sites are considered to be 100% irreplaceable.

The Metro Southeast Strandveld Conservation Implementation Plan (CIP) technical report (City of Cape Town 2020) details the proposed management actions relating to remnants of Cape Flats Dune Strandveld within the city. The CIP comes from the BioNet and the CIP is categorised to prioritise remnants for inclusion in the Protected Area network. There are four CIP categories:

1. Protected and Conserved – sites currently managed for conservation, with or without formal proclamation under the Protected Areas Act or a contractual Stewardship agreement
2. Priority – sites that are appropriate to be added to the Protected Area network
3. Impact – sites that are appropriate to be added to the Protected Area network but are also targeted for development
4. Unselected – sites that are NOT a priority for conservation, due to their location, size and/or condition.

In the case of the study area, the north-east part of the site was mapped as ‘unselected’ (i.e. loss would be acceptable) in the 2020 CIP (orange area in Figure 6A). The south-west part of the site (approximately 40 ha) was mapped as a ‘priority’ site (green area in Figure 6A). This area was proposed to be conserved and would have formed a coastal corridor connecting intact vegetation to the south of Baden Powell Drive.



Figure 6A. CONSERVATION PLANNING MAP: The study area in relation to the City of Cape Town CIP (City of Cape Town, 2020) overlaid on a Google Earth TM aerial image.

Table 2. City of Cape Town Biodiversity Network category descriptions and permissible activities relevant to the study areas and immediate surrounds (Holmes & Pugnalin, 2016).

Critical Biodiversity Area (CBA) Category	CBA Name	Description	Significance of Habitat	Objective	Action	Compatible Activities	Area and percentage of site
CBA 1b	Irreplaceable Good & Fair Condition sites	Critically Endangered vegetation of Good & Fair quality. Needed for biodiversity targets. Any loss is a permanent & irrevocable loss.	Local, National & International significance: Loss of habitat will probably result in extinction of some species & inability to attain biodiversity targets.	Obtain appropriate ecosystem protection level. Maintain natural ecosystems, restore degraded land to natural & manage for no further degradation.	Needed for biodiversity targets. High priority, very high urgency (immediate). Invasive aliens to be controlled.	Conservation, low impact recreation & environmental education as outlined in the management plan for the site; hard infrastructure should not be situated in critical biodiversity areas, but outside & adjacent to these, or in existing highly degraded areas only.	98.4 ha or 89.4 %
OESA	Irreversibly modified Site of Conservation Significance	Open space irreversibly modified by agriculture or other activities. Essential for protected sites.	Local significance: These areas may be required for long-term ecological functioning of neighbouring ecosystem s. Loss would result in degradation of ecological processes & potential loss of biodiversity elements.	Maintain as open space & where appropriate restore degraded land to natural or near-natural for improved ecological functioning.	Ensure agricultural activity is compatible with ecosystem processes. Possible rehabilitation but low urgency (15 year horizon)	Generally outside urban edge. Existing agricultural practices may continue or other compatible farming may occur but the long- term vision is to restore natural ecosystem structure to some of the area to improve ecological processes.	2.7 ha or 2.4 %



Figure 6B. CONSERVATION PLANNING MAP: The study area in relation to the Biodiversity Network (BioNet)(City of Cape Town, 2017) overlaid on a Google Earth™ aerial image.

6.4. THE VEGETATION OF THE STUDY AREA

The current (May 2021) vegetation condition on the site is described below in sections 6.4.1 – 6.4.5 and according to habitat categories provided in Table 3. The habitats mapped by the author are represented in Figure 8. It is noted that the study area had no informal housing up to 2019. The most significant increase in informal housing occurred between April 2020 and September 2020 as per the Google Earth TM satellite imagery. Prior to the establishment of these informal dwellings, the study area was Intact or Semi-intact (Figure 9).

Table 3. Habitat category descriptions and criteria

Habitat category	Description
Intact vegetation	A true representation of the original vegetation type in terms of structure and species makeup. Minimal soil disturbance. Unlikely to have ever been ploughed. Disturbance may be evident.
Semi-intact	Resembles the original vegetation type in terms of structure and species makeup but has lower species diversity than intact vegetation. Dominated by disturbance-resilient species. Soils may have been heavily disturbed in the past. Restoration potential is high.
Degraded	Only a few species representative of the original vegetation type are present. The vegetation has undergone heavy disturbance. Restoration potential is either low or moderate.
Highly degraded	The original vegetation is usually absent and has been removed in the past. Only a few remnant or pioneer species are present. Soils usually ploughed in the past. Restoration potential is very low.
Transformed	No remnant species exist anymore. The landscape is altered irreversibly with no restoration potential. Examples include cultivated farmland and the built environment.

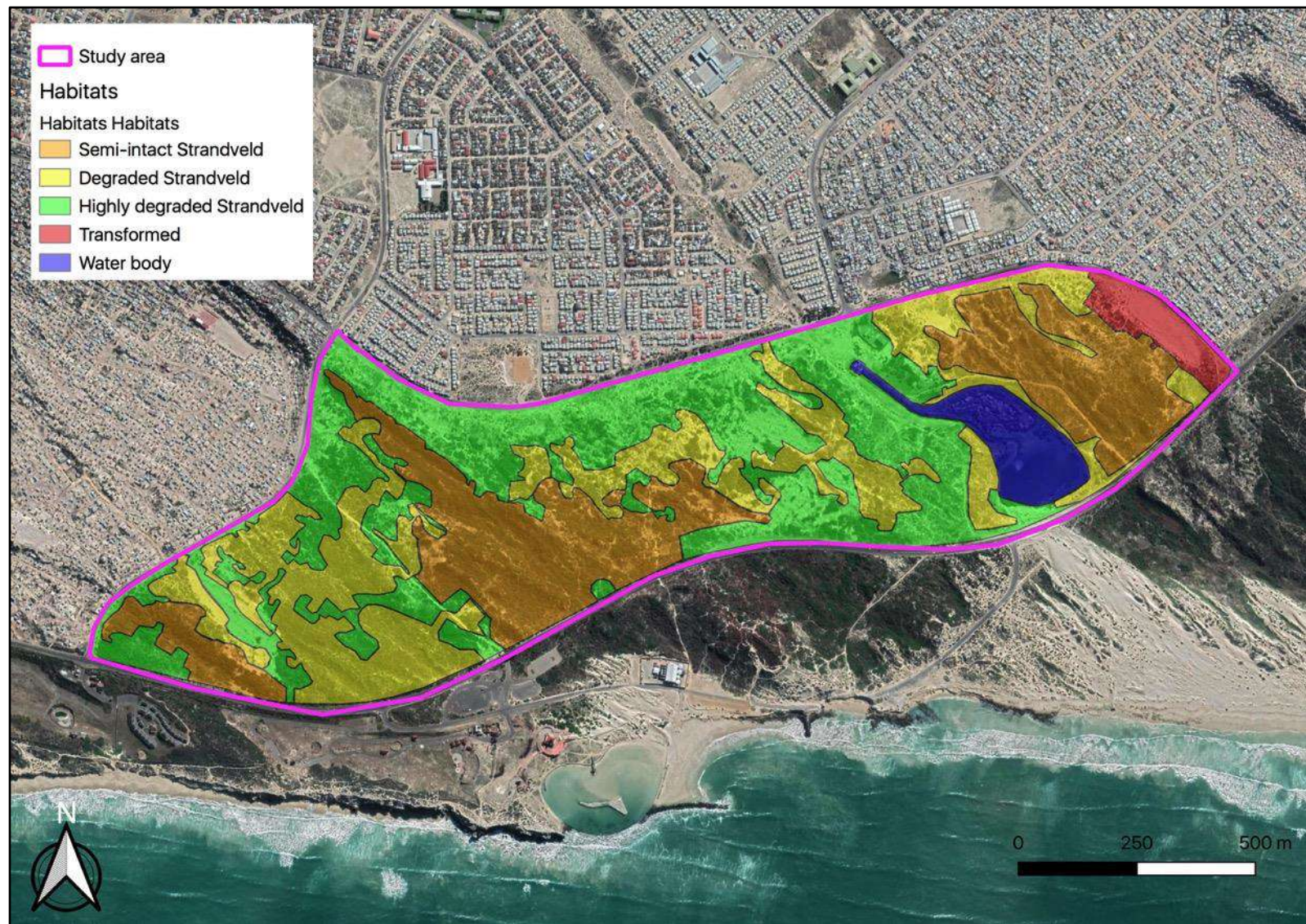


Figure 8. HABITAT MAP: Google Earth™ aerial image showing the habitats mapped within the study area.

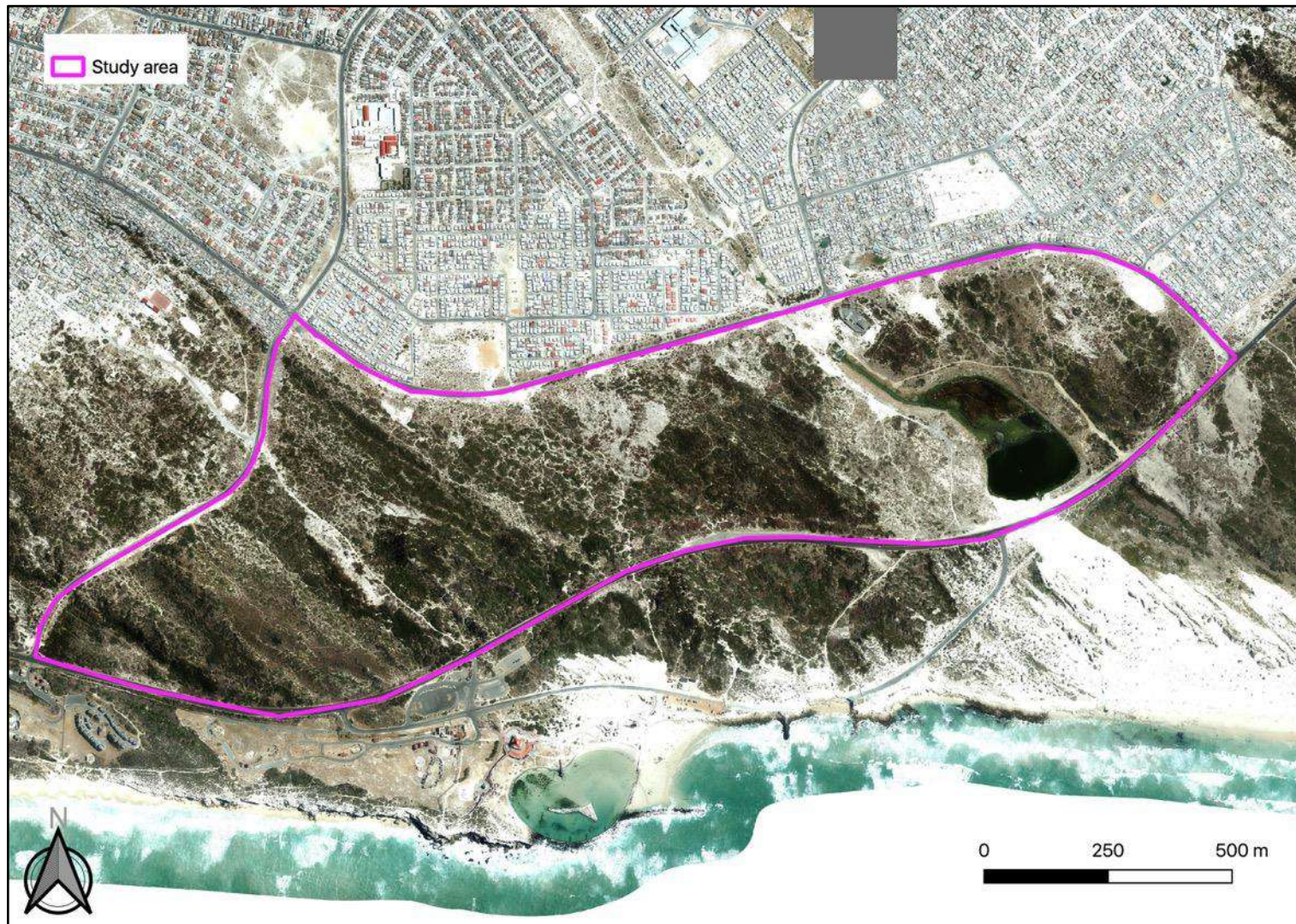


Figure 9. City of Cape Town aerial image of the study area from 2018 showing the condition of the site prior to illegal land occupation.

6.4.1 Semi-intact Strandveld

The areas that have not been degraded through informal housing occur mostly on the larger and steeper dunes. The largest undisturbed area lies on the east side of the site where high and steep dunes dominate the landscape. The vegetation in this habitat is dominated by large shrubs known as thicket vegetation (Figure 10). The dominant species here are typical of Cape Flats Dune Strandveld thicket communities and include sea gwarrie (*Euclea racemosa*), blue kunirhus (*Searsia glauca*), waxy currant (*Searsia lucida*), dune currant (*Searsia laevigata*), bluefruit curranthrus (*Searsia crenata*) and dune olive (*Olea exasperata*). The invasive rooikrans (*Acacia cyclops* – NEMBA category 1b) occurs within these thicket patches. Other species that occur within or on the margins of the thickets are arum lily (*Zantedeschia aethiopica*), cobra lily (*Chasmanthe aethiopica*), dune nightshade (*Solanum guineense*), porcupine potato (*Kedrostis nana*), bridal asparagus (*Asparagus asparagoides*), hairy cineraria (*Cineraria geifolia*), tabakbos (*Senecio halimifolius*), beach pegreed (*Restio eleocharis*) and bitou (*Osteospermum moniliferum*).

The lower and flatter areas of Cape Flats Dune Strandveld typically contain smaller shrubs and more graminoids and herbs (when compared to the thickets)(Figure 11). These habitats have mostly been occupied by informal housing and/or disturbed. Some of the species associated with these communities do occur within the Semi-intact habitat, however, they are more common in the Degraded or Highly degraded habitats (described below). One Species of conservation concern occurs in this habitat: the beach snakethistle (*Cullumia squarrosa* - Vulnerable): one subpopulation of approximately 5 plants



Figure 10. The Semi-intact habitat is dominated by the thicket community on high dunes.



Figure 11. The strandveld community commonly found on the lower and flatter areas has been mostly degraded on the site. This small area is still Semi-intact and dominated by blombos (*Metalasia muricata*) and spiny tortoiseberry (*Muraltia spinosa*) remained in the east of the site where the level of informal housing is low.

6.4.2 Degraded Strandveld

This habitat contains Strandveld that has been disturbed. The disturbances relates to (1) establishment of the informal dwellings, (2) areas that have been cleared for dwellings but have not yet been built on, and have recovered to a degree and (3) natural areas that have been used for dumping or other activities. This habitat does include a low density of informal dwellings (Figure 12).



Figure 12. The Degraded habitat contains a low to moderate level of informal housing with patches of indigenous vegetation between.

The species found here would have occurred in much greater numbers and prior to the invasion of the site. Species diversity would have also likely been higher. Degraded thicket patches do occur here and the species associated with these communities have been described above.

The plant community found on the lower and flatter areas contain blombos (*Metalasia muricata*), klimopkinkelbos (*Tetragonia fruticosa*), dune spinach (*Tetragonia decumbens* – occasional), kusmalva (*Pelargonium capitata*), pypgras (*Ehrharta villosa*), beach fingerflox (*Manulea tomentosa*), heath hardleaf (*Phylica ericoides*), kill ragwort (*Senecio burchellii*), Cape buckhorn (*Cynanchum africanum*), bristle Capegorse (*Aspalathus hispida*), sabre sourfig (*Carpobrotus acinaciformis*), common Capespinach (*Trachyandra ciliata*), velvet bedstraw (*Galium tomentosum*) brown sage (*Salvia aurea*), strand dottypea (*Otholobium bracteolatum*), strandveld gonna (*Passerina paleacea*), spiney tortoiseberry (*Muraltia spinosa*), wedgeleaf indigo (*Indigofera brachystachya*), white twin leaf (*Roepera sessilifolia*) and sand everlasting (*Helichrysum niveum*)(Figure 13).



Figure 13. The Degraded strandveld on the east of the site has not been occupied by informal housing, however it has undergone some disturbance in the past and the species diversity is lower than expected for the vegetation community present.

Some of the higher areas on the site contain exposed calcrete as described in Section 6.1. Some small sections occur within the Semi-intact habitat, however, most of it occurs as a large outcrop in the Degraded habitat (Figure 14). The only species that occurs specifically on this outcrop is the hanging dewfig (*Drosanthemum candens*). Species diversity is likely to have been higher before illegal occupation of the site occurred.



Figure 14. The major limestone outcrop found on the site occurs within the Degraded habitat. Rooikrans is dominant on the edges of the ridge, and the hanging dewfig (*Drosanthemum candens*) occurs on the top and sides on the limestone. The outcrop was surprisingly low in species diversity but this is attributed to human disturbance.

A few bulbs were found in this habitat and these include spider lily (*Ferraria crispa*), hairy sorrel (*Oxalis hirta*), spotted bloodlily (*Haemanthus coccineus*), dotted viooltjie (*Lachenalia punctata*) (Figure 15) and the Strandveld trumpet bobbajaantjie (*Babiaba tubiflora*).



Figure 15. The early flowering *Lachenalia punctata* was one of the few bulbs found on the site that was in flower.

Two species of conservation concern (SCC) were found in this habitat. These include:

1. creeping fountainbush (*Psoralea repens* – Near Threatened): one population of approximately 3 plants.
2. *Lessertia argentea* (*Endangered*): one population of approximately 7 plants (Figure 16).



Figure 16. The Endangered *Lessertia argentea* was found in only one place within the site. It potentially occurred in other parts of the site that have been occupied by informal dwellings, however, it is known to be an uncommon plant with small sub-populations.

Two other invasive species were noted in this habitat namely Port Jackson willow (*Acacia saligna* – NEMBA category 1b) and Manatoka (*Myoporum montanum* – NEMBA category 3).

6.4.3 Highly degraded Strandveld

This habitat covers the greater part of the site and is characterised by areas that have been occupied by informal dwellings (Figure 17). Small patches of vegetation remain between the dwellings, however these are in poor condition from a botanical perspective. Furthermore they will be further degraded or completely removed in the near future if the *status quo* remains.



Figure 17. The Highly degraded habitat is dominated by dwellings and animal pens where very few indigenous species remain. Those that do survive are hardy disturbance tolerant species and will potentially be lost in the near future.

6.4.4 Transformed

On the eastern side of the site an area has been completely cleared of all vegetation and has been fenced off and is being used as a construction area (Figure 18).



Figure 18. The Transformed area on the east of the site has been fenced off.

6.4.5 Water body

A large water body is found on the site. This is likely to be a storm water detention pond but is currently taking in sewerage from the surrounding areas and is polluted (Figure 19). The dominant plants that occur in the wet habitat at this site are the Cape bulrush (*Typha capensis*), bunching clubrush (*Isolepis prolifera*) and watercress (*Nasturtium officinale* – NEMBA category 2). On the edge of the wet area species such as tabakbos, stink vleireed (*Nidorella foetida*), inkberry (*Cestrum laevigatum* – NEMBA category 1b) and castor oil plant (*Ricinus communis* – NEMBA category 2) occur.



Figure 19. The Water body is dominated by the Cape reed (*Typha capensis* – sides) and watercress (*Nasturtium officinale* - foreground)

7. SENSITIVITY AND CONSTRAINTS

7.1 SENSITIVITY

Sensitivity is defined here as the ‘**conservation value**’ together with the ‘**degree of resilience to disturbance**’. The conservation value relates to the conservation status (including the ecosystem threat status) and other factors including ecological connectivity, habitat condition, persistence of ecological process and the site’s role in supporting biodiversity. The degree of resilience takes into consideration factors such as sensitivity to disturbance and restoration potential. The sensitivity categories are described below.

The Transformed Habitat is of **Very low Sensitivity** for the following reasons:

1. This areas is not representative of the original vegetation.
2. Rehabilitation potential is very low.

The Highly degraded habitat is of **Low sensitivity** for the following reasons:

1. Almost all of the indigenous vegetation has been lost and is not representative of the original vegetation type.
2. Rehabilitation potential is low.
3. If the *status quo* remains the vegetation will be entirely lost.

The Degraded habitat is of **Medium sensitivity** for the following reasons:

1. Although in a Degraded condition, these areas have medium botanical sensitivity as they are partially representative of the original vegetation (Endangered). They have been disturbed or cleared but are not completely developed.
2. This habitat fall within a valid CBA 1b site.
3. At least two SCC, namely *Psoralea repens* (NT) and *Lessertia argentea* (EN), occur here.
4. Rehabilitation potential is moderate.

The Semi-intact habitat is of **High sensitivity** for the following reasons:

1. Species diversity is highest here compared with the remainder of the study area and associated ecological processes are relatively intact.
2. The vegetation is representative of the original vegetation type.
3. This habitat falls within a valid CBA 1b site.
4. One SCC, namely *Culumbia squarrosa* (VU) was recorded in this habitat, and there is a moderate likelihood that other SCC could be found here.
5. Due to the good condition no rehabilitation would be required.

7.2 CONSTRAINTS

There are two fairly large areas of Semi-intact Strandveld that have been mapped as High sensitivity within the site (Figure 20). One occurs in the central part of the site and the other in the east of the site. The more central High sensitivity area is surrounded by informal dwellings and the area is currently experiencing further densification of informal dwellings. Under the current trajectory of illegal land occupation, it is highly likely that this site will be lost in the near future. Under 'normal' circumstances (i.e. no illegal land occupation), this site should not be

considered for development, however, considering the likely future development of informal housing, it may be futile to exclude this area from the proposed development.

The southern part of this central Semi-intact area is a very important area as it allows for some connectivity between remnant Cape Flats Dune Strandveld south of Baden Powell Drive to the east and west of this area (See Figure 20). A corridor here and a setback from the Baden Powell Drive along the southern edge of the development would mitigate some of the impacts associated with the developments.

The High sensitivity area on the east of the site occurs on high dunes. This area has potential as a conservation site if it can be protected from future expansion. The area between the water body and the transformed habitat on the eastern border of the site could form a conservation site. This area includes the water body that is already be excluded from development (Figure 4), the Semi-intact habitat and the smaller Degraded habitats (in total around 20ha)(Figure 20). It is only separated from the large natural areas to the south-east by Baden Powell Drive. It is noted that this area could potentially be invaded by informal housing and this would therefore render this site not conservation worthy. It should only be considered as a worthwhile conservation site if all stakeholders agree to protect it from future degradation.

An informal discussion has been held with the City of Cape Town Biodiversity Management Branch regarding the future conservation of these Semi-intact remnants within the study area. The opinion of the Biodiversity Coordinator for the City is that any remnants left undeveloped would be extremely difficult to defend from future occupation. Furthermore, the operational budget that would be required to manage and protect these small remnants is extremely high and the City does not have the resources to manage small areas. In this scenario, the City would prefer to focus on higher priority sites and ensure that no illegal occupation occurs on the south of Baden Powell Drive (pers. comm. Cliff Dorse, 24 May 2021).

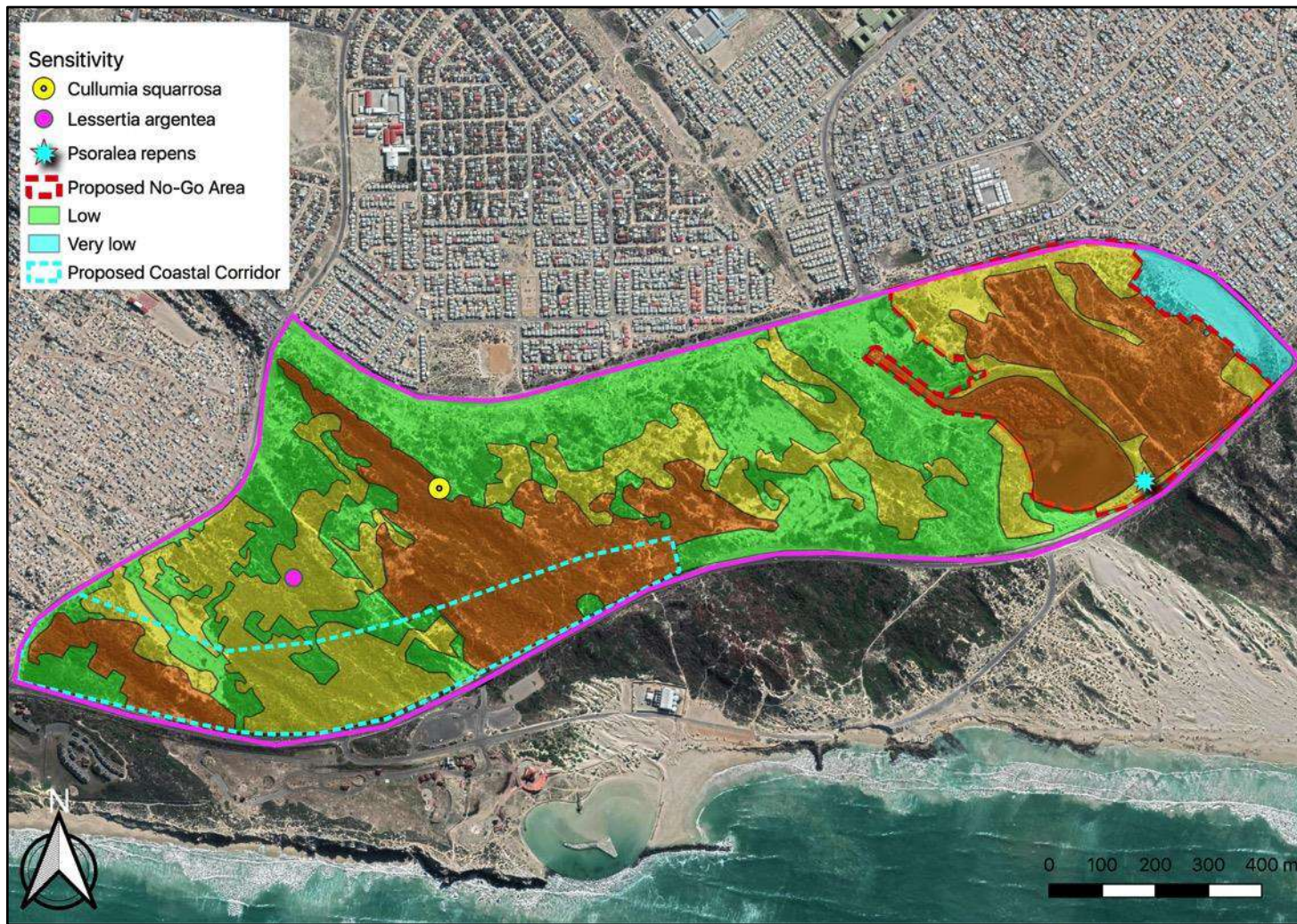


Figure 20. SENSITIVITY MAP: Google Earth™ aerial image showing the sensitivities, SCC and theoretical corridor and No-Go areas mapped within the Study area.

9. IMPACT ASSESSMENT

The impact assessment is a measure of the impacts likely to occur on the affected environment, specifically the vegetation, ecological processes, important species and habitats. They are considered for (a) the 'No Go' scenario (which technically comprises the existing impacts and level of invasion) and (b) the direct, indirect and cumulative impacts of the proposed project. Impacts are assessed for both construction and operational phases.

9.1. 'No Go' or No Development Scenario

The 'No Go' or no development scenario takes into consideration the impacts associated with the no construction option. It is a prediction of the future state of the affected area in the event of no construction activities taking place and is based on the current and historical impacts on the site (see section 6) and/or anticipated future land use. If no developments were to take place it is likely that further invasions of informal dwellings would occur and this would have a **High negative** impact depending on the extent of the invasions.

9.2. 'Direct impacts'

Direct impacts are those that would occur as a direct result of the development of the housing and associated infrastructure. The development scenario is assessed separately for the construction and operational phases of the project. The construction phase is assessed for two impacts:

- Loss of vegetation type and ecological processes – including indigenous vegetation and ecologically important species.
- Loss of species of conservation concern – associated with the loss of indigenous vegetation.

9.2.1. Construction phase

Loss of vegetation and ecological processes

Most of the impacts would occur during this phase since it would involve clearing the vegetation. It is assumed that all indigenous vegetation (Semi-intact and Degraded) would be lost, comprising 58.1 ha. Note that Highly degraded and Transformed areas do not comprise important indigenous vegetation and are not included in the calculation. These habitats are of High or

Medium sensitivity, with impacts expected to be **Very high negative** before mitigation (Table 4). If mitigation is successfully implemented the impact can be reduced to **High Negative** (see section 9.3).

Table 4. Impact-significance table for the loss of vegetation and ecological processes during the construction phase of the proposed developments.

	Proposed project		“No go”	
	Without Mitigation	With mitigation	Without Mitigation	With mitigation
Nature	Negative	Negative	Negative	Negative
Extent	Regional	Site	Site	Site
Magnitude	High	High	High	High
Duration	Long-term	Long-term	Long-term	Long-term
Consequence	Very High	High	High	High
Probability	Highly probable	Probable	Probable	Probable
Significance	Very High	High	High	High
Confidence	High	High	High	High
Reversibility	Low	Low	Low	Low
Irreplaceable loss of resources	High	High	High	High
Cumulative Impact	High	Medium	Medium	Medium
Indirect Impacts	Low	Low	Low	Low
Degree to which the impact can be avoided	Low		Medium	
Degree to which the impact can be managed	Low		Medium	
Degree to which the impact can be mitigated	Medium		Medium	
Residual Impacts	High		High	
Mitigation: Offset for the loss of Degraded and Semi-intact vegetation.				

Loss of species of conservation concern (SCC)

At least three SCC namely the beach snakethistle (*Cullumia squarrosa* - Vulnerable), creeping fountainbush (*Psoralea repens* – Near Threatened) and *Lessertia argentea* (Endangered) were found on the site. There is a chance that further subpopulations of these species, or other SCC occur within the study area. The collective loss of these species would have a **High negative** impact and no mitigation is possible for this loss (Table 5)(section 9.3).

Table 5. Impact-significance table for the loss of SCC during the construction phase of the proposed developments.

	Proposed project		“No go”	
	Without Mitigation	With mitigation	Without Mitigation	With mitigation
Nature	Negative	Negative	Negative	Negative
Extent	Site	Site	Site	Site
Magnitude	High	High	High	High
Duration	Long-term	Long-term	Long-term	Long-term
Consequence	High	Medium	High	High
Probability	Highly probable	Probable	Probable	Probable
Significance	High	High	High	High
Confidence	High	High	High	High
Reversibility	Low	Low	Low	Low
Irreplaceable loss of resources	High	High	High	High
Cumulative Impact	High	Medium	Medium	Medium
Indirect Impacts	Low	Low	Low	Low
Degree to which the impact can be avoided	Low		Medium	
Degree to which the impact can be managed	Low		Medium	
Degree to which the impact can be mitigated	Medium		Medium	
Residual Impacts	High		High	
Mitigation: No mitigation is proposed.				

9.2.2 Operational phase: Loss of vegetation and ecological processes

The overall operational phase impacts are expected to be **Low negative**. No mitigation is proposed (Table 6). The operational phase impacts would be the potential further loss or degradation of any adjacent vegetation not been developed during the construction phase

Table 6. Impact-significance table for the Operational phase of the proposed developments.

	Proposed project		“No go”	
	Without Mitigation	With mitigation	Without Mitigation	With mitigation
Nature	Negative	Negative	Negative	Negative
Extent	Site	Site	Site	Site
Magnitude	Low	Low	High	High
Duration	Long-term	Long-term	Long-term	Long-term
Consequence	Medium	Low	High	High
Probability	Highly probable	Probable	Probable	Probable
Significance	Low	Low	High	High

Confidence	High	High	High	High
Reversibility	Low	Low	Low	Low
Irreplaceable loss of resources	Low	Low	High	High
Cumulative Impact	Low	Low	Medium	Medium
Indirect Impacts	Low	Low	Low	Low
Degree to which the impact can be avoided	Medium		Medium	
Degree to which the impact can be managed	Medium		Medium	
Degree to which the impact can be mitigated	Medium		Medium	
Residual Impacts	Low		High	
Mitigation: No mitigation is proposed				

9.3. Mitigation

Construction phase

Mitigation options are generally considered in terms of the following mitigation hierarchy: (1) avoidance, (2) minimization, (3) restoration and (4) offsets. A distinction is also made between essential mitigation (mitigation measures that lower the impact significance) and non-essential mitigation (best practise measures that do not lower the impact significance).

Recommended essential mitigation

The essential mitigation is guided by the current *status quo* of illegal land occupation that is spreading through the site. Under these circumstances, and based on the inputs from the City of Cape Town Biodiversity Management Branch, the application of the mitigation hierarchy suggests that (1) avoidance, (2) minimization and (3) restoration are not practically feasible options. This leaves an offset as the only likely mitigation that could reduce the impact.

1. An offset for the loss of the Degraded and Semi-intact habitat on the site at the time of the study (May 2020) that totals 58.1 ha.

If these mitigation measures are implemented the residual impacts associated with the project would still be **High negative** due to the loss of an Endangered vegetation type and SCC and CBA1b and a substantial portion of the coastal corridor link. According to the guidelines on Biodiversity offsets a High negative residual impact requires a Biodiversity offset. In this case, an offset is already part of the project description and therefore will be initiated to offset the loss of habitat and species. The offset calculation will be based on the total area of vegetation lost, therefore the amount of habitat excluded from the development footprint, if any, will affect the offset.

Operational phase

1. The site must be monitored for at least two years after development has taken place to ensure that no exotic or weedy species establish and spread into the surrounding vegetation.

9.4. Indirect impacts

Indirect impacts are those that do not occur as a direct result of the activity on the site but that occur further away. In this case no indirect impacts were identified.

9.5. Cumulative impacts

Cumulative impacts are those impacts linked to increased loss of vegetation type or the ecosystems listed in The National List of Ecosystems that are Threatened and in Need of Protection (Government Gazette, 2011). Cumulative impacts are assessed as the overall impact of loss of habitat in relation to loss of the same or similar habitat at a local scale due to past, present and future habitat loss. The loss of 58.1 ha of Cape Flats Dune Strandveld in relation to the remaining 8012 ha (Homes and Pugnalin 2016) represents 0.72 % of the remaining area. Due to the fact that this calculation is based on the 2016 figure it is highly likely that the percentage is higher than 0.72%. The site adjacent to the study area has also been occupied in the past three to four years. Future land invasion into the surrounding areas of the same habitat may also be expected. Considering that the False Bay ecotype of Cape Flats Dune Strandveld was nearing the Critically Endangered threshold since 2012 and the documented losses of the vegetation type in the surrounding areas the cumulative impact is rated as **High negative**.

10. CONCLUSIONS AND RECOMMENDATIONS

The study area contains Cape Flats Dune Strandveld, an **Endangered** vegetation type. Over half of the study area has been disturbed and at least half has been lost to the establishment of informal housing (Highly degraded habitat). Other areas have been disturbed by dumping, sand mining, animals grazing and most significantly clearing of vegetation for housing. These areas are Degraded, but have good rehabilitation potential and are of **Medium sensitivity**. There are two large areas within the site that contain Semi-intact vegetation. However, these areas are still under pressure from further illegal occupation. These areas are in a conservation-worthy condition and have **High sensitivity**.

At least three SCC were identified on the site, namely the beach snakethistle (*Cullumia squarrosa* - Vulnerable), creeping fountainbush (*Psoralea repens* – Near Threatened) and *Lessertia argentea* (Endangered). These species represent small subpopulations.

In the context of the Endangered conservation status of Cape Flats Dune Strandveld and more specifically the False Bay ecotype, the loss of this site (over 58 ha) would have regional significance and a **Very high negative** impact.

The loss of the populations of SCC would have a **High negative** impact and no mitigation can reduce this.

It must be noted that in the No-Go scenario, it is likely that the remainder of the site will be invaded by informal dwellings and the resulting impact would also be **High or Very High negative**.

All invasive species must be eradicated from any part of the site that is not developed (i.e. the storm water detention ponds 'water body'). Regardless of development, this is a legal requirement for all landowners set out in Section 73(2) of the Invasive and Alien Species (IAS) Regulations (published on 1 August 2014) in the NEMBA (National Environmental Management and Biodiversity Act) Act 10 of 2004 to remove all listed species.

Under other circumstances, any of the Medium or High sensitivity areas at this site would be No-Go areas. However, given the nature of the illegal land occupation and the projected future scenario of further occupation, mitigation options for the site are very limited.

Given that the both the No-Go scenario and the development scenario are likely to result in the loss of almost all the vegetation on the site and result in a High or Very high negative impact, the development scenario and associated offset are supported. The exclusion of the buffer area from the development footprint and an offset for the remaining area lost are seen as the best-case scenario from a botanical perspective.

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APPENDIX 1: ASSESSMENT METHODOLOGY

(Source: SRK Consulting)

7.3 Impact Rating Methodology

The standard methodology used in EIA to assess and rate impacts based on the methodology and rating criteria is outlined in this section.

The significance of an impact is defined as a combination of the consequence of the impact occurring and the probability that the impact will occur.

The criteria used to determine impact consequence are presented in Table 5 below.

Table 1: Criteria used to determine the Consequence of the Impact

Rating	Definition of Rating	Score
A. Extent– the area over which the impact will be experienced		
None		0
Local	Confined to project or study area or part thereof (e.g. site)	1
Regional	The region, which may be defined in various ways, e.g. cadastral, catchment, topographic	2
(Inter) national	Nationally or beyond	3
B. Intensity– the magnitude of the impact in relation to the sensitivity of the receiving environment		
None		0

Low	Natural and/or social functions and processes are negligibly altered	1
Medium	Natural and/or social functions and processes continue albeit in a modified way	2
High	Natural and/or social functions or processes are severely altered	3
C. Duration– the time frame for which the impact will be experienced		
None		0
Short-term	Up to 2 years	1
Medium-term	2 to 15 years	2
Long-term	More than 15 years	3

The combined score of these three criteria corresponds to a Consequence Rating, as set out in Table 6:

Table 2: Method used to determine the Consequence Score

Combined Score (A+B+C)	0 – 2	3 – 4	5	6	7	8 – 9
Consequence Rating	Not significant	Very low	Low	Medium	High	Very high

Once the consequence is derived, the probability of the impact occurring will be considered, using the probability classifications presented in Table 7.

Table 3: Probability Classification

Probability of impact – the likelihood of the impact occurring	
Improbable	< 40% chance of occurring
Probable	40% - 70% chance of occurring
Highly probable	> 70% - 90% chance of occurring
Definite	> 90% chance of occurring

The overall significance of the individual impacts will be determined by considering consequence and probability using the rating system prescribed in Table 8.

Table 4: Impact Significance Ratings

Significance Rating	Consequence		Probability
Insignificant	Very Low	&	Improbable
	Very Low	&	Possible
Very Low	Very Low	&	Probable
	Very Low	&	Definite
	Low	&	Improbable
	Low	&	Possible
Low	Low	&	Probable
	Low	&	Definite
	Medium	&	Improbable
	Medium	&	Possible
Medium	Medium	&	Probable
	Medium	&	Definite
	High	&	Improbable
	High	&	Possible
High	High	&	Probable
	High	&	Definite
	Very High	&	Improbable
	Very High	&	Possible
Very High	Very High	&	Probable
	Very High	&	Definite

Finally the impacts will also be considered in terms of their status (positive or negative impact) and the confidence in the ascribed impact significance rating. The prescribed system for considering impacts status and confidence (in assessment) is laid out in Table 9.

Table 5: Impact status and confidence classification

Status of impact	
Indication whether the impact is adverse (negative) or beneficial (positive).	+ ve (positive – a 'benefit')
	– ve (negative – a 'cost')
	Neutral
Confidence of assessment	

The degree of confidence in predictions based on available information, EAP's judgment and/or specialist knowledge.	Low
	Medium
	High

The impact significance rating should be considered by the authority in their decision-making process based on the implications of ratings described below:

- **Insignificant:** the potential impact is negligible and will not have an influence on the decision regarding the proposed activity/development.
- **Very Low:** the potential impact should not have any meaningful influence on the decision regarding the proposed activity/development.
- **Low:** the potential impact may not have any meaningful influence on the decision regarding the proposed activity/development.
- **Medium:** the potential impact should influence the decision regarding the proposed activity/development.
- **High:** the potential impact will affect the decision regarding the proposed activity/development.
- **Very High:** The proposed activity should only be approved under special circumstances.

In the EIA practicable mitigation measures will be recommended and impacts rated in the prescribed way both without and with the assumed effective implementation of mitigation measures.

Mitigation measures are either:

- Essential: must be implemented (as they minimise potentially significant negative impacts) and are non negotiable; and
- Optional: "nice-to-have's" as they do little to minimise a key potentially significant negative impacts and/or improve benefits.

APPENDIX 2: MINIMUM CONTENT REQUIREMENTS FOR TERRESTRIAL BIODIVERSITY SPECIALIST REPORTS AS PER PROTOCOL FOR THE SPECIALIST ASSESSMENT OF ENVIRONMENTAL IMPACTS ON TERRESTRIAL BIODIVERSITY (GN 320 OF 20 MARCH 2020)

Protocol ref	Terrestrial Biodiversity Specialist Assessment Report Content	Section / Page
3.1.1.	contact details of the specialist, their SACNASP registration number, their field of expertise and a curriculum vitae;	Page ii and Appendix 3
3.1.2.	a signed statement of independence by the specialist;	Page iii
3.1.3.	a statement on the duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	Section 5
3.1.4.	a description of the methodology used to undertake the site verification and impact assessment and site inspection, including equipment and modelling used, where relevant;	Section 5
3.1.5.	a description of the assumptions made and any uncertainties or gaps in knowledge or data as well as a statement of the timing and intensity of site inspection observations;	Section 5
3.1.6.	a location of the areas not suitable for development, which are to be avoided during construction and operation (where relevant);	Section 8
3.1.7.	additional environmental impacts expected from the proposed development;	Section 9
3.1.8.	any direct, indirect and cumulative impacts of the proposed development;	Section 9
3.1.9.	the degree to which impacts and risks can be mitigated;	Section 9
3.1.10.	the degree to which the impacts and risks can be reversed;	Section 9
3.1.11.	the degree to which the impacts and risks can cause loss of irreplaceable resources;	Section 9
3.1.12.	proposed impact management actions and impact management outcomes proposed by the specialist for inclusion in the Environmental Management Programme (EMPr);	Section 9
3.1.13.	a motivation must be provided if there were development footprints identified as per paragraph 2.3.6 above that were identified as having a "low" terrestrial biodiversity sensitivity and that were not considered appropriate;	N/A
3.1.14.	a substantiated statement, based on the findings of the specialist assessment, regarding the acceptability, or not, of the proposed development, if it should receive approval or not; and	Section 10
3.1.15.	any conditions to which this statement is subjected.	Section 10

APPENDIX 3: ABBREVIATED CURRICULUM VITAE: GREG NICOLSON

Experience

- Expertise in field work in the CFR – vegetation surveys, plant identification, plant collection, ecological monitoring
- Data management and analysis
- Basic skills in GIS programs
- Vegetation and species mapping
- MSc thesis entitled “ *Road reserves as conservation assets: exploring the species of conservation concern and the ecological condition of the N7 road reserve*”. Graduation date: December 2010
- Experience leading teams of field assistants in remote mountainous areas
- Completed over 100 botanical survey/assessment reports

Career History

- 2019 – present: Co-founder and independent botanist at Capensis Ecological Surveys
- March 2013 – Dec 2018: independent botanical specialist and associate of Bergwind Botanical Surveys & Tours CC
- March 2011 – December 2012: conducted a comprehensive post fire survey of the Paardeberg (Paardeberg Sustainability Institute)

Education and qualifications

- Pr. Nat. Sci. (116488)
- MSc (Botany) – University of Cape Town (2010).
- BSc: Hons (Env. Science) – University of Cape Town (2005)
- BSc: Environmental and Geographical Science - University of Cape Town (2002 – 2004)

Personal Details

- Greg Nicolson
- 25 Dartmouth Road, Muizenberg, 7945
- Cell: 072 211 9843. Home: 021 709 0750
- greg@capensis.co.za
- Date of birth – 26/08/1981
- Marital status – Single
- Dependents – 3

APPENDIX 4: PLANT SPECIES THEME PROTOCOL REPORT

1. Introduction

The relative plant species theme sensitivity for the site generated by the web-based Screening Tool (<https://screening.environment.gov.za>) is rated as “Medium” (Figure 1).

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“An applicant intending to undertake an activity identified in the scope of this protocol, on a site identified by the screening tool as being of “medium sensitivity” for terrestrial plant species, must submit either a **Terrestrial Plant Species Specialist Assessment Report** or a **Terrestrial Plant Species Compliance Statement**, depending on the outcome of a site inspection undertaken in accordance with paragraph 4” (Government Gazette 2020b). Plants listed as Species of Conservation Concern (SCC) have been identified at this site and therefore a Terrestrial Plant Species Specialist Assessment Report is required. This report has been compiled following the guidelines set out for the **Terrestrial Fauna and Terrestrial Flora Species Protocols for Environmental Impact Assessments in South Africa** (SANBI 2020).¹

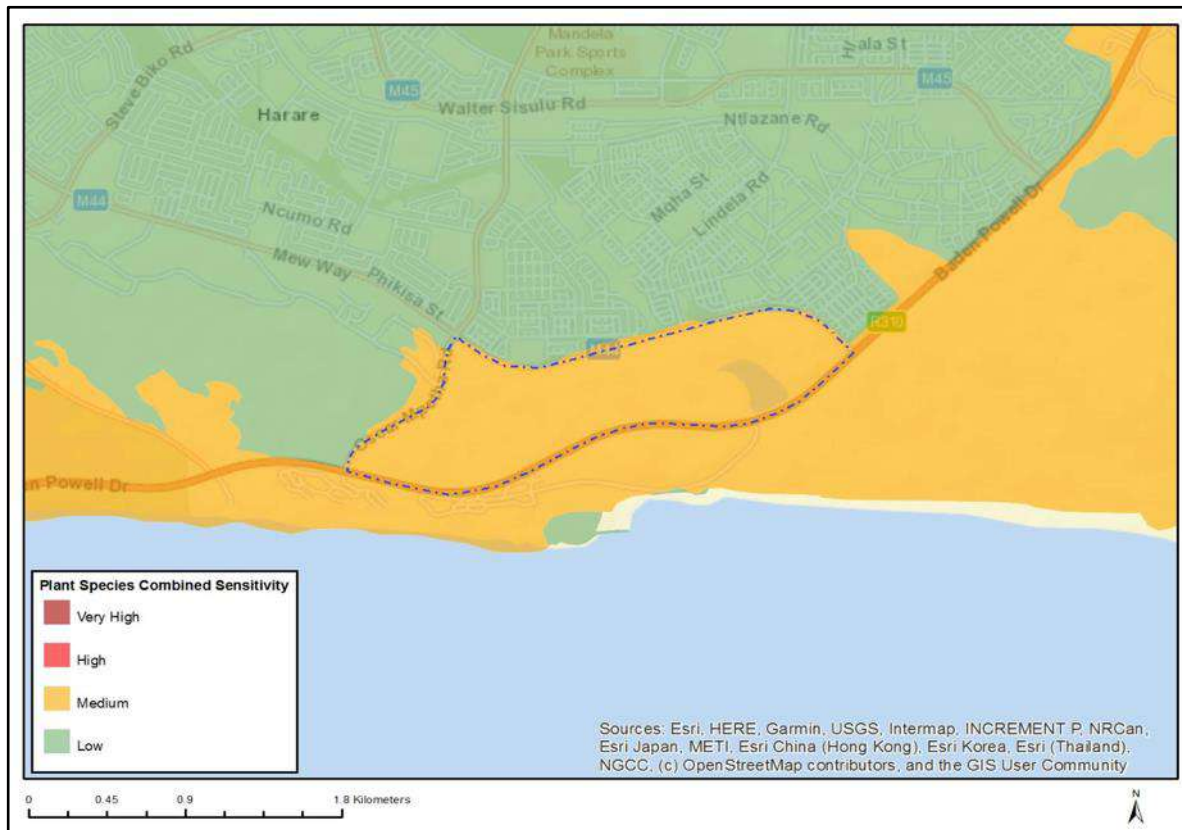


Figure 1. The map of Relative Plant Species Sensitivity based on the national screening tool (accessed from <https://screening.environment.gov.za/>).

The density of recorded waypoints in the Study area is 0.5 waypoints/ha (51 waypoints in 110 ha). It should be noted that the area that have already been Highly degraded by

¹ South African National Biodiversity Institute (SANBI). 2020. *Species Environmental Assessment Guideline. Guidelines for the implementation of the Terrestrial Fauna and Terrestrial Flora Species Protocols for environmental impact assessments in South Africa*. South African National Biodiversity Institute, Pretoria. Version 1.2020.

informal dwelling invasion were not surveyed in detail and the density of waypoints for the area surveyed is higher in reality.



Figure 2. The map of the study area showing the proposed development areas and the survey track and waypoints recorded.

2. SCC within the study area

At least three SCC were recorded during the site visits (See Figure 3 and Tables 1 – 4 below).

The contents of tables 1 – 4 appears below:

Table 1: The SCC predicted to occur within the study area (based on the screening tool).

Table 2: The SCC confirmed within the study area.

Table 3: Additional details about the SCC confirmed or suspected to occur within the study area.

Table 4: Additional information on the SCC confirmed on the site or likely to be found on the site from The Redlist of South African Plants website (www.redlist.sanbi.org)

Table1. Species predicted to be in the study area (by the screening tool) AND those not predicted in the screening tool that were found in the adjacent vegetation.

FAMILY	Species	IUCN Status	Observed/Likelihood of occurrence	Justification for likelihood of occurrence
AIZOACEAE	<i>Lampranthus stenus</i>	EN	No/Low	No plants from this genus were found on the site.
AIZOACEAE	<i>Lampranthus tenuifolius</i>	EN	No/Low	No plants from this genus were found on the site.
AIZOACEAE	<i>Erepsia dunensis</i>	EN	No/Low	No plants from this genus were found on the site.
AIZOACEAE	<i>Ruschia geminiflora</i>	VU	No/Low	No plants from this genus were found on the site.
AIZOACEAE	<i>Jordaaniella anemoniflora</i>	CR EX	No/Low	No plants from this genus were found on the site.
FABACEAE	<i>Lessertia argentea</i>	EN	Confirmed	One sub population found on the site
FABACEAE	<i>Psoralea glaucina</i>	CR	No/Low	Species habitat no found on the site.
FABACEAE	<i>Indigofera psoraloides</i>	EN	No/Low	Distinctive growth form not observed
FABACEAE	<i>Aspalathus globulosa</i>	EN	No/Low	Only one <i>Aspalathus</i> (<i>hispida</i>) was found on the site.
FABACEAE	<i>Podalyria sericea</i>	VU	No/Low	No plants from this genus were found on the site.
PROTEACEAE	<i>Leucadendron coniferum</i>	VU	No/Low	No plants from this genus were found on the site.
PROTEACEAE	<i>Leucadendron linifolium</i>	VU	No/Low	No plants from this genus were found on the site

BOTANICAL SCOPING REPORT: ENKANINI HOUSING DEVELOPMENT, CITY OF CAPE TOWN

PROTEACEAE	<i>Leucospermum hypophyllocarpodendron</i> subsp. <i>canaliculatum</i>	VU	No/Low	No plants from this genus were found on the site. Fynbos species not expected on the site.
PROTEACEAE	<i>Leucospermum hypophyllocarpodendron</i> subsp. <i>hypophyllocarpodendron</i>	VU	No/ Low	No plants from this genus were found on the site. Fynbos species not expected on the site.
AIZOACEAE	<i>Tetragonia caesia</i>	EN	No/Low	Only two species from this genus were found on the site (<i>T. decumbens</i> and <i>T. fruticosa</i>).
CYPERACEAE	<i>Isolepis venustula</i>	VU	No/Low	Specific habitat not found on the site
RESTIONACEAE	<i>Cannomois arenicola</i>	EN	No/Low	Family is distinctive and only one species was found on the site (<i>Restio eleocharis</i>).
RESTIONACEAE	<i>Elegia prominens</i>	VU	No/Low	Family is distinctive and only one species was found on the site (<i>Restio eleocharis</i>).
RESTIONACEAE	<i>Restio sabulosus</i>	EN	No/Low	Family is distinctive and only one species was found on the site (<i>Restio eleocharis</i>).
APOCYNACEAE	<i>Cynanchum zeyheri</i>	VU	No/Low	Only one species from this genus was found on the site (<i>C. africana</i>).
ORCHIDACEAE	<i>Sensitive species 985</i>	EN	No/Low	Distinctive leaves that would have been present not observed.
THYMELAEACEAE	<i>Gnidia spicata</i>	VU	No/Low	Distinctive species known by the author not present on the site and habitat also not present on site.
THYMELAEACEAE	<i>Passerina paludosa</i>	EN	No/Low	Only one species of this genus was found (<i>P. paleacea</i>) and the habitat for this species does not occur on the site.

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ASTERACEAE	<i>Poecilolepis maritima</i>	VU	No/Low	The habitat for this species does not occur on the site.
ASTERACEAE	<i>Steirodiscus tagetes</i>	VU	No/Low	Known to author and not seen on site.
ASTERACEAE	<i>Cotula eckloniana</i>	VU	No/Low	The habitat for this species does not occur on the site.
ASTERACEAE	<i>Cullumia squarrosa</i>	VU	Confirmed	One sub-population found on the site.
ROSACEAE	<i>Cliffortia ericifolia</i>	EN	No/Low	This is a distinctive genus and no species were found on the site.
ROSACEAE	<i>Cliffortia hirta</i>	EN	No/Low	This is a distinctive genus and no species were found on the site.
ROSACEAE	<i>Cliffortia longifolia</i>	VU	No/Low	This is a distinctive genus and no species were found on the site.
POLYGALACEAE	<i>Muraltia macropetala</i>	VU	No/Low	Only one species from this genus was found on site (<i>M. spinosa</i>).
POLYGALACEAE	<i>Muraltia mitior</i>	EN	No/Low	Only one species from this genus was found on site (<i>M. spinosa</i>).
HYACINTHACEAE	<i>Sensitive species 214</i>	CR	No/Low	The habitat for this species does not occur on the site.
RHAMNACEAE	<i>Phylica plumosa</i> var. <i>squarrosa</i>	EN	No/Low	This is a distinctive genus and only one species was found on the site (<i>P. ericifolia</i>).
FABACEAE	<i>Xiphotheca reflexa</i>	EN	No/Low	This is a distinctive genus and no species were found on the site
ASPHODELACEAE	<i>Sensitive species 599</i>	VU	No/Medium	Potentially still dormant or overlooked
ORCHIDACEAE	<i>Sensitive species 654</i>	VU	No/Low	
THYMELAEACEAE	<i>Lachnaea grandiflora</i>	VU	No/Low	This is a distinctive genus and no species were found on the site

ASTERACEAE	<i>Cotula pusilla</i>	VU	No/Low	This is a distinctive genus and no species were found on the site
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Table 2. Species found within the proposed development footprint.

FAMILY	Species	Status	Observed/Likelihood of occurrence	Url link to observation(s)
FABACEAE	<i>Lessertia argentea</i>	Endangered C2a(i)	Confirmed	https://www.inaturalist.org/observations/77443150
FABACEAE	<i>Psoralea repens</i>	Near Threatened A4bc	Not predicted in Screening tool Confirmed	https://www.inaturalist.org/observations/77443108
ASTERACEAE	<i>Cullumia squarrosa</i>	Vulnerable B1ab(ii,iii,iv,v)	Confirmed	https://www.inaturalist.org/observations/77443139

Table 3. SCC confirmed on the site or likely to be found on the site

Species	Distribution (see Figure 23)	Viability	Population Size	Nature and extent of impact on SCC	Known population size* and AOO (Appendix 8 of Guidelines) and loss	Conservation importance of SCC
<i>Lessertia argentea</i>	One sub-population near the centre of the site	This population will be lost due to the proposed development.	Estimated at 7 plants	Loss of all individuals within development footprint. Associated with Degraded strandveld habitat on site but only occurring in an area of 1000 m ² (0.001km ²).	0.45 km ² 0.001/0.45 = 0.2 % of known AOO.	Very rare and uncommon species. This is the only known sub-population on the site. No change to IUCN status is expected, however this is an important population and

						the significance of the loss is High.
<i>Psoralea repens</i>	One sub-population near the south-east the site	This population will be lost due to the proposed development unless the No-Go area is observed. Even so it may still be lost.	4 plants	Potential loss of these four individuals if not avoided during construction (occupies 0.001 km ²).	Unknown AOO or EOO	This sub-population is of importance on the site, however if it is lost no change to IUCN status would occur.
<i>Cullumia squarrosa</i>	One sub-population near the centre of the site	This population will be lost due to the proposed development.	5 plants	Loss of all individuals within development footprint. Associated with Semi-intact strandveld habitat on site but only occurring in an area of 1000 m ² (0.001km ²).	9.68 km ² 0.001/9.68 = 0.01 % of AOO	This sub-population is of importance on the site, however if it is lost no change to IUCN status would occur.

* Derived from the Red List of South African Plants (www.redlist.org.za)

Table 4. Additional information on the SCC confirmed on the site or likely to be found on the site from The Red List of South African Plants website (www.redlist.sanbi.org)

Name	Status and Criteria	Justification	Range	Habitat Description	Threats	Population
<i>Lessertia argentea</i>	Endangered C2a(i)	EOO 1 952 km ² , a range-restricted, very uncommon species known from about 10 subpopulations. Observations of five subpopulations indicate that subpopulations tend to be very small, consisting of fewer than 50 mature individuals and continue to decline due to ongoing habitat loss to urban development and alien plant invasion.	Saldanha Bay to False Bay.	Coastal dunes.	Habitat loss to coastal and urban development, expanding informal settlements and alien invasive plants.	This is a very uncommon species, and subpopulations are very small, in most cases consisting of fewer than 50 mature individuals (N.A. Helme, pers. obs.).
<i>Psoralea repens</i>	Near Threatened A4bc	A population reduction of 20% is estimated based on a decline in the number of known locations due to coastal development	Cape Peninsula to Kenton-on-Sea.	Coastal fynbos.	Coastal development has already caused at least 20% habitat loss and is continuing. Many areas of coastal vegetation is also	Decreasing

		since 1970 (generation length $\pm$ 15 years). Population decline as a result of coastal development is highly likely to continue into the future.			densely invaded by alien plants, causing an ongoing deterioration of the natural vegetation.	
<i>Cullumia squarrosa</i>	<i>Vulnerable</i> <i>B1ab(ii,iii,iv,v)</i>	EOO 4586-5757 km ² , between five and 10 remaining locations continue to decline due to ongoing habitat loss and degradation due to expansion of urban and coastal development, competition from unmanaged alien invasive plants and overgrazing.	Cape Peninsula to the Agulhas Plain.	Deep sandy coastal flats.	Threatened by habitat loss to urban expansion on the Cape Peninsula, and coastal development further east. Competition from unmanaged alien invasive plants threaten remaining plants around Macassar and on the Agulhas Plain, where one known subpopulation is also threatened by overgrazing.	Historical records indicate that this species was formerly very common on sandy coastal lowlands from the Cape Peninsula to the Agulhas Plain, but much of these areas have now been transformed for urban and coastal development, with many subpopulations now lost around Noordhoek, Simon's Town, Macassar, Pringle Bay and Hermanus. It is however still common in the Cape Point section of the Table Mountain National Park, but has also been overlooked and undersampled elsewhere and is possibly more common than records indicate (N.A. Helme pers. comm. 2012).

3. Impacts and Mitigation

See section 9 of the Basic Assessment Report (BAR).

4. Buffers

A buffer of 200 m has been applied to the EN *Lessertia argentea* and the VU beach snakethistle *Cullumia squarrosa* and this produces a large overlap with development footprint (Figure 3).

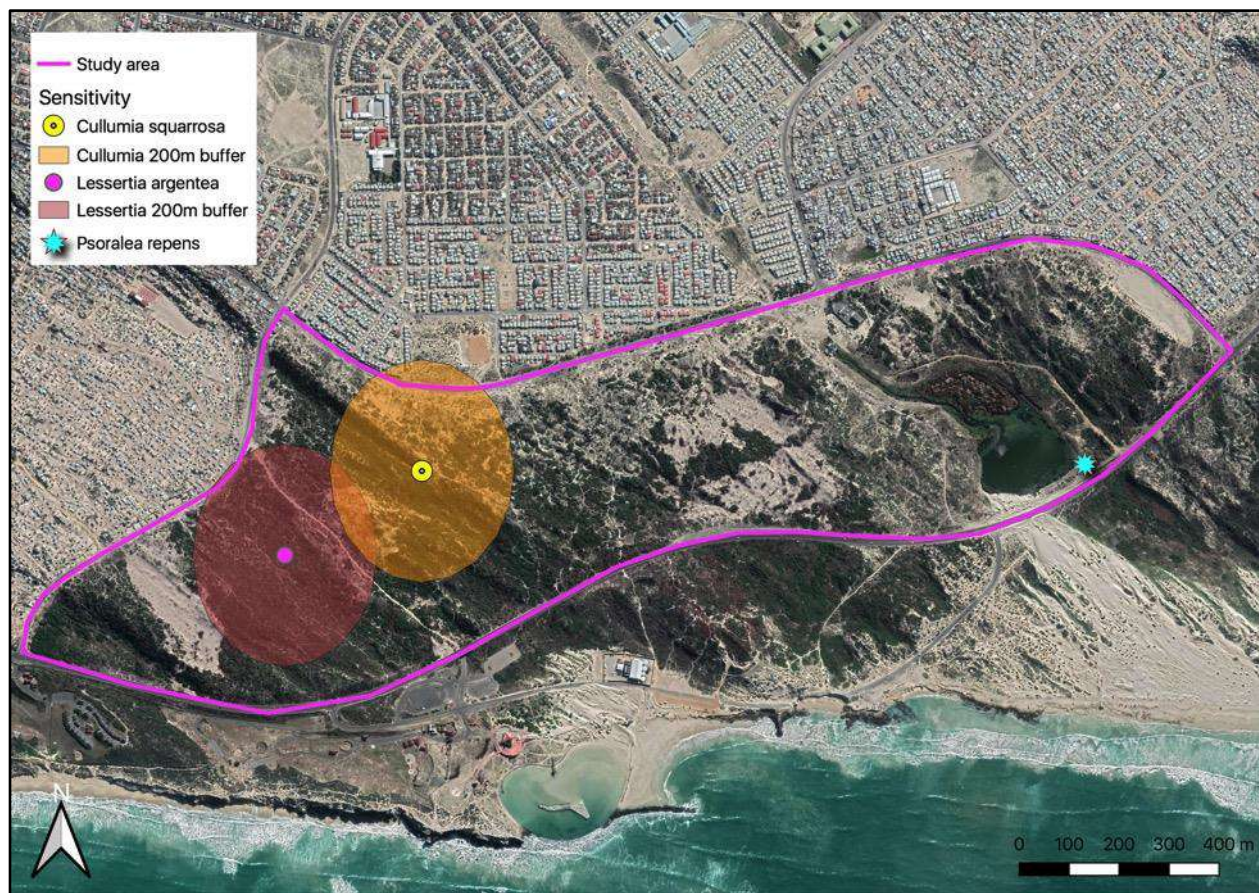


Figure 3. The map of the study area showing the SCC found in or surrounding the proposed development footprint. A 200 m buffer has been applied to the Endangered *Lessertia argenteum* and the Vulnerable *Cullumia squarrosa* individuals recorded.

Considering the current scenario the author is of the opinion that the 200 m buffer is not necessary in this case for the following reasons:

1. The populations of SCC are highly likely to be lost even under the No-Go scenario.

5. Conclusion

This plants species theme sensitivity report has been compiled according to the relevant legislation using the guidelines provided.

6. Content of report requirement and relevant sections

		Section or page of report
2.1	The assessment must be undertaken by a specialist registered with the South African Council for Natural Scientific Professions (SACNASP), within a field of practice relevant to the taxonomic groups ("taxa") for which the assessment is being undertaken. [1] [SEP]	Page ii and Appendix 3
2.2	The assessment must be undertaken within the study area. [1] [SEP]	It was
2.3	The assessment must be undertaken in accordance with the <i>Species [1] [SEP] Environmental Assessment Guideline</i> ²³ and must:	
2.3.1	Identify the SCC which were found, observed or are likely to occur within the study area; [1] [SEP]	Tables 1 and 2 in Appendix 4
2.3.2	provide evidence (photographs) of each SCC found or observed within the study area, which must be disseminated by the specialist to a recognized online database facility ²⁴ immediately after the site inspection has been performed (prior to preparing the report contemplated in paragraph 3); [1] [SEP]	Tables 1 and 2 in Appendix 4
2.3.3	identify the distribution, location, viability ²⁵ and detailed description of population size of the SCC identified within the study area; [1] [SEP]	Table 2 and 3 in Appendix 4
2.3.4	identify the nature and the extent of the potential impact of the [1] [SEP] proposed development to the population of the SCC located within [1] [SEP] the study area; [1] [SEP]	Section 9
2.3.5	determine the importance of the conservation of the population of the [1] [SEP] SCC identified within the study area, based on information available in national and international databases including the IUCN Red List of Threatened Species, South African Red List of Species, and/or other relevant databases; [1] [SEP]	Table 3 in Appendix 4
2.3.6	determine the potential impact of the proposed development on the habitat of the SCC located within the study area; [1] [SEP]	Table 3 in Appendix 4
2.3.7	include a review of relevant literature on the population size of the SCC, the conservation interventions as well as any national or provincial species management plans for the SCC. This review must provide information on the need to conserve the SCC and indicate whether the development is compliant with the applicable species management plans and if not, a motivation for the deviation; [1] [SEP]	Table 3 in Appendix 4
2.3.8	identify any dynamic ecological processes occurring within the broader landscape, that might be disrupted by the development and result in negative impact on the	N/A

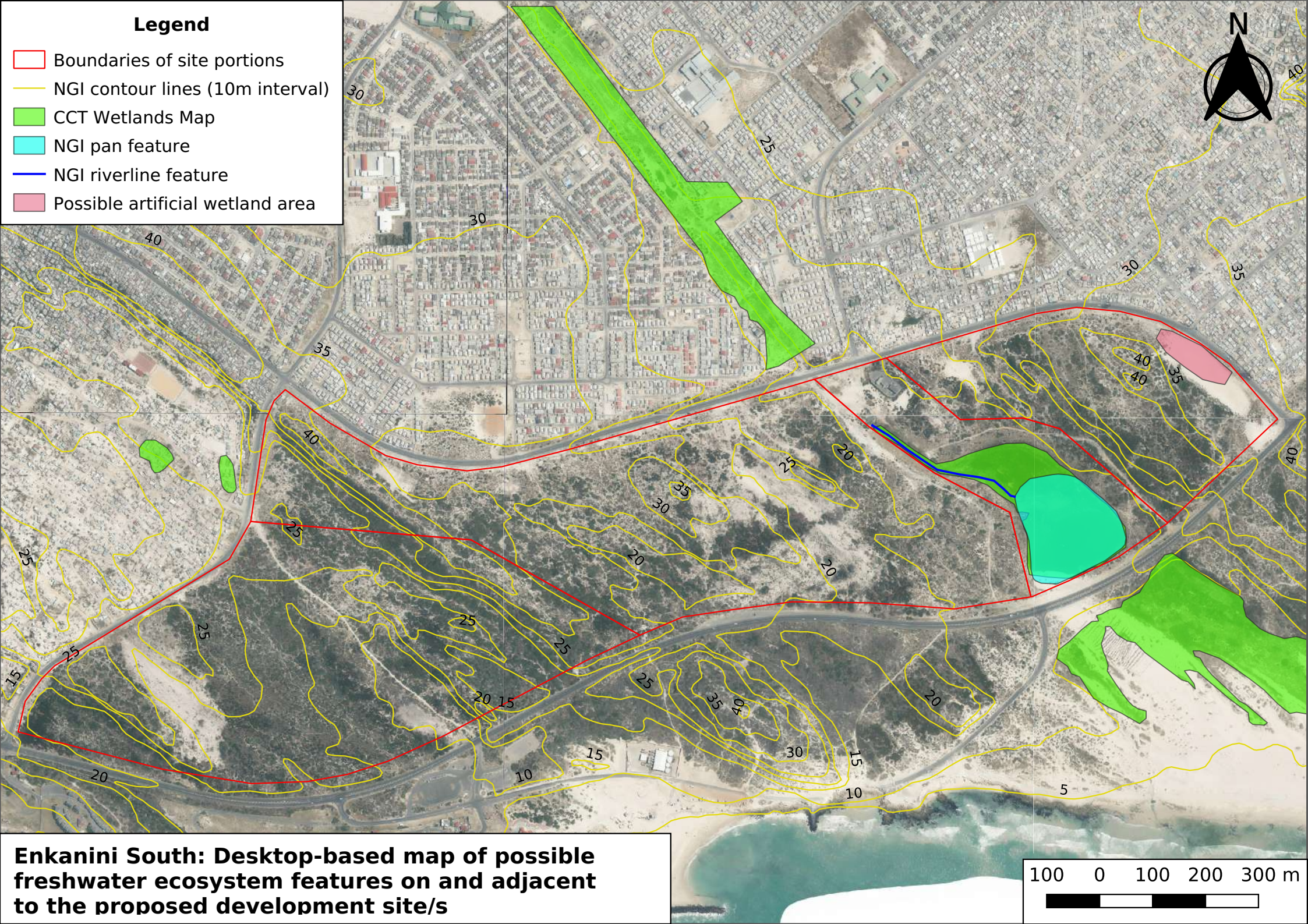
	identified SCC, for example, fires in fire-prone systems; ^{1} _{SEP}	
2.3.9	identify any potential impact on ecological connectivity within the broader landscape, and resulting impacts on the identified SCC and its long term viability; ^{1} _{SEP}	N/A
2.3.10	determine buffer distances as per the <i>Species Environmental Assessment Guidelines</i> used for the population of each SCC; and ^{1} _{SEP}	Section 4 of Appendix 4
2.3.11	discuss the presence or likelihood of additional SCC including threatened species not identified by the screening tool, <i>Data Deficient or Near Threatened Species</i> , as well as any undescribed species ²⁶ ; and	Table 1 of Appendix 4.
2.3.12	identify any alternative development footprints within the preferred development site which would be of “low” sensitivity” or “medium” sensitivity as identified by the screening tool and verified through the site sensitivity verification.	N/A

3.	Terrestrial Plant Species Specialist Assessment Report²⁷	Section/Page
3.1	This report must include as a minimum the following information:	
3.1.1 ^{1} _{SEP}	contact details and relevant experience as well as the SACNASP registration number of the specialist preparing the assessment ^{1} _{SEP} including a curriculum vitae;	See above
3.1.2	a signed statement of independence by the specialist; ^{1} _{SEP}	Page iii
3.1.3	a statement on the duration, date and season of the site inspection ^{1} _{SEP} and the relevance of the season to the outcome of the assessment; ^{1} _{SEP}	Section 4
3.1.4 ^{1} _{SEP}	a description of the methodology used to undertake the site sensitivity verification and impact assessment and site inspection, including ^{1} _{SEP} equipment and modelling used where relevant;	Section 4
3.1.5	a description of the assumptions made and any uncertainties or gaps ^{1} _{SEP} in knowledge or data; ^{1} _{SEP}	Section 4
3.1.6	a description of the mean density of observations/number of samples ^{1} _{SEP} sites per unit area ²⁸ of site inspection observations; ^{1} _{SEP}	Figure 2 of Appendix 4.
3.1.7	details of all SCC found or suspected to occur on site, ensuring ^{1} _{SEP} sensitive species are appropriately reported; ^{1} _{SEP}	See above
3.1.8	the online database name, hyperlink and record accession numbers ^{1} _{SEP} for disseminated evidence of SCC found within the study area; ^{1} _{SEP}	Table 2 of Appendix 4
3.1.9	the location of areas not suitable for development and to be avoided ^{1} _{SEP} during construction where relevant; ^{1} _{SEP}	N/A
3.1.10 ^{1} _{SEP}	a discussion on the cumulative impacts;	Section 9
3.1.11	impact management actions and impact management outcomes ^{1} _{SEP} proposed by the specialist for inclusion in the Environmental ^{1} _{SEP} Management Programme (EMPr); ^{1} _{SEP}	Section 9

3.1.12	a reasoned opinion, based on the findings of the specialist ^{11.11.21} 11.11.21 _{SEP} assessment, regarding the acceptability or not, of the development related to the specific theme considered, and if the development should receive approval or not, related to the specific theme being considered, and any conditions to which the opinion is subjected if relevant; and ^{11.11.21} 11.11.21 _{SEP}	Section 10
3.1.13	a motivation must be provided if there were any development footprints identified as per paragraph 2.3.12 above that were identified as having “low” or “medium” terrestrial plant species sensitivity and were not considered appropriate	N/A
3.2	A signed copy of the assessment must be appended to the Basic Assessment Report or Environmental Impact Assessment Report	

Legend

- Boundaries of site portions
- NGI contour lines (10m interval)
- CCT Wetlands Map
- NGI pan feature
- NGI riverline feature
- Possible artificial wetland area



Enkanini South: Desktop-based map of possible freshwater ecosystem features on and adjacent to the proposed development site/s

100 0 100 200 300 m

Enkanini Housing Development: Biodiversity Offset Study

by

Amrei von Hase and

Susie Brownlie (deVilliers Brownlie Associates)

17 March 2022

Client: Sillito Environmental Consulting

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Acronyms, abbreviations

BMB	City of Cape Town's Biodiversity Management Branch
CFDS	Cape Flats Dune Strandveld
CoCT	City of Cape Town
CIP	Southeast Strandveld Conservation Implementation Plan
DEA&DP	Department of Environmental Affairs and Development Planning
EHD	Enkanini Housing Development
NEMA	National Environmental Management Act 107 of 1998
NEM: PAA	NEM Protected Areas Act 57 of 2003
SoCC	Species of Conservation Concern

Introduction

This introductory section describes the proposed Enkanini Housing Development (EHD) and the Terms of Reference for the offset work, notes the assumptions and limitations of the offset study, and provides a 'road map' of the report structure.

1.1 The Enkanini Housing Development

The proposed EHD is located on a site in the South-East Metropole near the False Bay coastline. It is bounded by Baden Powell Drive in the south, Oscar Mpetha Road to the west and Mew Way to the north and east (Figure 1). The site is on parts of two erven: Erf RE/18370 and RE/18332. The proposed development layout is shown on Figure 2.



Figure 1. Location of the Enkanini site and immediate surroundings overlaid on a Google TM satellite image (Source: Figure 3, Nicolson, 2022).

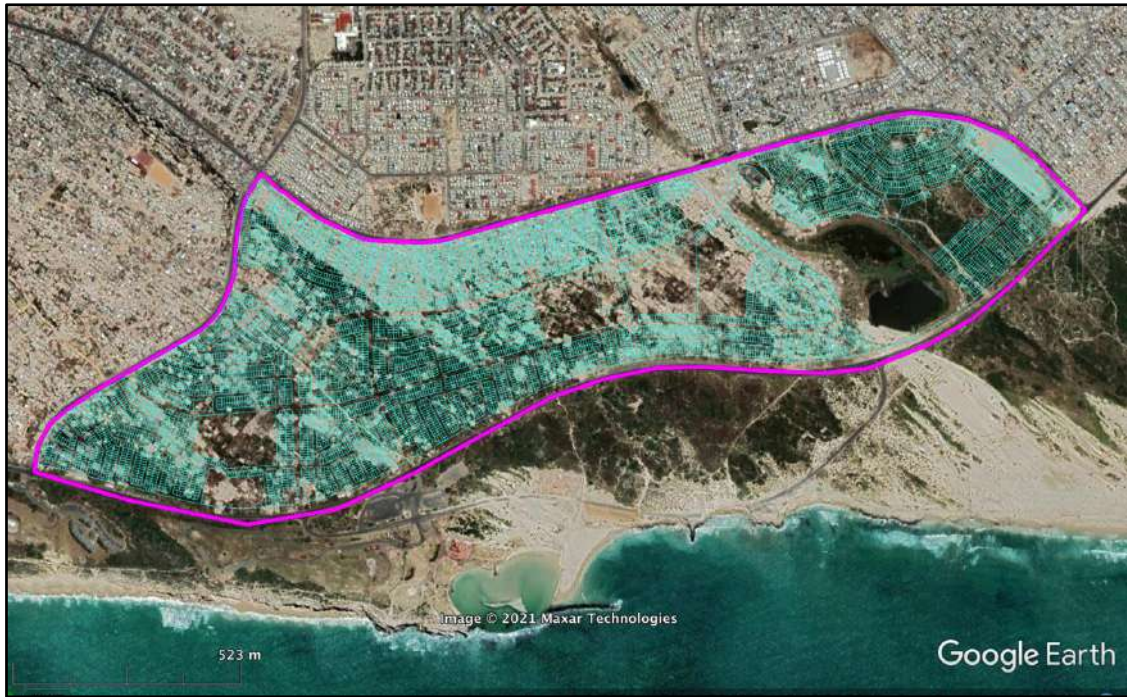


Figure 2. The proposed layout of the project overlaid on a Google TM satellite aerial image date February 2021. (Source: Figure 4B, Nicolson, 2022).

1.2 Terms of reference

Dr Amrei von Hase, in collaboration with Susie Brownlie (deVilliers Brownlie Associates) was appointed by Sillito Environmental Consulting to design an appropriate biodiversity offset for the EHD.

The services comprised calculating a measure of the likely residual negative impacts of a City of Cape Town (Human Settlement Department) housing development on Cape Flats Dune Strandveld (CFDS) vegetation and associated plant Species of Conservation Concern (SoCC), determining the associated offset requirements, and identifying and evaluating possible offset options. These options included principally, the Macassar Dunes East Conservation Landbank¹, hereinafter referred to as ‘the landbank’.

In addition, implementation (i.e. institutional, financial and management) arrangements were to be explored, and high-level recommendations formulated for effective offset implementation.

¹ Oxtoby, Dorse & Wood, 2019.

1.3 Assumptions and limitations

This report assumes that:

- a) If needed, offsets for residual impacts on wetlands or other freshwater ecosystems are to be designed by the appointed freshwater specialist to meet the Department of Water and Sanitation's requirements and the wetland offset guidelines.
- b) Recommendations are made regarding arrangements for offset implementation. Implementation arrangements have not been finalised, however; agreements and final arrangements must be reached between the applicant (City's Human Settlement Department) and the City's Environmental Resource Management Department.
- c) The on-site areas which are to remain in a natural condition (i.e. excluded from the development footprint) do not constitute biodiversity offsets, and the responsibility for their maintenance and management lies outside the scope of this study.

1.4 Structure of this report

This report begins by describing the context for the proposed EHD and checking that the mitigation hierarchy² has been applied. It then identifies and measures residual negative impacts on vegetation and flora in order to determine offset requirements. Following on from this step, the report identifies and evaluates the potential use of the landbank as a priority offset option.

Based on the outcome of engagement with relevant competent and commenting authorities (CapeNature, CoCT and the provincial Department of Environmental Affairs and Development Planning: DEA&DP), the report provides recommendations for offset implementation and offset conditions, should the environmental authorisation be granted by the competent authority.

Context and approach

According to the City's Biodiversity Management Branch (BMB), around 23,6% of the historic extent of CFDS remains. The implication is that the national target of 24% can no longer be met for the False Bay subtype of CFDS. To manage and help reconcile development and conservation needs within the City's boundaries, and particularly in the Southeast metropole, the 'Southeast Strandveld Conservation Implementation Plan' (CIP)³ was established. The CIP focuses on CFDS.

² i.e. first avoid significant negative impacts, then minimise them, then rehabilitate damage, and finally consider offsets.

³ The CIP was formulated ten years ago in the face of land requirements for housing development and conservation and determining ways to reconcile these needs, as best possible. City authorities and partners (CapeNature, DEA&DP and SANBI) agreed to a process in which priority sites for conserving CFDS were selected to meet a reduced biodiversity target (15% of the original extent of this vegetation type, rather than 24%) and where impacts should thus be completely avoided. At the same time, where 'unselected' areas of CFDS on City-owned land would be affected by proposed City project (especially housing), the loss of the vegetation could be offset at a 1:1 ratio through the conservation and management of CFDS at a proposed Conservation Landbank (Oxtoby, Dorse & Wood, 2019).

In 2019, the BMB reassessed the status of this vegetation type in the Metro Southeast. The CIP Phase 2 Steering Committee, comprising key stakeholders from BMB, CapeNature and DEA&DP, met on 20 September 2019. The resulting revised plan (Figure 3) and way forward for implementing Phase 2 of the CIP includes a proposed conservation land banking component. 'The vision is proactively to secure land and management resources to provide a conservation landbank. This would be used to facilitate the development of City-owned land, where it might affect CFDS identified as 'unselected' in the CIP, if the competent authority deems it appropriate⁴.

According to the BMB, deductions from the conservation landbank area to meet offset requirements are advocated on the basis of a 1:1 ratio (extent lost: extent protected and managed). Importantly, this ratio applies irrespective of the condition of the unselected Strandveld.

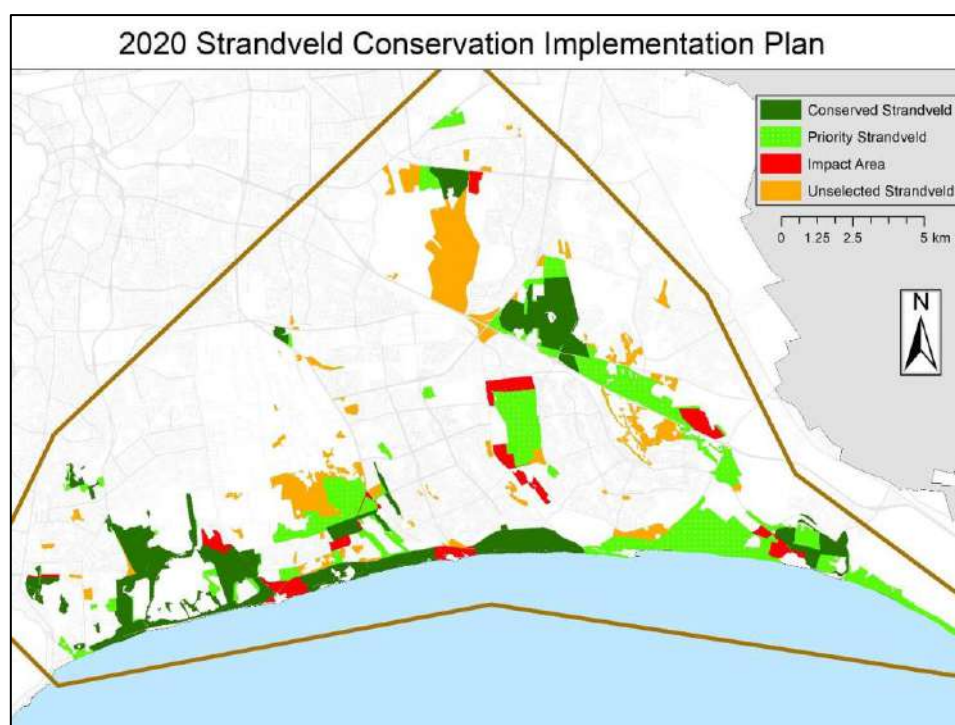


Figure 3: 2020 Southeast Strandveld CIP (Source: Oxtoby, Dorse & Wood, 2019)

The Macassar Dunes East Conservation Landbank, 150 ha in total, comprises wetlands and river, and approximately 130 ha of CFDS False Bay subtype. The landbank was reserved for Biodiversity Management in 2019 through the City's property vesting process (Figure 4). However, there is currently no budget within the BMB to secure or manage the area over the long term.

⁴ CoCT BMB 2020.



Figure 4: Location of Macassar Dunes East Conservation Landbank (Source: Oxtoby, Dorse & Wood, 2019)

2.1 Vegetation and flora

Cape Flats Dune Strandveld is an Endangered vegetation type (or ecosystem) under Criterion D1 (threatened plant associations) in the Listed Threatened Terrestrial Ecosystems (DEA 2011), and under Criteria A1 and D1 in the Western Cape Biodiversity Spatial Plan Framework (Pool-Stanvliet *et al* 2017). CFDS is endemic to the City of Cape Town and is found in two distinctive subtypes, the West Coast and the False Bay subtypes. The False Bay subtype is now considered to be Critically Endangered⁵.

The EHD site was initially mapped as a priority site in the City's CIP⁶, intended to be included in the City's conservation network over the long term. It contains CFDS vegetation of various levels of condition, with much of it described as fair to good. As noted in a letter from BMB dated May 2021 (Annexure 1), the BMB reserved a c40 ha portion on the western side of Erf 18370 Khayelitsha in 2019, agreeing that the remainder of Erf 18370 and Erf 18332-RE could be reserved for Human Settlement purposes.

However, the site became subject to illegal land invasion in 2020, resulting in the cancellation of the BMB's reservation of this western portion. Prior to 2020, the vegetation on site was assessed as intact or semi-intact (lower species diversity than undisturbed, intact vegetation)⁷

⁵ Biodiversity Management Branch, City of Cape Town. 2019.

⁶ The CIP was formulated ten years ago in the face of land requirements for housing development and conservation and determining ways to reconcile these needs, as best possible. City authorities and partners (CapeNature, DEA&DP and SANBI) agreed to a process in which priority sites for conserving CFDS were selected to meet a reduced biodiversity target (15% of the original extent of this vegetation type, rather than 24%) and where impacts should be completely avoided. At the same time, where 'unselected' areas of CFDS on City-owned land would be affected by proposed City project (especially housing), the loss of the vegetation could be offset at a 1:1 ratio through the conservation and management of CFDS at a proposed Conservation Landbank (Oxtoby, Dorse & Wood, 2019).

⁷ Nicolson 2022.

by the botanical specialist. Most of the site is now considered to be ‘highly degraded’ (the original vegetation is mostly absent, and only remnant or pioneer species occur. Restoration potential is described as ‘very low’). A small part on the eastern side of the site has been completely cleared of all vegetation (described as ‘transformed’). There are some remaining areas of semi-intact vegetation, as well as ‘degraded’ CFDS (having only a few species representative of this vegetation type, and with low to moderate restoration potential), as shown in Figure 5.

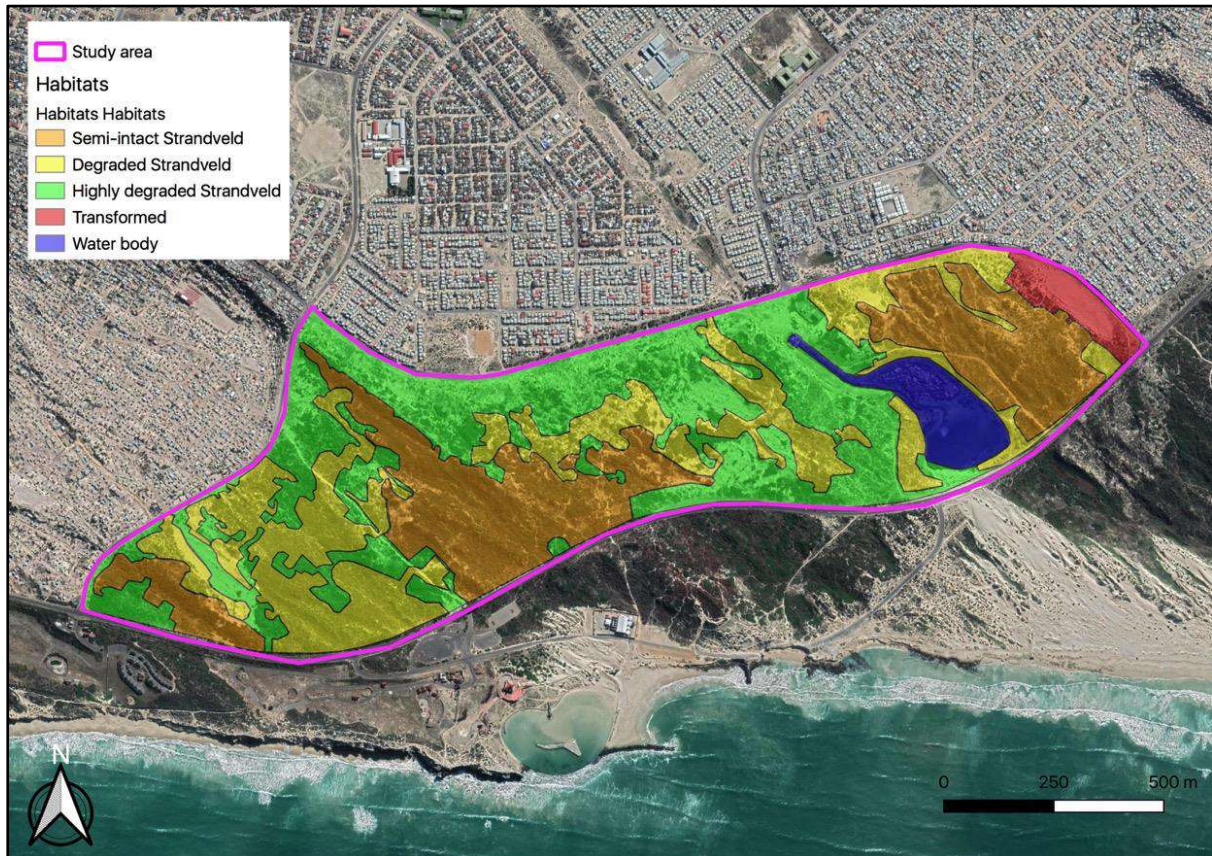


Figure 5: Condition of affected vegetation on site (Source: Figure 8, Nicolson 2022)

The ‘sensitivity’ of the EHD site, defined as the conservation value and degree of resilience to disturbance, ranges from ‘very low’ to ‘high’ (Figure 6) The conservation value relates to the conservation/ecosystem threat status, ecological connectivity, habitat condition, persistence of ecological process and the site’s role in supporting biodiversity. The degree of resilience takes into consideration factors such as sensitivity to disturbance and restoration potential.

Three flora SoCC were identified at the site: beach snakethistle, *Cullumia squarrosa* (Vulnerable), creeping fountainbush *Psoralea repens* (Near Threatened) and *Lessertia argentea* (Endangered).

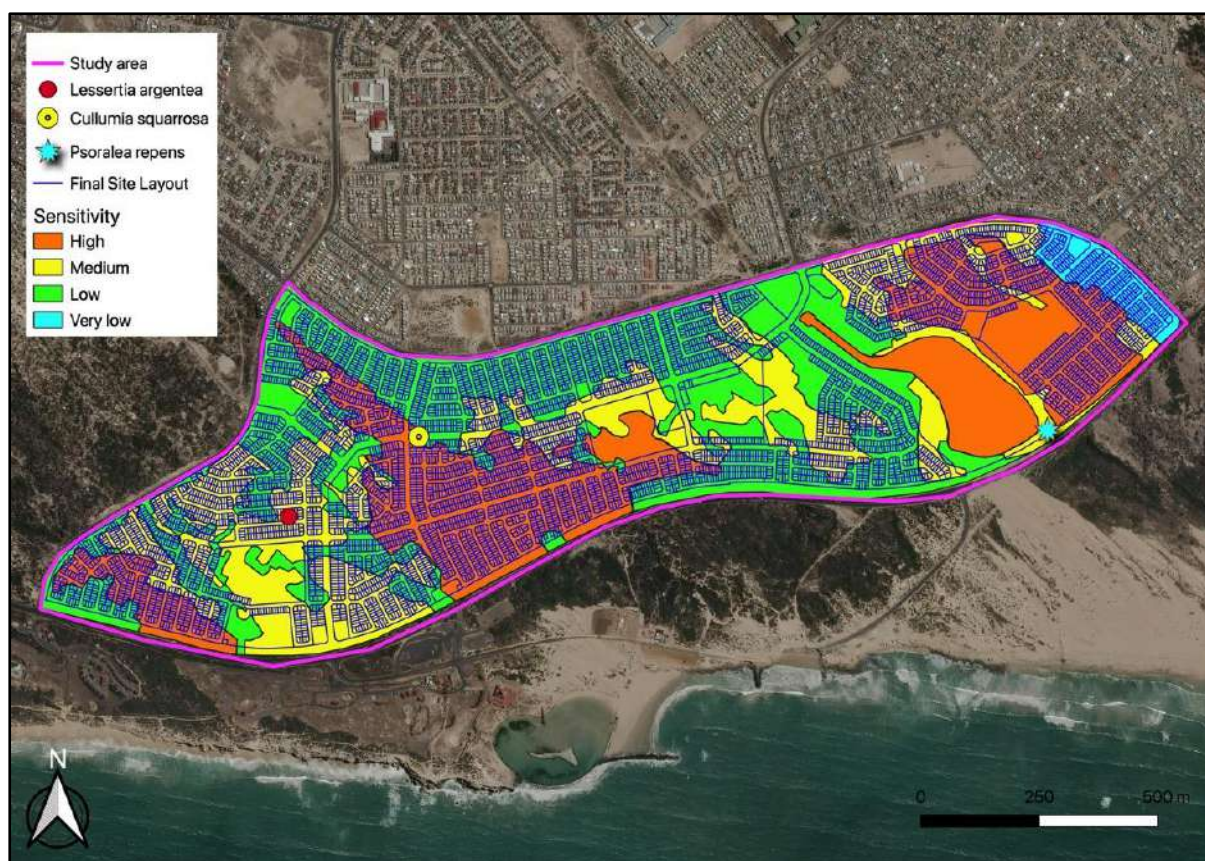


Figure 6: Sensitivity of the affected vegetation on site and occurrence of SoCC (Source: Figure 20, Nicolson 2022)

Given the intensity of informal settlement on the site and the consequent degradation of vegetation, it was agreed by BMB that the entire Enkanini South site could be reserved for Human Settlement use, and that it was no longer a viable or defensible addition to the protected area network in the City. Moreover, based on the high risk of further habitat degradation and/ or loss, on-site mitigation is no longer supported by the BMB⁸.

2.2 Land use and threats to biodiversity in the area

Approximately 50% the site has been illegally occupied by informal housing since 2020. Vegetation has been cleared, sites have been levelled and fill material has been brought in to construct houses, roads and other informal infrastructure. Land to the north and west has been converted for both formal and informal housing, and there are threats of ongoing land invasion.

⁸ Letter from Biodiversity Management Branch dated 25 May 2021, attached as Annexure 1.

Application of the mitigation hierarchy and alternatives considered

3.1 Appropriateness of biodiversity offsets

While CFDS is an Endangered ecosystem/ vegetation type, the False Bay subtype is considered to be Critically Endangered. That is, any additional loss of this vegetation should be avoided if conservation targets are to be met for this subtype.

However, the particular context of the EHD is of direct relevance: the pressure for housing is anticipated to lead to ongoing modification of the Enkanini site, making efforts to avoid or minimise further conversion of vegetation futile. This situation is recognised by the BMB (Annexure 1).

Through the environmental authorisation process for EHD, the applicant would be required to compensate for residual negative impacts by providing a biodiversity offset, in line with provincial and City guidelines on biodiversity offsets and the NEMA principles. While there would be loss of vegetation and populations of SoCC on site, an offset could result in a material contribution to the protection and effective management of the affected CFDS off-site in the long term, and is thus deemed appropriate in this specific case.

3.2 Consideration of alternatives, avoidance, minimisation and rehabilitation

The 'no go' development option is not considered to be a feasible alternative in the current context of ongoing conversion and loss of biodiversity. As noted in Section 2.1, the BMB no longer considers the area as having conservation-worthy vegetation and would not support on-site mitigation (i.e. avoidance or on-site set asides), given negligible potential for post-development restoration and rehabilitation of CFDS.

A large water body, likely to constitute a stormwater detention pond, is found on the site with fringing wetland plants. This area is excluded from the development footprint. According to the botanical specialist, the planned exclusion of the water body and wetland areas on the EHD site, with a buffer zone, could provide for one of the SoCC found on the site (the creeping fountainbush) to persist at this locality. It is recommended that vegetation within this exclusion area on site is rehabilitated.

While there is limited potential for rehabilitation/ restoration of CFDS on the site, the principal mitigation option remaining to address residual impacts is to provide a biodiversity offset for lost vegetation and flora.

This report assumes that all recognizable CFDS on the EHD site would be lost following development.

Residual impacts on vegetation and flora

4.1 Available guidance on biodiversity offsets

Both the Western Cape (DEA&DP 2011, revised 2016) and the City of Cape Town (CoCT 2009) have draft guidelines for biodiversity offsets that need to be taken into consideration. In addition, a draft National Biodiversity Offset Policy has been gazetted (DEA 2017) which must be taken into account.

4.2 Quantification of residual negative impacts

Residual impacts are quantified specifically in terms of the affected area of intact natural vegetation types or ecosystems, which are nationally recognised and classified according to their ecosystem status. This approach follows the DEA&DP Offset Information Document (2011, revised in 2016). The flora characteristic of the vegetation type is considered as partly represented/ addressed by well-mapped units of vegetation communities and vegetation types acting as surrogates for species. Species of Conservation Concern (SoCC) are given separate consideration.

According to all available guidance on biodiversity offsets, residual impacts of medium or high significance would require biodiversity offsets. For this reason, all residual negative impacts on biodiversity of medium to high significance must be quantified to provide a defensible basis for determining offset requirements.

Applying the DEA&DP guideline, only where vegetation has been highly modified to the point where there are no recognisable elements of vegetation or flora that support the presence of CFDS (i.e. only common, weedy and pioneer species) and/ or restoration to enable more than 25% of original diversity were not feasible, would areas be excluded from calculations of residual negative impacts.

According to the botanical specialist, there would be residual impacts of high significance on vegetation, loss of ecological processes, and SoCC, affecting 23.15 ha of 'degraded' area, and 32.2 ha of 'semi-intact' habitat; i.e. a total area of CFDS of 55.35 ha which would need to be offset.

Biodiversity offset requirements

As noted above, the Western Cape and the City of Cape Town have draft guidelines for biodiversity offsets, and a draft National Biodiversity Offset Policy has been gazetted. These policies/ guidelines need to be applied in this case.

The City's CIP is also of direct relevance to this project and its offset requirements. The choice of a biodiversity offset should be consistent with the CIP. The landbank essentially provides priority conservation areas for the City to use as 'in advance' offsets for City projects on sites that are unselected in the CIP.

1.1 Available guidance on biodiversity offsets

Biodiversity offsets involve securing and managing equivalent areas for conservation in the long term, to remedy residual negative impacts in line with the 'environmental degrader pays' principle in s2 of NEMA. The project proponent applying for environmental authorization is responsible for delivering the required mitigation measures, including any biodiversity offsets, as set out in conditions of authorisation.

- a) At national level, scientifically based conservation goals have been set for all vegetation types, and each is classified according to its ecosystem threat status (Least Concern/Least Threatened, Vulnerable, Endangered, or Critically Endangered⁹).

⁹ These categories are based on set of agreed data-driven criteria published in the Government Gazette (2011).

According to the draft national biodiversity offsets policy (DEA 2017), ecosystem threat status is a key factor determining whether an offset would be regarded as appropriate, i.e. whether residual impacts are likely to be 'offsetable'. Where an offset is deemed appropriate, ecosystem status also informs offset requirements (i.e. size of offset). The draft national policy states that 'already transformed areas' do not require an offset.

The draft national policy is intended as an 'overarching' guidance; provinces may develop their own more detailed biodiversity offset policies and/ or guidelines with explicit provisions, provided that they are not in conflict with the national position.

- b) The system outlined in DEA&DP (2011, 2016¹⁰) considers ecosystems to act as an umbrella for the constituent species, provided that i) the residual impacts do not cause irreplaceable loss with respect to these species, particularly regarding SOCC, and ii) the offset adequately provides for such SOCC. In addition, factors such as ecological processes and functions which are important for the long-term viability/ persistence of an offset, as well as the relative condition of the impact and offset sites, need to be taken into account when selecting potential offset sites.
- c) The condition of affected vegetation must be taken into account when determining an appropriate offset (DEA&DP 2016): for vegetation in Good or Moderate condition, the relevant basic ratio would apply; for vegetation in a Degraded condition (i.e. <25% of characteristic species), this basic ratio could be reduced by a biodiversity specialist in collaboration with CapeNature, provided that the habitat serves no other significant function.
- d) The basic offset ratio to compensate for residual negative impacts within the demarcated urban edge is 1:1 for Endangered Ecosystems¹¹.
- e) The CoCT drafted its own policy and guidelines for biodiversity offsets in 2009, which is consistent with the provincial guidelines in its approach. The City's preference is to be proactive in securing priority areas for biodiversity and requiring contributions from developers commensurate with their residual negative impacts to enable their effective conservation management. That is, biodiversity offsets must have a demonstrated positive impact on securing and managing priority areas within the CoCT's Biodiversity Network in the long term.

5.2 Requirements of the offset for Enkanini Housing Development

Since the project site lies within the City's demarcated urban edge, a basic offset ratio of **1:1** for nationally Endangered Ecosystems applies¹².

While the DEA&DP offset guidelines provide for a reduction in the basic ratio in cases where there are less than 25% of species characteristic of the specific vegetation type present, the botanical specialist does not provide quantification of the proportion of characteristic species

¹⁰ According to Ms Marlene Laros, the revised version of the draft DEA&DP guideline (March 2016) should be used in the interim, until the national biodiversity offset policy has been finalized (pers comm, 17 August 2017).

¹¹ This approach supports one of the main objectives of the Western Cape Provincial SDF, namely to contain development within urban edges.

¹² Western Cape Guideline on Biodiversity Offsets. Revised 2016.

present, and states that the rehabilitation/ restoration potential is 'low to moderate'. There is thus no defensible basis to reduce the offset ratio.

Moreover, the DEA&DP offset guidelines specifically note that local authorities within whose areas the impacts of development and/ or the biodiversity offsets will be located, have their own priorities for biodiversity conservation set out in bioregional and other spatial development plans that inform both the significance of residual impacts and appropriate offset receiving areas. For this reason, their input is crucial if the biodiversity targets of not only provincial but local municipal areas are to be achieved.

The BMB's technical report on the CIP states explicitly that use of the landbank is to involve a 1:1 exchange of residual impacts of development in unselected CFDS for managed strandveld in the landbank, 'irrespective of the condition of the unselected strandveld'¹³.

For the above reasons, a 1:1 offset ratio is deemed appropriate to apply to the EHD for loss of CFDS, as shown in Table 1.

Table 1: Offset requirements for EHD

Loss of CFDS	• 32.2 ha of 'semi-intact' vegetation • 23.15 ha of 'degraded' vegetation
Offset required	55.35 ha of CFDS

In summary, **55.35 ha of CFDS is required to be secured for conservation purposes in perpetuity and managed effectively.**¹⁴

It is important that the offset for residual impacts provides habitat known to support the three SoCC identified on the EHD site, which will be lost as a consequence of the housing project (although there is some potential to retain one of the SoCC, creeping fountainbush, in the detention pond/ wetland buffer on the site).

Stakeholder engagement

Meetings and/or conversations were held, and correspondence entered into with the client (Sillito Environmental Consulting), CoCT's Environmental Management Department, CoCT's BMB, CapeNature and DEA&DP.

Information on rehabilitation and management costs for CFDS in the landbank was obtained from the City's BMB in May 2021; this information was updated in February 2022.

¹³ BMB, 2020. Technical report on the criteria applied for classification of Cape Flats Dune Strandveld as 'unselected', 'selected' and 'impact' areas in the Metro Southeast Strandveld Conservation Implementation Plan (CIP) March 2020

¹⁴ The effective management of a biodiversity offset in South Africa is the responsibility of the holder of an environmental authorisation, who must provide adequate resources for management for at minimum a 30-year period.

Identification and evaluation of potential offset sites

The emphasis in all policy and guidelines on biodiversity offsets is to seek a 'like for like' offset to compensate for residual negative impacts, so that the same biodiversity components as those components that are negatively affected would benefit.

Where the development sites will impact on 'unselected' CFDS in the CIP, it would be optimal to meet offset requirements by using the Macassar Dunes East Conservation Landbank as an 'offset receiving area' (see Figure 4). This option was thus investigated as a priority. (It was also acknowledged that the alternative of finding 55.35 ha of CFDS within the City area, which could be acquired, protected and managed as a bespoke biodiversity offset, would be prohibitively difficult given its Critically Endangered status.)

The advantages of using the landbank to deliver the required offset comprise minimising administrative, legal, financial and management complexities, including:

- a) Given that the landbank has been proactively identified and reserved by the BMB, the Human Settlement Department would not need to expend resources and incur potentially significant time delays and costs in finding a suitable offset site, acquiring and/ or securing that site, declaring the site as a protected area, and being responsible for implementing management of that site in the long term
- b) Use of the landbank would help to ensure that the offset site would be protected in the long term: it has been reserved for conservation (i.e. it has been vested in the City's BMB) and it is intended that the landbank would be declared as a S23 Nature Reserve in terms of the NEM Protected Areas Act 57 of 2003, NEM: PAA).
- c) Use of the landbank as an offset option would satisfy the need for a 'like for like' exchange between residually impacted biodiversity components and those components in the offset, given that both involve CFDS. With specific regard to the need for the biodiversity offset to compensate not only for residual impacts on vegetation and ecological processes, but also for SoCC, it has been confirmed by the botanical specialist that the landbank supports populations of all three species residually affected by EHD (Nicolson, 2022).
- d) Use of the landbank would satisfy the need for 'additionality', or additional conservation outcomes because, although the City intends to secure the landbank as a formal protected area, the declaration process is yet to be initiated and furthermore the City lacks funds for its protection and ongoing management. That is, using the landbank as an offset for the EHD would provide the necessary resources to ensure that the area was formally declared as a Nature Reserve, and that there would be effective ecological management over at least a 30-year period, but potentially in the long term.

The proposed biodiversity offset

The proposed offset comprises the formal protection of a 55.35 ha land parcel of CFDS as a portion of the Macassar Dunes East Conservation Landbank and its effective management over a minimum 30-year period. **These outcomes, and the associated financial and other resources necessary to achieve them, must be provided by the City's Human**

Settlement Department, to offset the residual negative impacts of EHD on CFDS and associated SoCC. The proposed offset represents an estimated 37% of the total area of the landbank.

1.2 Securing the biodiversity offset

The proposed offset site is owned by the City of Cape Town, is vested in the City's BMB, and is intended to provide, in a proactive manner, offset areas for developments proposed by the City, including the Human Settlement Department. The proposed offset site must be declared as a s23 Nature Reserve in terms of the NEM: PAA and thus protected in perpetuity.

The declaration as a Nature Reserve should preferably specify its purpose, namely to serve as a biodiversity offset bank, as this would support justifying the additionality of the anticipated outcomes.

The City's BMB has undertaken to manage the declaration process for the landbank (Annexure 2).

1.3 Managing the offset site

The residual impacts of the proposed project would last in perpetuity. In line with current thinking, it is considered reasonable for an environmental authorisation holder to be held responsible for managing an offset site for not less than 30 years, providing the necessary resources (including staff, equipment and funds for establishment, rehabilitation and ongoing management) to ensure that standards for biodiversity conservation are met. Table 2 sets out typical offset activities and resource needs.

Table 2: Typical offset activities and associated costs

Typical offset activities and associated costs comprise:

- delineation of the boundary of the area as a nature reserve (e.g. fencing, equipment, etc.);
- initial rehabilitation of degraded and disturbed areas. Locally occurring species of CFDS should be re-introduced prior to the growing season, with advice from a suitable qualified botanist;
- initial and ongoing clearing of invasive alien vegetation such as rooikrans (*Acacia cyclops*), Port Jackson willow (*Acacia saligna*) and Manatoka (*Myoporum montanum*¹⁵;
- clearing of any agricultural weeds and alien invasive grasses on the site, and limiting their spread to adjacent natural areas;
- fire management. CFDS does not require fire but could be negatively affected by frequent burns (naturally, fires would occur approximately once every 40-100 years) and thus needs some protection for fires;

¹⁵ Ineffective clearing of invasive alien plants will increase fuel loads and increase the intensity of any burns, presenting an added risk to the survival of indigenous seed banks.

- adaptive or corrective management of the offset site should be informed by annual monitoring of veld condition and species composition, and any emerging threats to the diversity and quality of CFDS; and
- ongoing prevention illegal access, dumping of rubbish, land invasion and unplanned fires.

As an indication of resources which are likely to be needed for the EHD offset:

- a) Initial establishment and rehabilitation costs would be needed to cover immediate tasks such as clearing of invasive alien species, removing rubble or wastes from the landbank site, erecting fencing and gates.
- b) Ongoing maintenance, site protection and ecological management would require staffing (reserve manager/ ranger and security staff) and equipment/ materials (e.g. radios, uniforms, vehicles and transport costs, alien plant clearing, etc.).

The BMB is to be responsible for managing the landbank and would act as the assigned management authority for the intended Nature Reserve¹⁶, as explicitly stated in Annexure 2. The BMB would record the taking up of hectares of the landbank by City Departments as biodiversity offsets, and would report annually on the performance of the Macassar Dunes East Conservation Landbank to the Human Settlement Department, CapeNature and DEA&DP.

1.4 Financial implications

BMB have provided a spreadsheet of staffing, materials and equipment required to secure and manage the entire landbank effectively over time. Indicative CAPEX and OPEX costs, taking into account escalation, have been calculated over a 30-year period, from 2022 to 2052. The following points are relevant:

- a) CAPEX payments are seen as a 'once off' contribution to the capital costs of establishing and operating the whole landbank.

These costs (radios, laptop/ desktop computer, vehicles, bollards, signage and gates) are estimated at R3 111 372 for 2022-2023. For the 55.35 ha offset required by EHD, the pro rata contribution would be R1 148 096¹⁷.

- b) For the operational management costs over 30 years, the City's BMB applies escalation for staffing and security costs (including vehicle running costs/ transport costs) at 8% p.a. Costs of general expenses (fuels, materials, PPE), contracted services (e.g. alien and invasive plant clearing) and repairs and maintenance are escalated at 5% p.a.¹⁸

OPEX costs for the year 2022-2023 for the entire landbank are estimated at R7 274 428. For the 55.35 ha of offset required by EHD, the pro rata contribution in

¹⁶ Confirmed by Clifford Dorse, 17 February 2022, *pers comm*.

¹⁷ If CAPEX payments were provided later than this date, they would need to be escalated.

¹⁸ These escalation rates have been confirmed by BMB; Clifford Dorse and Julia Wood, 15 February 2022.

year 2022-2023 would be R2 684 264. This amount would need to be escalated over time for the 30-year period.

These funds would need to be provided to BMB as the proposed management authority for the landbank and offset area through the City's formal budgeting process.

Recommended conditions of Environmental Authorisation

The following conditions are recommended should the EHD receive Environmental Authorisation:

- a) The applicant must secure, and through the provision of the necessary resources, ensure the formal protection and effective ecological management of, 55.35 ha of Cape Flats Dune Strandveld in the Macassar Dunes East Conservation Landbank for a 30-year period.
- b) **Before any listed activity may commence** on the project site:
 - i) A formal agreement must be concluded between the applicant (City's Human Settlement Department) and the City of Cape Town's Environmental Resource Management Department (representing the Biodiversity Management Branch) who will implement the offset on its behalf.

This agreement must clearly set out the respective rights and responsibilities, and timeframes in which to deliver specific outcomes, with respect to:

- declaring the Macassar Dunes East Conservation Landbank site as a Section 23 Nature Reserve¹⁹ (including title deed restrictions and rezoning);
- the respective roles and responsibilities for the initial establishment and ongoing ecological management of 55.35 ha Cape Flats Dune Strandveld (i.e. the offset site) within the Macassar Dunes East Conservation Landbank over a period of at least 30 years, and the scheduling of the applicant's provision of the necessary financial and other resources to this end;
- reporting on the performance of the offset site (as an integral component of the Macassar Dunes East Conservation Landbank) and its compliance with requirements of a Nature Reserve in terms of meeting management effectiveness thresholds; and
- mechanisms to resolve any breach in the agreement.

¹⁹ The conditions regarding declaration of the offset site as a Nature Reserve are not intended to replicate or replace the existing legal requirements (as per NEM: PAA) with regard to the steps that need to be taken for an area to be declared a Nature Reserve in terms of s23 of this Act. It is therefore assumed that once the offset area has been secured as a Nature Reserve, there would be oversight of performance (as with any Protected Area) by CapeNature, who could alert the provincial environmental authority should there be incidents of non-compliance with the conditions of environmental authorisation.

- c) Provide proof of submission of the application for Nature Reserve status under the NEM: PAA to the competent authority within 24 months of this authorisation.
- d) Audit compliance with the formal agreement described in b) i) on an annual basis, and every three years thereafter, to check both the ecological performance of the offset site and the adequacy of provision of necessary resources to deliver the required offset outcomes, and to identify any corrective or adaptive measures that must be taken to ensure that the intended offset outcomes (as reflected in the management plan for the Macassar Dunes East Nature Reserve) are achieved.

Information and Resources consulted

10.1 References

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Pool-Stanvliet R, Duffell-Canham A, Pence G, and Smart R. 2017. Western Cape Biodiversity Spatial Plan Handbook. Stellenbosch: CapeNature.

10.2 List of people consulted for information²⁰

City of Cape Town's Biodiversity Management Branch (Clifford Dorse, Charmaine Oxtoby, Lewine Walters).

City of Cape Town's Environmental Resource Management Department (Keith Wiseman).

CapeNature (Ismat Adams: Land Use Scientist, Landscape West, Conservation Operations).

DEA&DP (Taryn Dreyer, Saa-rah Adams).

²⁰ We gratefully acknowledge the time, information and assistance provided to us at various points during the project work.

Annexure 1: Letter from City of Cape Town's Biodiversity Management Branch on the history and land use of the Enkanini site

Annexure 2: Letter from City of Cape Town's Biodiversity Management Branch regarding declaration of the landbank as a Nature Reserve, and acting as the management authority for this Nature Reserve [still to be received]

Ref: LS/ls/9002/015/034/1011/02

28 June 2021

City of Cape Town
Engineering Services – Informal Settlements Upgrades
21st Floor, 2 Bay, Tower Block
Civic Centre
Cape Town,
8001

Attn : Mr Diaan Rangolie

Dear Sir,

PROJECT DESCRIPTION : ENKANINI SOUTH GREENFIELD DEVELOPMENT
RE : BULK STORMWATER ASSESSMENT REPORT

The included Bulk Stormwater Assessment Report refers.

Based on the report, the existing stormwater infrastructure to manage the increase in potential runoff from the eastern portion of the development is in place and does not require upgrading or augmentation.

The western portion closest to the Monwabisi resort will require a detention facility to manage the increase in runoff. The required size for this detention facility is in the region of 13, 500m³.

Overall, it is our opinion that the topography of the site and the planned layout are supportive of this development.

Note that to comply to generally accepted best practise management of stormwater, that litter traps and stilling basins be installed on all planned stormwater outlets to limit pollutants travelling downstream.

We trust you will find the above in order. Please contact us should you require additional information.

Yours faithfully

BOSCH PROJECTS (PTY) LTD



L STREICHER Pr Tech Eng, Pr CPM
PROJECT MANAGER

Encl. SW Assessment Report-Draft





**BLACKHEALTH LOWER BULK
RESERVOIR**
FULL SUPPLY LEVEL IS :
DEPTH of 11.84m @ 110.6 m
MSL Cap = 537.604 MI
TOP WATER LEVEL IS :
DEPTH of 12.14m @ 110.9 m
MSL Cap = 555.456 MI



Legend

- Levels
- Water Reservoir
- Sewer Pumpstation
- Raising Main
- Sewer Main
- Bulk Water Main
- Blackhealth Lower Bulk Reservoir
- Enkanini South Housing
- Zandvliet WWTW
- Suburbs Project

2	FOR APPROVAL	OCT 20	
1	FOR INTERNAL REVIEW	OCT 20	
REV.	DESCRIPTION	DATE	APPRD

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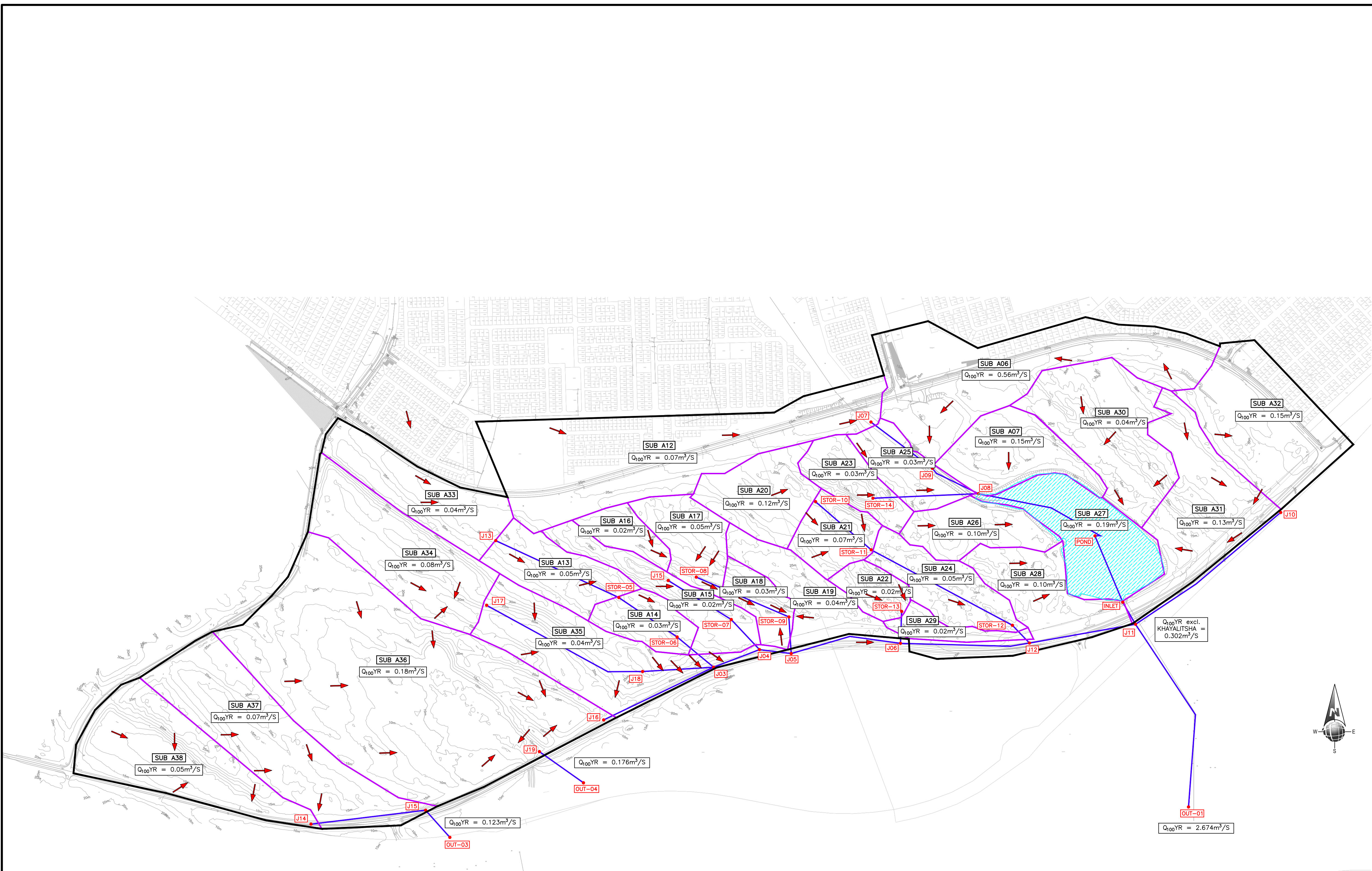
TYGERVLEI CHAMBERS 1, 27 WILLE VAN SCHOR KEMPE, BELLEVILLE, 7530.
P.O. BOX 5036, TYGERVLEI, 7536.
TELEPHONE: (021) 914 2700
E-mail: bpc@boschprojects.co.za
www.boschprojects.co.za

DESIGNED	T.S	DRAWN	S.M
CHECKED	G.C	CIVIL ENGINEER	R.D.B
STRUCTURAL ENGINEER	N/A	MECHANICAL ENGINEER	N/A
ELECTRICAL ENGINEER	N/A	CO-ORDINATION ENGINEER	N/A

APPROVED		
	PROJECT MANAGER	DIRECTOR

CITY OF CAPE TOWN
ENKANINI SOUTH GREENFIELD DEVELOPMENT
BULK SERVICES FOR WATER AND SANITATION
SCHEMATIC - LAYOUT PLAN

SCALE	1:25,000	DATE	OCT 2020
DRAWING NUMBER	9002/15/34/GSD/019	REVISION	A1



LEGEND

OVERLOAD FLOW PATH

CATCHMENT BOUNDARYSUB-CATCHMENTS BOUNDARIESSUB-CATCHMENTS NUMBERJUNCTIONSJUNCTION NUMBEREXISTING DETENTION POND

1	INTERNAL REVIEW	JUN 21
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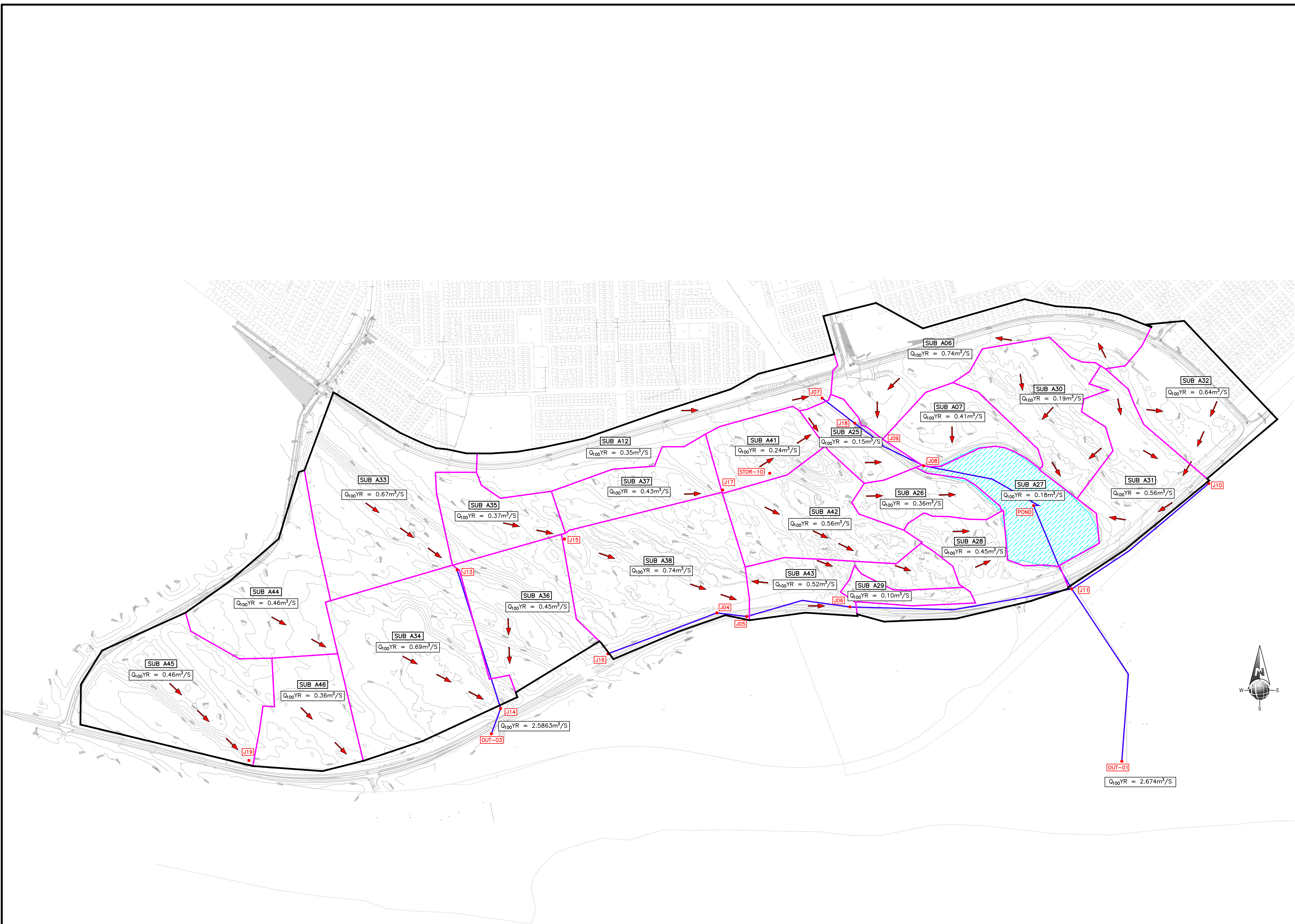
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BELLVILLE, 7530.
P.O. BOX 5090, TYGERVALLEY, 7536.
TELEPHONE: (021) 914 2756
E-mail: bpcT@boschprojects.co.za
www.boschprojects.co.za

DESIGNED	LS	DRAWN	S.M
CHECKED	G.C	PROCESS ENGINEER	N/A
CIVIL ENGINEER	LS	STRUCTURAL ENGINEER	N/A
INSTRUMENT ENGINEER	N/A	ELECTRICAL ENGINEER	N/A
MECHANICAL ENGINEER	N/A		

APPROVED	PROJECT MANAGER	DIRECTOR
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CITY OF CAPE TOWN
ENKANINI HOUSING DEVELOPMENT
PRE-DEVELOPMENT SUBCATCHMENT RUNOFF

SCALE 1:4000	DATE JUN 2021
DRAWING NUMBER 9002/15/34/RSD/001	REVISION 1



LEGEND

- OVERLOAD FLOW PATH
- CATCHMENT BOUNDARY
- SUB-CATCHMENTS BOUNDARIES
- SUB-CATCHMENTS NUMBER
- JUNCTIONS
- JUNCTION NUMBER
- EXISTING DETENTION POND

1	INTERNAL REVIEW	JUN 21
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P.O. BOX 5090, TYGERVALLEY, 7536.
TELEPHONE: (021) 914 2756
E-mail: bpcT@boschprojects.co.za
www.boschprojects.co.za

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CHECKED	G.C	PROCESS ENGINEER	N/A
CIVIL ENGINEER	LS	STRUCTURAL ENGINEER	N/A
INSTRUMENT ENGINEER	N/A	ELECTRICAL ENGINEER	N/A
MECHANICAL ENGINEER	N/A		

APPROVED	PROJECT MANAGER	DIRECTOR
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CITY OF CAPE TOWN
ENKANINI HOUSING DEVELOPMENT
POST-DEVELOPMENT SUBCATCHMENT RUNOFF

SCALE 1:4000	DATE JUN 2021
DRAWING NUMBER 9002/15/34/RSD/002	REVISION 1

JUNE 2021



CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

CITY OF CAPE TOWN

ENKANINI SOUTH GREENFIELD DEVELOPMENT

BULK SERVICES REPORT FOR WATER AND SANITATION

PROJECT N° 9002/15/35

JUNE 2021

CITY OF CAPE TOWN
ENKANINI SOUTH GREENFIELD DEVELOPMENT
BULK SERVICES REPORT FOR WATER AND SANITATION

BOSCH PROJECTS N°: 9002/15/35	DATE: Jun-2021	REPORT STATUS: DRAFT		
CARRIED OUT BY: Bosch Projects Pty Ltd PO Box 27158 GREENACRES 6057 Tel: 041 363 0598 Fax: 041 363 7646	COMMISSIONED BY: City of Cape Town Private Bag X0181 CAPE TOWN 8000 Tel: 086 010 3089 Fax: 086 201 1017			
AUTHOR: Mr Rowan Bode	CLIENT CONTACT PERSONS: Mr Diaan Rangolie			
SYNOPSIS: Water and Sanitation Bulk Service Report for Enkanini South Greenfield Development				
FUNCTION: Civil Engineering				
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QUALITY VERIFICATION This report has been prepared under the control of the Bosch Projects Quality Management System which meets the requirements of ISO 9001:2015 as independently certified by international auditors				
Verification	Capacity	Name	Signature	Date
By Author	BP PM	R Bode		
Checked by	BP Director	G Cummings		
Authorised by	BP Director	G Cummings		
Received by	CoCT PM	D Rangolie		

CITY OF CAPE TOWN
ENKANINI SOUTH GREENFIELD DEVELOPMENT
BULK SERVICES REPORT FOR WATER AND SANITATION

JUNE 2021

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CITY OF CAPE TOWN
ENKANINI SOUTH GREENFIELD DEVELOPMENT
BULK SERVICES REPORT FOR WATER AND SANITATION

1. EXECUTIVE SUMMARY

The Enkanini South Greenfields Development is located south-east of Khayelitsha between Cape Town and Strand and situated just north of Baden Powell Drive and south of Mew Way. Access to the proposed development is from the N2 off Baden Powell Drive.

Purchase Order 4503707448 dated 12 June 2020 and reference 030C/2018/19A and the Service Level Project Agreement dated 5 May 2020, entered between the City of Cape Town Directorate: Human Settlements Department: Informal Settlements Engineering Services and Bosch Projects Consultants for the Provision of Professional Consultant Services for Construction Projects for the City of Cape Town for the Enkanini South Greenfield Development.

In terms of Water and Sanitation provision the Bulk Services report has considered 6000 residential units planned for Enkanini South Greenfield Development. Bosch Projects has carried out investigations required for the Bulk Water and Sanitation provision.

1.1 Conclusion

Bulk Water

An additional 3.6Ml/day (AADD) water requirement for the proposed Enkanini South Development is envisaged.

There is currently a bulk water supply to the proposed development. The current peak pressure at this development in the system is approximately 24m which is sufficient.

The CoCT is to advise / clarify on the bulk water infrastructure and capacities available for the following existing infrastructure listed below in terms of Section 3 and 5 of the Bulk Services Report.

- a) Existing water treatment works (WTW).
- b) Existing bulk water supply mains.
- c) Bulk reservoir storage supply.
- d) Distribution supply system.
- e) The new 1200mm dia bulk supply reinforcement water supply under construction along Baden Powell.

Bulk Sanitation

An additional 3.42Ml/day (ADWF) sewerage flow is envisaged to be discharging from the proposed Enkanini South Development.

There is currently a bulk sanitation discharge system in the area of the proposed development. Due to the existing landscape additional pumpstations would be required or the recommissioning of the Monwabisi Pumpstation and rising main if at all possible.

The CoCT is to advise / clarify on the bulk sanitation discharge and capacities available of the following existing infrastructure listed below in terms of Section 3 and 5 of the Bulk Services Report.

- a) Existing Kuyasa sewage pump station
- b) Existing 500mm dia rising main.
- c) Existing Zandvliet Wastewater Treatment Works (WWTW).
- d) Possibility of recommissioning of the decommissioned 600mm dia sewer to Monwabisi pump station.
- e) Possibility of recommissioning of the decommissioned Monwabisi Pumpstation.
- f) Possibility of recommissioning of the Monwabisi Pumpstation rising main.

1.2 Recommendation

Bulk Water

The CoCT must advise on the existing capacities as requested in the above Conclusion for the additional 3.6Ml/day (AADD) water requirement for the proposed Enkanini South Development.

Bulk Sanitation

The CoCT must advise on the existing capacities as requested in the above Conclusion for the additional 3.42Ml/day (ADWF) sewerage discharge for the proposed Enkanini South Development.

2. INTRODUCTION

2.1 Background

The project aims to provide the services required to complete the land use application, up to conceptual design phase, in conjunction with the City of Cape Town Informal Settlements Department Planning unit.

The Bulk services Report has considered the formal development of Enkanini South in terms of serviced sites. The department is currently aiming to produce approximately 6 000 formal housing opportunities. The project team is expected to undertake viability studies, produce a conceptual design, and undertake all necessary statutory processes to obtain approval for Enkanini South development. The resulting housing opportunities will be allocated to beneficiaries emanating from the neighbouring Enkanini Informal settlement.

Due to the nature of the work involved it is estimated that only stages 1 to 3 will be completed under 30C/2018/19. The formal development will be approximately 24 months.

It shall be noted that the agreement may be amended from time to time as and when required if the Employer and/or service provider deems necessary.

- Agreement Number: WP:153
- Compiled by: Diaan Rangolie
- Revision Number:01 Date:14 May 2020

The planning has also included other developments in this area. These developments include the following:

- Residential Zone (SR2),
- Community Zone,
- Education Zone,
- Commercial / Business Zone,
- Local Business Zone, and
- Public Open Space

Considering the 6000 residential units planned for Enkanini South in terms of serviced sites the following phases have also been considered (Annexure A); namely.

- Phase 1 = 15.35 ha and 10.29 ha UT
- Phase 2 = 73.95 ha
- Total = 99.59 ha
and
- Phase 1, 1000 units,
- Phase 2, 5000 units

2.2 Project Locality

The area earmarked for the proposed housing development is located southeast of Khayelitsha between Cape Town and Strand and situated just north of Baden Powell Drive and south of Mew Way. Access to the proposed development is from the N2 off Baden Powell Drive.

Refer to the locality map, Drawing No. **9002/035/001**, which shows the project area.

2.3 Source of Information

The sources of information used to compile this report are summarised below:

- Guidelines for Human Settlement Planning and Design, referred to in this report as the “Red Book”,
- City of Cape Town Minimum Standards for Civil Engineering Services in Townships Version 1 July 2013
- Water & Sanitation Department Service Guidelines & Standards (28 May 2015 Version 3.2)

2.4 Terms of Reference

Purchase Order 4503707448 dated 12 June 2020 and reference 030C/2018/19A and the Service Level Project Agreement dated 5 May 2020, entered between the City of Cape Town Directorate: Human Settlements Department: Informal Settlements Engineering Services and Bosch Projects Consultants for the Provision of Professional Consultant Services for Construction Projects for the City of Cape Town for the Enkanini South Greenfield Development.

Anticipated initial deliverables to consist of the following:

- Bulk Services Report for Water and Sanitation

Due to the nature of the work involved it is estimated that only stages 1 to 3 will be completed under 30C/2018/19. We estimate that phase two, formal development, will be approximately 24 months.

- Civil Engineering Services
- Transport Engineering Services
- Geotechnical Engineering Services
- Electrical Engineering Services
- Occupational Health and Safety Services
- Land Surveying Services
- Heritage Practitioner
- Environmental Assessment Practitioner
- Botanist

The brief included:

2.4.1 Civil Engineering Services

Bulk Services for Water and Sanitation

The Service Provider shall carry out all the investigations necessary to determine the Bulk Services for Water and Sanitation for the Development Area at the location proposed. The report will advise where the shortfalls are of the bulk services of the project.

The deliverables from civil engineer:

- Bulk Services Report for Water and Sanitation

2.5 Stakeholder and Professional Team

DESIGNATION	NAME	TEL.	CELL.	EMAIL
CLIENT	CITY OF CAPE TOWN			
Project Manager	Diaan Rangolie	021 400 9423	072 952 9170	diaan.rangolie@capetown.gov.za
Assistant Professional Officer	Avdullah Philander	021 400 2255	083 580 3816	abdullah.philander@capetown.gov.za
Town Planner	Gerhard Hanekom	021 400 2219	082 620 2355	Gerhard.Hanekom@capetown.gov.za
Road and Stormwater - Wayleaves	Noludwe Tchongwang	021 360 1104		Noludwe.tchongwang@capetown.gov.za
Road and Stormwater - Master Planning	Wayne Davids		071 425 6929	Wayne.Davids@capetown.gov.za
GIS section	Annestatia Davies			Annestatia.Davies@capetown.gov.za
Water and Sanitation - Wayleaves	Larry Cronje	021 360 1127	084 225 2039	larry.cronje@capetown.gov.za
Water and Sanitation - Master Planning	Shamile Manie	021 400 4961		Shamile.Manie@capetown.gov.za
Water and Sanitation - Demand Management	Chanee Johnstone	021 400 5244		Chanee.Johnstone@capetown.gov.za
Water and Sanitation - Demand Management	Pamella Mshweshwe	021 400 5244		Pamella.Mshweshwe@capetown.gov.za
Bulk Water	Khanyisa TyaliFeni	021 487 2451		Khanyisa.TyaliFeni@capetown.gov.za
Electrical CoCT	Michelle Louw		076 052 2417	Michelle.Louw@capetown.gov.za
Eskom	S G Swanepoel	021 980 3913	082 909 6027	SwanepSG@eskom.co.za
CIVIL ENGINEERING SERVICES	BOSCH PROJECTS			
Project Manager	Oscar Mia	021 914 2756	078 840 5839	miao@boschprojects.co.za
Civil Engineer	Mfundo Tyaliti		071 511 9711	tyalitim@boschprojects.co.za
Civil Engineer - Water and Sanitation	Rowan Bode		082 782 4230	BodeR@boschprojects.co.za
Civil Engineer - Roads and Stormwater	Lourens Streicher		084 550 3480	StreicherL@boschprojects.co.za
ELECTRICAL ENGINEERING SERVICES	BOSCH PROJECTS			
Electrical Engineer	Jaco Kotze		082 533 9014	KotzeJ@boschprojects.co.za
GEOTECHNICAL ENGINEERING SERVICES	SRK CONSULTING			
Geotechnical Engineer	John Brown	021 659 3060	082 600 6541	jbrown@srk.co.za
TRANSPORT ENGINEERING SERVICES	MOWANA ENGINEERS			
Transport / Traffic Engineer	Colin Tichauer	021 003 5093	082 826 8100	colint@mowana-engineers.co.za
ENVIRONMENTAL ASSESSMENT PRACTITIONER	SILLITO ENVIRONMENTAL CONSULTANTS			
Environmental Practitioner	Chantel Muller	021 712 5060	071 313 4193	chantel@environmentalconsultants.co.za
Botanist				
Heritage Practitioner				
Freshwater Ecologist				
LAND SURVEYING SERVICES	JOUBERT AND BRINK			
Land Surveyor	Jimmy Brink	021 910 2934		jbsur@mweb.co.za

2.5.1 Feasibility and Preliminary (including preliminary drawings)

- Stage 1 to 3 not covered under this scope.

2.5.2 Design and Tender Stage (including working drawings)

- Stage 4 not covered under this scope.

2.5.3 Construction Stage

- Stage 5 not covered under this scope.

2.5.4 Completion Report and Record Drawings

- Stage 6 not covered under this scope.

2.5.5 Additional Services

Various additional services, as and when required, can be provided at hourly rates (Sub Clause 2.2.1 of the Scope of Services set out in Government Gazette No. 27422).

2.6 Client Requirements

The objectives of this could be defined as:

- To provide stage 1-3 services for the proposed development.

2.6.1 Technical / Client Specific Standards

The following technical/Client specific standards have been identified:

- Water borne sewer system (no mid-block sewer lines);
- Internal water network with house connections to each individual erf, and
- Level 1 gravel roads with limited Stormwater distribution (depending on available funds).

2.6.2 Unresolved requirements/client specific issues to be defined.

Nil.

2.6.3 Exclusions

Electrical reticulation, bulk services.

2.7 Statutory and Third-Party Requirements

2.7.1 South African National Roads Agency (SANRAL)

Should the proposed development require access to roads that fall under the National or Provincial Roads jurisdiction of SANRAL an application for a wayleave agreement is to be forwarded to SANRAL.

2.7.2 ESKOM

The proposed development may follow or cross existing power lines which falls under the jurisdiction of Eskom. In this case an application for a wayleave agreement will be forwarded to Eskom to obtain the necessary approvals.

2.7.3 TELKOM

The proposed development may follow or traverse overhead or underground Telkom cables and an application for a wayleave agreement will be forwarded to Telkom.

2.7.4 Department of Environmental Affairs

Environment Approval

In terms of the National Environmental Management Act (NEMA Act No 107 of 1998) Environmental Impact Assessment (EIA) regulations promulgated in July 2006, the proposed work may include listed activities in terms of GNR 386 therefore a Basic Assessment application as described in GNR 385 would be required to be submitted to the Department of Economic Development and Environmental Affairs (DEDEA) for authorization prior to the proposed works taking place.

An environmental consultant, to be appointed on behalf of CoCT to proceed with the Basic Assessment Process for the proposed project and to submit EIA application to DEDEA for approval.

Environmental Management During Construction

DEDEA requires that the contractor awarded the construction contract adhere to an Environmental Management Plan (EMP). An EMP will be prepared by the environmental consultant and to be included with the tender document. DEDEA also requires that an independent Environmental Control Officer (ECO) be appointed to monitor compliance with the EMP. An ECO is to be appointed.

2.7.5 Construction Regulations of OH&S ACT

In terms of the Occupational Health and Safety Act of 1993, Construction Regulations 2003 a OH&S agent will be appointed during the design and implementation stage.

2.7.6 Social Facilitation/Community Liaison Officer

A social facilitator could be appointed on the project.

A community liaison officer will also be appointed during implementation to act as liaison with the community for employment and labour coordination matters.

2.7.7 Job Creation

Certain works envisaged for the proposed development is machine intensive and is not justifiable using hand labour. Activities that may be undertaken using labour will be identified and performed in this manner.

As part of the conditions of contract conditions will be entered for executing works using the EPWP principles.

Preference will also be given to outsource work to local SMME's within the CoCT procurement framework. As far as is possible local suppliers and manufacturers will be utilised.

2.7.8 Training and Skills Development

Allowance will be made during implementation for the accredited/non-accredited training of local labour.

2.8 Site Information

A detailed geological investigation to be conducted to ascertain the envisaged ground conditions. A report to be compiled by Engineering Geologists to detail ground conditions and soil sample analysis to be submitted.

2.9 Topography

A detailed survey has been conducted by Joubert and Brink to ascertain the existing infrastructure, lie of the land and existing services encountered throughout the proposed development.

The slope of the site is fairly constant from north to south, at grades averaging approximately 2%. The south western side of the site is characterised by a natural valley just north that effectively splits the area under consideration in two.

The slopes are well vegetated, and show no signs of being unstable or having experienced serious erosion of the natural ground in recent years.

The community residential & social housing portion is split in two by a natural drain through the site.

3. EXISTING INFRASTRUCTURE

3.1 Existing Services

The proposed Enkanini South Greenfield Development has existing services in the vicinity and through the development as detailed below in the relevant sections.

3.2 Bulk Water Supply

Water treatment

The development will be supplied from the **????** WTW

The CoCT must advise in terms of the above and Section 5 below if the existing WTW's has sufficient capacity to supply the estimated average daily demand of 3.6 MI/day(AADD) for the proposed development.

Bulk Water Network

The supply is via the CoCT 110 system as there are several reservoirs that have been constructed to the 110m contour to supply across the city.

The main supply to Khayelitsha is via a 1065 mm dia supply main that is pressure managed. This main is supplied by more than one reservoir from a TWL of 110m.

A new 1200mm dia reinforcement supply is under construction along Baden Powell to reinforce the supply to the zone and will also have to be pressure managed. No as Built details available at present.

The closest reservoir namely the Blackhealth lower bulk reservoir (TWL= 110.6m and storage of 537.6 MI) through a network of bulk connector and distribution water mains to the proposed Enkanini South Greenfield Development. A link to the 2400mm dia bulk main to Faure reservoir also exists with TWL 110.6 m.

There are two separate 300mm dia distribution main supplies to the north and west of the development from where the development can receive a supply.

The decommissioned Monwabisi Desalination Project had a 315mm dia pumping watermain that traverses the south-west corner of the development. This main is to be accounted for and can be used within the development.

The CoCT must advise in terms of the above and Section 5 below if the existing bulk supply system has sufficient capacity to supply the estimated average daily demand of 3.6 MI/day(AADD) for the proposed development.

Reservoir Storage

The development will be supplied from several reservoirs that have been constructed on the 110m contour. Blackhealth lower bulk reservoir is the closest to the proposed development (TWL= 110.6m and storage of 537.6 MI).

The CoCT must advise in terms of the above and Section 5 below if the existing bulk storage has sufficient capacity to supply the estimated average daily demand of 3.6 MI/day(AADD) for the proposed development.

Distribution System zone

The development will be supplied from the Khayelitsha PRV Zone. The development will be supplied from the 300mm dia distribution main to the north, a 300mm dia distribution main to the west of the development and the 315mm dia watermain that traverses the south-west corner can also be used within the developmet. The incoming pressure is at about 82m and after the PRV it is reduced to about 38m.

The CoCT must advise in terms of the above and Section 5 below if the distribution supply system has sufficient capacity to supply the estimated average daily demand of 3.6 MI/day(AADD) for the proposed development.

Reticulation Present Situation

The proposed Enkanini South Greenfield Development currently does not have a water reticulation network. The current peak pressure at this development in the system is approximately 24m. There is sufficient pressure and flow capacity in the system to supply the development. There is a plan to move the 300 mm water main out of the proximity of the proposed development.

Water saving measures will be incorporated in this development.

Monwabisi Desalination Project

The 315 mm dia watermain that traverses the south-west corner of the development that was installed for the now decommissioned Desalination Project is still in the ground and should be accounted for by the Town Planner, as it can be used by the City of Cape Town in future and for this development.

3.3 Bulk Sewerage

Bulk Sewage Network

There is a 600mm dia bulk outfall sewer to the south of the development which drains to the Kuyasa Pumpstation which intern pumps the sewerage via a 500mm dia pumping main to a 600mm dia outfall sewer situated to the north-east of the development which ultimately discharges at the Zandvliet Wastewater Treatment Works (WWTW).

There is a 600mm dia bulk outfall sewer that traverses the development from North to south to the decommissioned Monwabisi Pumpstation.

Sewerage Pump Station

A portion of the development drains to the existing Kuyasa Pumpstation. The balnce drains to low lying areas and would be pumped to either the existing outfall sewer or to the inlet at Kuyasa Pumpstation and in turn pumped to the Zandvliet WWTW.

The CoCT must advise in terms of the above and Section 5 below if the existing Kuyasa sewage pump station has sufficient capacity to supply the estimated average daily demand of 3.42 MI/day(ADWF) for the proposed development.

The Monwabisi Pumpstation to the south of the development has been decommissioned.

CoCT to verify if the Monwabisi Pumpstation could be recommissioned to cater for the sewerage from the proposed development.

Wastewater Treatment Plant

The proposed development is situated in the Zandvliet Waste Water Treatment Works (WWTW) drainage area. This works is currently overloaded and cannot take additional flow. Zandvliet WWTW has a capcity is 72 MI/d, the current upgrade underway is 18MI/d translating to a capacity of 90ML/d. A second Upgrade will eventually take the capacity to 150MI/d.

The current 18MI/d upgrade to the WWTW has an expected completion date of December 2024.

The CoCT must advise in terms of the above and Section 5 below if the existing Zandvliet WWTW has sufficient capacity to supply the estimated average dry weather flow of 3.42 MI/day(ADWF) for the proposed development.

Present situation

The proposed Enkanini South Greenfield Development currently does not have a sewer reticulation network. The proposed development would require a network of gravity sewers and additional pump stations to discharge the sewerage to the Zandvliet WWTW of 3.42MI/day (ADWF).

4. DESIGN CRITERIA

4.1 Water Reticulation Design

4.1.1 Adopted Design Philosophy

Relevant Codes of Practice, Policy and Guidelines used are based on the Guidelines for Human Settlement Planning and Design (Chapter 9) and CoCT document – Service Guidelines and Standards – October 2010 version 3.0. These guidelines have been used as a basis for sizing the theoretical capacity for the various elements under consideration.

4.1.2 Abbreviations

AADD	= Annual Average Daily Demand
TAADD	= Total Annual Average Daily Demand
PF _{week}	= Peak week Peak Factor
PF _{day}	= Peak day Peak Factor
PF _{hour}	= Peak hour Peak Factor

4.1.3 Peak Factors

PF _{week}	= 1,65 (Residential)
PF _{day}	= 2.0 (Residential)
PF _{hour}	= 4.0 (Residential)

4.1.4 Water Demand Per Erf

House connection = 600 ℓ / erf / day

4.1.5 Consumption Calculations

AADD (kL/d)	= Unit Water Demand per capita (L/c/d) × population ÷ 1 000
TAADD (kL/d)	= AADD x PF

4.1.6 Fire Fighting

Fire Flows for High to Moderate Risk Groups	= 1500 ℓ / min (minimum hydrant flow rate)
Fire Flows for all Low Risk Groups	= 900 ℓ / min (minimum hydrant flow rate)
Hydrant Spacing for Fire Fighting	= 120m

4.1.7 Residual Pressures

House Connections	= 24m (min) and 90m (max) at zero flow
Standpipes	= 10m (min) and 90m (max) at zero flow

4.1.8 Pumping Mains

The pumping main capacity is calculated using the pumped flow to deliver the water in a 24hr day.

$$\text{Rate of flow (ℓ/s)} = \{AADD / (24 \times 3600)\} \times SPF \times L_f \times L_d$$

4.1.9 Gravity Bulk Supply Pipelines

The gravity main capacity is calculated to be using actual demands to deliver the water in a 24hr day.

Rate of flow (ℓ/s) = {AADD / (24 x 3600)} x PF hour

4.1.10 Service Reservoirs

The reservoir capacity is calculated as follows.

Capacity (kℓ) = 48hrs x AADD for pumped schemes
= 36hrs x AADD for gravity schemes

4.1.11 Water Reticulation

End-users, through a network of pipework will receive a reticulated water supply.

4.1.12 Pipeline Velocity

Parameters used for the sizing of gravity mains are as follows:

Maximum Velocity in pipelines = 2.0 meters/sec

Minimum velocity in pipelines = 0.6 meters/sec

Parameters used for the sizing of pumping mains are as follows:

Maximum Velocity in pipelines = 1.5 meters/sec

Minimum velocity in pipelines = 0.6 meters/sec

5. TOWN PLANNING CONSIDERATIONS

5.1 Present Situation

The study area covers an area of approximately 99.59 ha.

Table – 1 Reflects the community and residential land use for the entire development.

Land Use	Area (ha)*	No. of Stands
Community Residential	99.59	6000
	99.59	6000

5.2 Development Trends

A formal town planning layout was prepared by the City of Cape Town Planning Department and is in the process of being approved and finalised.

6. POPULATION

6.1 Rate of Development

In view of the density of this development and the fact that no further development is planned to the Enkanini South Greenfield Development, it is thus not foreseen that further growth is possible.

Table – 2 Population

Zoning	Land Use	No of Erven	Persons per Erf	Population
Community Residential	Residential	6000	5	30000
		6000.00		30000

7. WATER SUPPLY

7.1 Anticipated Water Consumption

The anticipated water demands pertaining to the use of water in the Enkanini South Greenfield Development for low-income developments are as follows:

Table – 3 Reflects the water consumption for the Enkanini South Greenfield Development.

DESCRIPTION	No OF ERVEN	ADD / ERF	AADD		PEAK FACTOR	TAADD	
			kl/day	l/s	Table J.9 Red Book	kl/day	l/s
Community Residential	6000	600	3600.00	41.67	4.0	14400.00	166.67
Business / Commercial / Industrial (BCI)	0	0	0.00	0.00	0.0	0.00	0.00
TOTAL	6000	600	3600.00	41.67		14400.00	166.67

7.2 Water Demand

For residential water demand, Table J.2, J3 and J4 in the Red Book Guidelines (2019 Rev) was referenced which stipulated a 600-800 litre / erf / day requirement.

The City of Cape Town Minimum Standards for Civil Engineering Services in Townships advised that the minimum water demand for low-cost housing is 600 litre / erf / day.

For design purposes a figure of 600l/day was therefore adopted.

Note that no allowance is made for the reduction of the AADD for on-site supplementary water sources as recommended in Section J.4.1.2 of the Red Book.

7.3 Peak Factors

The Design Criteria for calculating peak demands have been based on Table J.9 of the Red Book Guidelines (2019 Rev) for residential TAADD between 1000 kl/day – 5000 kl/day.

- PF_{week} = 1,65 (Residential)
- PF_{day} = 2.0 (Residential)
- PF_{hour} = 4.0 (Residential)

The City of Cape Town Minimum Standards for Civil Engineering Services in Townships advised that the peak factor of 4 (minimum), or as given in the Red Book.

For design purposes a Peak Factor of 4 was therefore adopted.

7.4 Design Criteria used

The following design criteria are to be adopted as per Table J.12 the Red Book Guidelines (2019 Rev) and City of Cape Town Minimum Standards for Civil Engineering Services in Townships:

- Minimum residual pressure - 24m
- Maximum static head - 90m
- Design velocity during peak demand (max) - 1.5m/s
- Hazen-Williams Roughness factor - 140

7.5 Fire Fighting Supply

The following design criteria are to be adopted as per Table J.17 the Red Book Guidelines (2019 Rev) and City of Cape Town Minimum Standards for Civil Engineering Services in Townships:

- Moderate risk 2: Cluster & low-income housing is 25 l/s
- Moderate risk 2: Duration of design fire flow is 2hr
- Hydrant Spacing for Fire Fighting (for all risk groups) is 120m
- Minimum pressure at fire hydrant is 15m

7.6 Population Projection

No growth rate has been allowed as further growth and/or densification in the area is not expected.

7.7 Water Consumption of the Business Centre

Not Applicable.

7.8 Water Consumption of the Commercial Areas

Not Applicable.

7.9 Water Consumption of the Industrial Areas

Not Applicable.

7.10 Bulk Supply Watermains

7.10.1 Capacity of the existing bulk supply water mains

The Enkanini South Greenfield Development will be supplied from a 300mm $\varnothing$ watermain located in Mew Way (M44) which is located on the northern side of the Development. An additional 300mm $\varnothing$ watermain is located in Oscar Mpetha Road which is located on the western side of the Development.

These watermains all provide water to the surrounding suburbs and township areas.

The existing 315mm $\varnothing$ watermain that traverses the western corner of the site from north to south was used from the decommissioned Monwabisi Desalination Project as a pumping watermain and CoCT has advised that this can be incorporated in the development.

It is understood that these supply pipelines are fed directly from the main supply to Khayelitsha via a 1065 mm dia supply main that is pressure managed. This main is supplied by more than one reservoir from a TWL of 110m.

A new 1200mm dia reinforcement supply is under construction along Baden Powell to reinforce the supply to the zone and will also have to be pressure managed. No as Built details available at present.

This can only be confirmed once a detailed analysis of Enkanini South Greenfield Development water reticulation is performed (outside the scope of this report).

The closest reservoir namely the Blackhealth lower bulk reservoir (TWL= 110.6m and storage of 537.6 MI) through a network of bulk connector and distribution water mains to the proposed Enkanini South Greenfield Development. A link to the 2400mm dia bulk main to Faure reservoir also exists with TWL 110.6 m.

CoCT has indicated that the existing supply watermains should have adequate capacity to supply the Enkanini South Greenfield Development and may not require upgrading or augmentation. An analysis of the supply network watermains will be conducted at implementation stage of the project (outside the scope of this report).

7.10.2 Capacity required Bulk Water Mains

The Enkanini South Greenfield Development gravity supply watermains are required to transfer a peak flow rate as detailed below.

$$\begin{aligned}\text{Rate of flow (l/s)} &= \{ \{ \text{AADD} / (24 \times 3600) \} \} \times \text{PF}_{\text{day}} \\ &= 14,400 \text{ k\ell/day} \\ &= 166.67 \text{ l/s}\end{aligned}$$

The CoCT must advise in terms of the above if the existing bulk supply system has sufficient capacity to supply the estimated average daily demand of 3.6 MI/day(AADD) for the proposed development.

Depending on which route the bulk water supply for the Enkanini South Greenfield Development will eventually be fed from, certain additional lines in the existing water bulk supply network could require upgrading.

The 300mmø watermain supply in Mew Way (M44) located on the northern side of the Development and the second supply is a 300mmø watermain in Oscar Mpetha Road which is located on the western side of the Development, would supply the development.

Considering the water is supplied from a TWL of 110m and the site varies in level from 10m to 35m an average static head of 90m is available. The development is situated approximately 14km from the closest reservoir and with the above info the hydraulic gradeline is approximately 0.18% and an estimated flow of 52l/s being achieved at the development.

Should the Development be supplied from the two 300mmø watermains and not considering the supply to the surrounding suburbs and township areas the existing flow supplied could be approximately 104l/s. A shortfall of 63l/s at peak flow of the required 167l/s.

The 315mmø watermain traverses the western corner of the site from north to south has been ignored at this stage as it is supplied from the above to supply watermains.

The CoCT needs to advise on the new 1200mm dia reinforcement supply under construction along Baden Powell that is reinforcing the supply to the zone and which will also have to be pressure managed.

Once the above is known this it can then be determined should an additional bulk supply pipe line be required or not.

7.10.3 Water Reticulation

The proposed Enkanini South Greenfield Development currently does not have a water reticulation network. The current peak pressure at this development in the system is approximately 24m.

There is a plan to move the 300 mm water main out of the proximity of the proposed development.

Water saving measures will be incorporated in this development.

The CoCT must advise in terms of the above if the existing bulk supply system has sufficient capacity to supply the estimated average daily demand of 3.6 MI/day(AADD) for the proposed development.

7.10.4 Fire Fighting Supply

In terms of the Human Settlement Planning and Design Guidelines the proposed area falls in the Moderate-risk – Group 2 category (for low-income housing). Therefore, according to these guidelines hydrants to be positioned at 120m in the development. The water analysis model will be tested with one hydrant open @ 25 l/s with no point in the system falling below 15m available pressure. This complies with the Moderate-risk Group 1 category in terms of the Red Book.

7.11 Bulk Supply Storage Reservoirs

The development will be supplied from several reservoirs that have been constructed on the 110m contour. Blackhealth lower bulk reservoir is the closest to the proposed development (TWL= 110.6m and storage of 537.6 MI).

Through a network of bulk connector and distribution water mains to the proposed Enkanini South Greenfield Development. A link to the 2400mm dia bulk main to Faure reservoir also exists with TWL 110.6 m.

The CoCT must advise in terms of the above should the existing bulk storage have sufficient capacity to supply the estimated average daily demand of 3.6 MI/day(AADD) for the proposed development.

8. SANITATION

8.1 Proposed Sewage Outflow

The proposed Enkanini South Greenfield Development currently does not have a sewer reticulation network. The proposed development will therefore add additional load to the sewer network, pump stations and Zandvliet WWTW of 3.42MI/day (ADWF).

The anticipated sewage contribution for the Enkanini South Greenfield Development area is as follows (based on 95% of the expected water use):

Table – 4 reflects the proposed sewerage contribution from the entire Enkanini South Greenfield Development.

DESCRIPTION	No OF ERVEN	ADD / ERF Water Usage	ADWF / ERF Outflow	ADWF		PEAK FACTOR From CoCT	PDWF		PWWF (50% SW Infiltration)	
				kl/day	l/s		kl/day	l/s	kl/day	l/s
Community Residential	6000	600	570	3420.00	39.58	3.5	11970.00	138.54	17955.00	207.81
Business / Commercial / Industrial (BCI)	0	0	0	0.00	0.00	0.0	0.00	0.00	0.00	0.00
TOTAL	6000	600	600	3420.00	39.58		11970.00	138.54	17955.00	207.81

8.1.1 Overview of the Bulk Sewage System

There is a 600mm dia bulk outfall sewer to the south of the development which drains to the Kuyasa Pumpstation which intern pumps the sewerage via a 500mm dia pumping main to a 600mm dia outfall sewer situated to the north-east of the development which ultimately discharges at the Zandvliet Wastewater Treatment Works (WWTW) with a capacity of 72MI/day.

CoCT to advise whether Kuyasa Pumpstation and pumping main has spare capacity or not.

The 600mm dia bulk outfall sewer mentioned above also drains past the Kuyasa Pumpstation that traverses the proposed development and discharges at the Monwabisi Pumpstation to the south of the development.

The Monwabisi Pumpstation to the south of the development has been decommissioned.

8.1.2 Proposed Sewage System

The proposed development will include reticulation and collector sewers gravitating from north to south across the site and a fall from east to west as reflected from levels off google earth. These sewers will join together at the low points and this could result in one or two sewage pump stations from where it will be pumped to the existing outfall sewer and ultimately to the Zandvliet Wastewater Treatment Works (WWTW).

160mm and 200 mm ø sewers will drain all the erven to the low areas of the development. The approximate position of the sewer to be indicated once the site has been surveyed. The initial investigation indicates that a pump station and possibly two may be required, dependent on the survey.

Various routes for the reticulation would be considered and to limit the impact on the environment the proposed routes would be selected generally following existing and proposed roadways and boundaries.

The average slope of the sewer mains will be as detailed under the sewage pipeline design.

8.1.3 Sewage Treatment

The proposed development is situated in the Zandvliet Waste Water Treatment Works (WWTW) drainage area. This works is currently overloaded and cannot take additional flow. Zandvliet WWTW has a capacity is 72 MI/d, the current upgrade underway is 18MI/d translating to a capacity of 90ML/d. A second Upgrade will eventually take the capacity to 150MI/d.

The current 18MI/d upgrade to the WWTW has an expected completion date of December 2024.

The CoCT must advise in terms of the above if the existing Zandvliet WWTW has sufficient capacity to supply the estimated average dry weather flow of 3.42 MI/day(ADWF) for the proposed development.

8.1.4 Sewage Pump Stations

The proposed development would require approximately two (2) new sewage pump stations from the survey received. This is an assumption at this stage due to no formal housing / residential layout being provided.

The new pumpstations would discharge the pumped effluent to the existing Kuyasa pump station and then ultimately discharged at the Zandvliet Wastewater Treatment Works (WWTW).

Table – 5 reflects the proposed sewerage pump stations for the entire Enkanini South Greenfield Development.

Description	Erven	In Flow kl/d	ADWF l/s	PDWF Factor	PDWF l/s	Q _{pump} (Q _{in} x 2) l/s	PWWF = Q _{in} (PDWF x 2.0) l/s
New PS 1	2000	1140.00	13.2	3.50	46.18	92.36	92.36
New PS 2	4000	2280.00	26.4	3.50	92.36	184.72	184.72
Kuyasa PS	6000	3420.00	39.6	3.50	138.54	277.08	277.08

It has been assumed that PS1 would pump to PS2 and PS2 intern would pump to the Kuyasa pump station and then to discharge at the Zandvliet WWTW.

The flow into the pump stations have been estimated as taken a third to each pump station. This assumption at this stage is due to no formal housing / residential layout being provided.

The Monwabisi Pumpstation to the south of the development has been decommissioned.

CoCT to verify if the Monwabisi Pumpstation could be recommissioned to cater for the sewerage from the prosed development. If this is an option we will update the report and cater for this option.

8.1.5 Sump Volume

The proposed increase in the sump capacity is calculated based on the maximum number of starts per hour that will be allowed in order to prevent overheating of the motors and switchgear. This is normally limited to a maximum of 6 starts per hour. The starting frequency is a maximum when the flow into the sump is exactly half the pumping rate.

$$V = \frac{T \times Q \times N}{4} \text{ where}$$

$$T = \text{N}^\circ \text{ of starts per hour (3600 / (6 or 4))}$$

$$N = \text{N}^\circ \text{ of pumps required (N)}$$

$$Q \text{ (m}^3\text{/s)} = \text{The capacity of each pump (2 x } Q_{in}\text{)}$$

8.1.6 Emergency overflow

In line with the provisions of Section K4.3.4 (a), emergency storage should be provided for a minimum of four to six hours of the design flow rate over and above the design capacity. The required volume is thus:

$$V_e = q \times T_e \text{ where}$$

$$V_e = \text{sump emergency volume (m}^3\text{)}$$

$$q = \text{ADWF}$$

$$T_e = \text{min. emergency storage time (Kouga Municipality) (6 hours)}$$

8.1.7 Sewage Pumping Mains

Various routes for the pumping mains would be considered and to limit the impact on the environment the proposed routes would be selected generally following existing and proposed roadways and boundaries.

The effluent is to be pumped through the pumping main and to discharge into an existing sump/manhole from where it gravitates through the existing system to the WWTW.

The Darcy-Weisbach equation the anticipated friction loss will be determined by:

$$H_f = \frac{4fLv^2}{2gD} \text{ where:}$$

$$H_f = \text{friction loss (m)}$$

$$f = \text{friction factor (0.005 for uPVC pipe)}$$

$$L = \text{length of rising main}$$

$$g = \text{gravity acceleration constant (9.81m/s}^2\text{)}$$

$$D = \text{pipe diameter}$$

Table 6: Proposed Flows and velocity through the proposed and existing Rising Main

PUMPS	PIPE	FLOW	VELOCITY	SYSTEM HEAD
PS1 to PS 2	350mm Ø	92.4 l/s	1.0 m/s	20.0 m
PS2 to Kuyasa PS	500mm Ø	184.7 l/s	0.9 m/s	20.0 m
Kuyasa PS to Zandvliet WWTW	500mm Ø	277.1 l/s	1.4 m/s	25.0 m

The flow from pump station 1 and 2 has been estimated at this stage. This assumption at this stage is due to no formal housing / residential layout being provided.

Considering the inflow from the development only and not from the surrounding suburbs and township areas the velocity of 1.4m/s is slightly high for the existing Kuyasa rising main to the outfall sewer, but achievable, however the existing inflow from the surrounding area must be taken into consideration and a new rising main be installed.

The CoCT must advise in terms of the existing inflow to the Kuyasa PS to determine if the pipeline has sufficient capacity to supply the pumped supply of 277l/s for the proposed development.

8.1.8 Power Requirements

The power requirement based on a typical submersible sewerage pump with a pumps efficiency of 70% is as follows:

$$\text{Power Requirements kW} = \frac{(Q \times H \times \gamma)}{\eta} / 0.9$$

H (m)	=	Total manometric head
γ	=	Density of liquid (taken as 1002kg/m ³ x 9.81)
η	=	Pump efficiency expressed as a decimal (0,70,)
Q (m ³ /s)	=	Peak PWWF
0.9	=	Motor efficiency

8.1.9 Capacity of the Outfall Sewer

The Enkanini South Greenfield Development sewage is to be pumped from the Kuyasa Pumpstation which intern pumps the sewerage via a 500mm dia pumping main to a 600mm dia outfall sewer situated to the north-east of the development which ultimately discharges at the Zandvliet WWTW.

Considering the inflow from the development only and not from the surrounding suburbs and township areas the existing 600mm ø outfall sewer to Zandvliet WWTW must cater for a discharge of 277 l/s from Kuyasa PS and flowing at 50% of its capacity.

Table 7: Velocity and pipe capacity of the existing 600mm ø sewer pipe at an assumed minimum grade of 1 : 600.

PIPE DIA. mm	PIPE ID mm	FLOW DEPTH %	SLOPE m/m	VELOCITY m/s	FLOW (ℓ/s)
600	600	50	0.0016	1.05	148.12
600	600	93	0.0016	1.15	318.64

The 277 ℓ/s from Kuyasa PS discharged into the 600mm dia outfall sewer could be accommodated at this stage, however this considers the inflow from the development only and not from the surrounding suburbs and township areas.

The CoCT must advise in terms of the existing inflow to the 600mm dia outfall sewer to determine if the pipeline has sufficient capacity to cater for the pumped supply of 277ℓ/s for the proposed development.

8.1.10 Sewer Reticulation

The sanitation system is a fully waterborne sewerage system with separate connections to individual erven.

The main sewer line will be constructed within road reserves. Midblock sewers are generally not permitted and will only be allowed where it is impossible to drain to the road reserve.

Ref: RDB/rdb/9002/015/035/1011/01

21 June 2021

City of Cape Town
Engineering Services – Informal Settlements Upgrades
21st Floor, 2 Bay, Tower Block
Civic Centre
Cape Town,
8001

Attn : Mr Diaan Rangolie

Dear Sir,

PROJECT DESCRIPTION : ENKANINI SOUTH GREENFIELD DEVELOPMENT
RE : WATER AND SANITATION BULK SERVICES REPORT

The attached Water and Sanitation Bulk Services Report for the Enkanini South Greenfield Development, has reference.

In terms of Water and Sanitation provision the Bulk Services report has considered 6000 residential units planned for Enkanini South Greenfield Development. Bosch Projects has carried out investigations required for the Bulk Water and Sanitation provision.

The following investigations were performed, namely:

- Bulk Water, and
- Bulk Sanitation

Bulk Water

An additional 3.6Ml/day (AADD) water requirement for the proposed Enkanini South Development is envisaged.

There is currently a bulk water supply to the proposed development. The current peak pressure at this development in the system is approximately 24m which is sufficient.

The CoCT is to advise / clarify on the bulk water infrastructure and capacities available for the following existing infrastructure listed below in terms of Section 3 and 5 of the Bulk Services Report.

- a) Existing water treatment works (WTW).
- b) Existing bulk water supply mains.
- c) Bulk reservoir storage supply.
- d) Distribution supply system.
- e) The new 1200mm dia bulk supply reinforcement water supply under construction along Baden Powell.

Bulk Sanitation

An additional 3.42Ml/day (ADWF) sewerage flow is envisaged to be discharging from the proposed Enkanini South Development.

There is currently a bulk sanitation discharge system in the area of the proposed development. Due to the existing landscape additional pumpstations would be required or the recommissioning of the Monwabisi Pumpstation and rising main if at all possible.

The CoCT is to advise / clarify on the bulk sanitation discharge and capacities available of the following existing infrastructure listed below in terms of Section 3 and 5 of the Bulk Services Report.

- a) Existing Kuyasa sewage pump station
- b) Existing 500mm dia rising main.
- c) Existing Zandvliet Wastewater Treatment Works (WWTW).
- d) Possibility of recommissioning of the decommissioned 600mm dia sewer to Monwabisi pump station.
- e) Possibility of recommissioning of the decommissioned Monwabisi Pumpstation.
- f) Possibility of recommissioning of the Monwabisi Pumpstation rising main.

A layout drawing has also been included reflecting the bulk water and sanitation.

Should you require additional information, please do not hesitate to contact the undersigned.

Yours faithfully

BOSCH PROJECTS (PTY) LTD



R.D. BODE Pr Tech Eng, Pr CPM
PROJECT ENGINEER

Encl. Bulk Services Report

June 2021



CITY OF CAPE TOWN
ISIXEKO SASEKAPA
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City of Cape Town

ENKANINI SOUTH GREENFIELD HOUSING DEVELOPMENT

Bulk Stormwater Services Assessment - Draft

PROJECT N^o 9002/015/34

June 2021

CITY OF CAPE TOWN

ENKANINI SOUTH GREENFIELD HOUSING DEVELOPMENT

BULK STORMWATER SERVICES ASSESSMENT - DRAFT

JUNE 2021

BOSCH PROJECTS N^o: 9002/014/008	DATE: June 2021	REPORT STATUS: Draft		
CARRIED OUT BY: Bosch Projects Pty Ltd PO Box 27158 Greenacres 6057 Tel: 041 363 0598 Fax: 041 363 7646		COMMISSIONED BY: Directorate: Human Settlements City of Cape Town 12th Floor, Cape Town Civic Centre Cape Town 8001 Tel: 27 21 400 2329 Fax: 27 21 425 2685		
AUTHOR: Mr Lourens Streicher		CLIENT CONTACT PERSONS: Mr G Hanekom/W Davids		
SYNOPSIS: Enkanini South Housing Development Bulk services Assessment				
FUNCTION: Civil Engineering (Services)				
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QUALITY VERIFICATION This report has been prepared under the control of the Bosch Projects Quality Management System which meets the requirements of ISO 9001:2008 as independently certified by international auditors.				
Verification	Capacity	Name	Signature	Date
By Author	Project Manager	L Streicher		24 June 2021
Checked by	Project Director	O Mia		
Authorised by	Project Director	O Mia		
Received by	City of Cape Town	G Hanekom/W Davids		

CITY OF CAPE TOWN
RUSTHOFF CEMETERY
STORMWATER MANAGEMENT PLAN – REVISION 1

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CITY OF CAPE TOWN
RUSTHOFF CEMETERY
STORMWATER MANAGEMENT PLAN

1. INTRODUCTION

1.1 DESCRIPTION OF THE DEVELOPMENT

The Enkanini South Greenfields Housing Development consist of approximately 110 ha area situated to the south of Khayalitsha (see locality plan).

It is bordered by Mew Way to the North, Baden Powell to the south and Oscar Mpetha Road to the west.

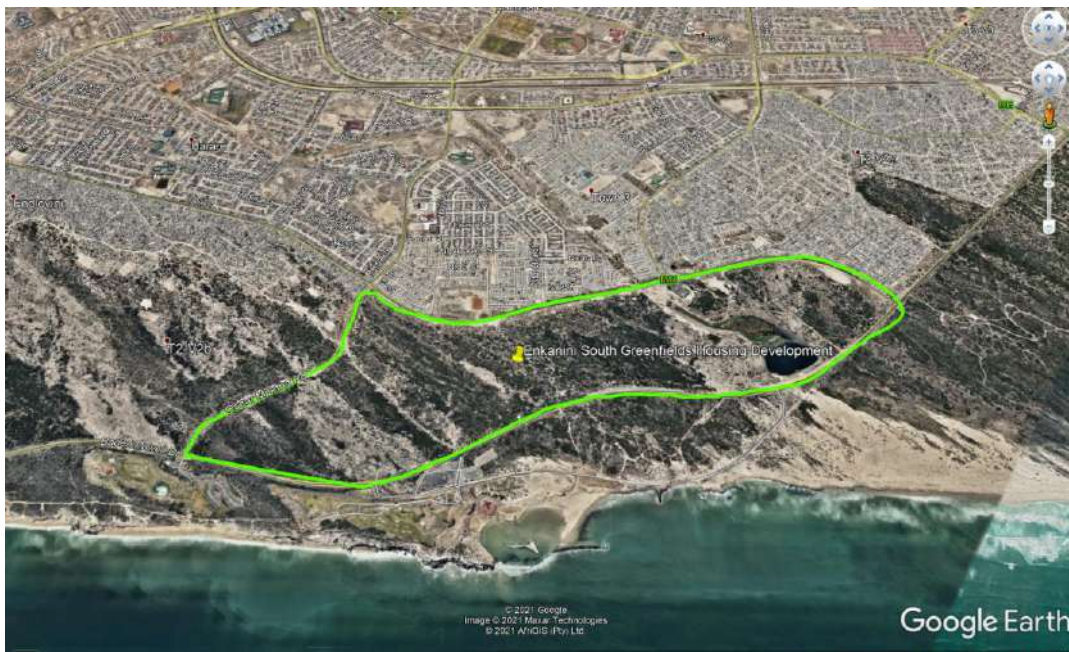


Figure 1: Locality Plan

The intention of the City of Cape Town is to develop this greenfields area in a dense low-cost housing development with associated public open spaces (POS), business and institutional sites. In terms of the NEMA Regulations and DEDEA requirements, confirmation of the adequacy of the existing bulk services are required before consideration can be given for the development to continue. The purpose of this report thus is to review the existing bulk infrastructure and confirm the adequacy (or shortcomings) thereof.

1.2 DEVELOPMENT PLAN

The proposed development footprint (up to the latest available layout dated 9 June 2021 is as follows:

Enkanini South Development Planning	
Land Use	No. of Units
Residential sites	5431
PWO/ECD	8
Public Open Spaces (POS)	11
Business/Commercial	7
Res/Small Business	288
School/Institutional	4
Stormwater Pond	1
	5750

Due to the small development footprint of 110ha, residential units will be small (less than 80m²).

1.3 SOURCES OF INFORMATION

The source of information are listed below:

- Neighbourhood Planning Design Guide, referred to in this report as the “Updated Red Book”, 2018
- SANRAL Road Drainage Manual 6th Edition, 2013,
- Design Rainfall Estimation in South Africa, JC Smithers & RE Schulze, 2002,
- National Water Act (Act 36 of 1998),
- National Environmental Conservation Act (Act 107 of 1998),
- Policy for development control near watercourses, CoCT, 2002,
- Management of Urban Stormwater Impacts Policy, CoCT Roads and SW Department, 2009,
- The South African Guidelines for Sustainable Drainage Systems, Armitage et al, WRC Report No. TT 558/13, 2013, and
- The Vegetation of South Africa, Lesotho and Swaziland, Mucina, L., & Rutherford, M.C., 2006.
- Draft Scoping Report – proposed Housing Development on Erf RE/18370 and RE/18332, Khayalithsa, WC (Draft), June 2021, and
- Khayalithsa Stormwater Management Plan, Appendix I (as received from W Davids).

1.4 CURRENT USE & TOPOGRAPHICAL FEATURES OF THE SITE

The land is covered with vegetation and bare shale/rock outcrops noticeable from aerial photography and observations on site.

The land also has a number of low-lying areas or “pond features” that does not have a natural runoff route which could possibly account for the limited stormwater services found downstream in Baden Powell Drive (as it acts as ponding facilities). Overall though the land slope is fair i.e. ranging from 1% to 4% in some places.

From the draft scoping report by Sillito Environmental Consulting the following is relevant:

“The study area contains Cape Flats Dune Strandveld, an Endangered vegetation type. Over half of the study area has been disturbed and at least half has been lost to the establishment of informal housing (Highly degraded habitat). Other areas have been disturbed by dumping, sand mining, animals grazing and most significantly clearing of vegetation for housing.. These areas are degraded but have good rehabilitation potential and are of Medium sensitivity. There are two large areas within the site that contain semi-intact vegetation. However, these areas are still under pressure from further illegal occupation. These areas are in a conservation-worthy condition and have high sensitivity”.

To the east of the development there is a large natural detention pond area, referred to as “Pond 33” in the Khayelitsha Stormwater Management Plan.

1.5 GEOLOGICAL FEATURES

A freshwater site assessment by the Freshwater Consulting Group (FCG) indicated no wetlands on site with the exception of an artificial wetland on the eastern border of the site. No significant other features of noticeable consideration are identified to be on the site.

1.6 LEGAL REQUIREMENTS

The provision and management of stormwater on site for development purposes is governed by two main acts:

- National Water Act (36 of 1998) which deals which deals with pollution control and the protection of existing watercourses, and

- National Environmental Management Act (NEMA, 107 of 1998) which deals with compliance and duty of care and remediation to the existing environment.

Typically authorisation by DEDAT will only be granted if evidence is provided that adequate bulk services are in place to support the development.

1.7 LOCAL AUTHORITY REQUIREMENTS

In terms of the CoCT's policy on the Management of Urban Stormwater Impacts (2009), it is a requirement that undesirable impacts of stormwater runoff be minimised by the use of "*water sensitive urban design principles*" to urban planning and stormwater management. This is typically achieved by utilising "Best Management Practices (BMPs)" to remove, reduce and retard post-development runoff flows.

The CoCT's policy dictates the on-site reduction of post-development pollutants with 80% for suspended solids (SS) and a 45% reduction in total phosphorous (TP) for a ½ year storm event and a reduction of the rate and quantity of runoff to the 1 in 50 year storm event interval.

Further specific requirements are:

- Provision of low flow channels next to sports fields where these are used as detention facilities,
- Extensive use of litter traps and stilling basins to intercept pollutants. This will need to be done as far as possible at the source level.

1.8 ON-SITE STORMWATER MANAGEMENT

The overall development's bulk and internal stormwater infrastructure will be operated and maintained by the City of Cape Town.

2. EXISTING STORMWATER INFRASTRUCTURE

The most predominant infrastructure is the following:

- 1) A main stormwater outfall channel and culvert (2m x 0.9m culvert close to the intersection of Lindela Road and Mew Way that drains runoff to Pond 33
- 2) "Pond 33", a large detention pond situated on the eastern side of the development.

- 3) A network of catchpits and pipes crossing Mew Way to the north (spaced approx. at 80m intervals (it appears that the network of catchpits are to drain Mew Way itself.
- 4) A similar sized network of catchpits and pipes crossing Oscar Mpetha to the west.

The site itself contains no stormwater infrastructure.

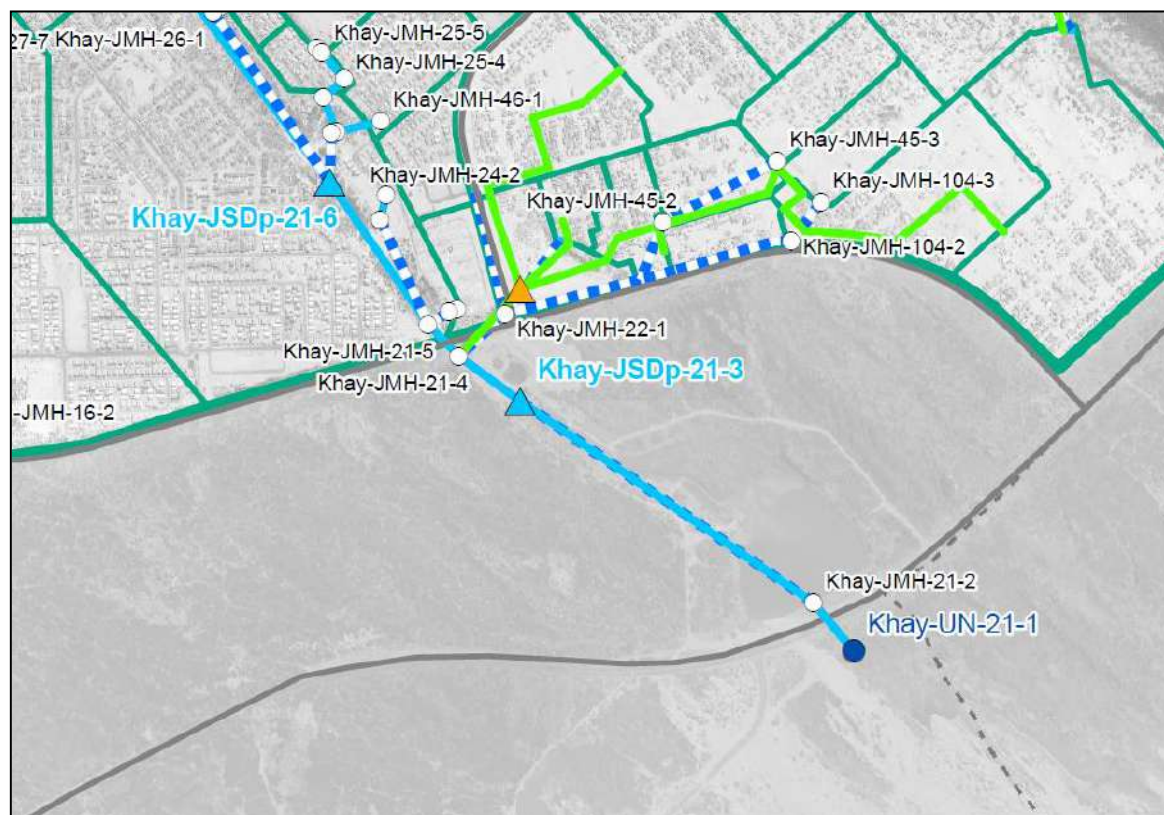


Figure 2: Existing Bulk Stormwater Infrastructure

From the Eastern Catchment High Level Master Plan undertaken by Gibb for the Khayalithsha area it does not appear that upstream runoff is expected to drain overland to the study area, implying that the Baden Powell Road is a watershed between the north and south catchment areas. Cognisance is taken of the overland link to Pond 33.

3. EXCLUSIONS

The stormwater assessment report provides a holistic overview of the impact of development on site from a stormwater perspective including the availability of bulk stormwater infrastructure and is not intended for design development use. For design development of more comprehensive and detailed stormwater model will be required.

4. MAJOR IDENTIFIED RISKS

The proposed development will have certain impacts of which some may affect the natural flow and quality of run-off water. Sound stormwater management can limit the negative impacts and enhance the positive impacts, to produce the best result possible.

The major risks applicable to this development are as follows:

4.1 POTENTIAL FLOODING AS A RESULT OF HARDENING

The development of the area will result in increased “hardening” of the area (i.e. increased impermeable surface areas), especially considering the small size of residential erven (less than 80m³) and associated high coverage. This will result in significant increased overland runoff that will have to be catered for. Potential risks include downstream flooding in the vicinity of Baden Powell Drive.

As the site is now from a topology perspective, the presence of a number of low lying areas and increased hardening will likely lead to increased ponding on these areas.

4.2 EROSION

An increase in runoff will result in the increased likelihood of erosion. To reduce erosion it is recommended that runoff be routed away from direct discharge at embankments and not be concentrated at points of discharge.

4.3 POLLUTION

The development of the site will increase the risk of pollution in the form of hydrocarbons from vehicles and total suspended solids (TSS) from domestic waste. In addition pollution from construction materials for the proposed development and associated facilities is also a potential risk.

4.4 SEDIMENTATION

Accumulated material on hardened surfaces can lead to a build-up of transported material to the stormwater discharge outlets. This material normally contains the bulk of the pollutants.

4.5 ENVIRONMENTAL IMPACTS

One artificial wetland was identified on the eastern part of the site (which was as a result of the creation of the temporary transit area (TRA) – see report by Sillito Environmental Consulting. The report did conclude that the wetland is isolated, small, degraded and not connected to any groundwater sources and as such had limited environmental value.

5. CONCEPT HYDROLOGY MODEL

5.1 STORMWATER SYSTEM

To assess the ability of the existing stormwater infrastructure to adequately cater for the development, a conceptual stormwater model for the pre-development and post-development scenario was created.

In terms of the CoCT's Roads and Stormwater Department's Policy requirements, cognisance of the system's ability to handle a 1 in 50-year storm event was considered with a risk review of storms of a higher magnitude (i.e. 1 in 100-year).

A Best Management Practice (BMP's) approach was followed with the key objectives being:

- Run-off control at source,
- The prevention of pollution, and
- Prevention of erosion.

5.2 FEASABILITY INVESTIGATION MODELLING LIMITATIONS AND ASSUMPTIONS

For this assessment the following limitations and assumptions were made in this report:

- The runoff from sub-catchment is theoretically calculated using widely accepted design methodologies.
- The stormwater model developed for this assessment is conceptual in nature and detail design layout might differ in certain areas.
- Should there be subsequent changes to the development layout, these must be taken into account and runoff recalculated before commencing with detail designs of the stormwater system.

5.3 CONCEPT STORMWATER MODELLING PARAMETERS

5.3.1 RAINFALL DATA

The following SAWS rainfall station data in the vicinity of the development were considered.

Table 1: SAWS Rainfall Station Data

Station Name	Station No.	Records (Yrs)	MAP (WRC) (mm)
EERSTERIVIER (BOS)	0021330_W	81	522
ZEEKOEVLEI	0005034_W	39	607
KUILSRIVIER	0021326_W	35	566
LONG ACRES	0021357_W	22	566
RONDEVLEI	0004874_W	47	724
BELLVILLE (BOS)	0021235_W	51	476
Avg.			577

The following Point Intensity rainfall data was used for the development {(based on the Rational Method (Midgeley & Pitman (HRU 2/78) generally used in South Africa:

Table 2: Point Intensity

Station	EERSTERIVIER (BOS) 0021330_W					
MAP	522mm					
Rainfall	Intensity Duration (mm/h)					
Storm Duration (hrs)	Point Intensity (mm/h) 1/2 Yrs.	2 Yrs	5 Yrs	10 Yrs	50 Yrs	100 Yrs
0.18	25.6	34.4	46.1	54.7	76.1	86.3

5.3.2 DESIGN STORM FREQUENCIES

The following design storm frequency was used:

- i) Minor stormwater system: 1 in 2 year frequency (the proposed development is low risk and a smaller design return period is suggested).
- ii) Major stormwater system/pollution control: 1 in 10 & 50 year frequency. Building floor levels to be above the 1:100 year flood level. Cognisance is to be taken of risks for a 1:100 year flood event.

5.3.3 RUNOFF GENERATION

For the purpose of this investigation, the SCS method of runoff calculation was used. Runoff was calculated using the Autodesk Storm and Sanitary Sewer Analysis software.

Parameters used in the model are as follows:

Table 3: SWMM modelling parameters

Hydrology Method	SWMM
Distribution Curve	SA SCS Type 2
Link Routing	Kinematic Wave
Pre-development Weighted SCS Curve No.	Various (Refer to Annexure
Post-development Weighted SCS Curve No.	Various
Conduit Manning's roughness factor	0.015
Stream Manning's roughness factor	0.032 (streambanks 0.040)

The SCS curve numbers adopted for the development are based on the SCS Urban Hydrology for Small watersheds, 2nd Ed. June 1986, SCS Curve Number Table for various land uses. The adopted values were based on a Hydrological Soil Group A/B based on the extensive coverage of sandy material.

Category A/B soils typically have typically high infiltration rates with low stormflow potential.

The adopted SCS CN for the pre-development scenario is as follows:

- Desert shrub – good condition – 68
- Waterbodies - 100

The adopted SCS CN for the post-development scenario is as follows:

- Residential development – 95
- Waterbodies - 100

The high CN for the developed areas are due to the high coverage expected from the small residential sites (< 80m²).

5.4 CATCHMENT HYDROLOGY RESULTS

Annexure A contains a tabulated summary of expected runoff flows for the pre-development scenario. The expected pre-development flows for the various sub catchments are indicated on dwg. **P9002/015/034/SW001 (Annexure C)**.

The anticipated runoff for the 1:100 year storm event for the post-development sub catchments is shown in **Annexure B**.

Dwg. P9002/015/034/SW002 (in Annexure C) shows potential runoff for the post-development catchments for the 1:100 year storm event.

5.4.1 PRE-DEVELOPMENT INTERPRETATION

From the pre-development model the expected runoff during major storm events are relatively low. From **Dwg P9002/015/034/SW001** the expected peak runoff for a 1:100 year event to the east of the Monwabisi Resort is in the region of $0.123\text{m}^3/\text{s}$.

The low runoff at this point which does not have a natural point of discharge due to the flat topography next to Baden Powell Drive is expected as it contains a number of low-lying areas that retain runoff.

Close to the 2nd resort the pre-development runoff is $0.173\text{m}^3/\text{s}$ for the pre-development scenario - again fairly minor as expected due to the presence of low lying areas.

Further east the expected peak runoff that contributes from the study area to the existing waterbody is $0.302\text{m}^3/\text{s}$. The peak inflow from upstream areas to this waterbody (referred to as "Pond_33" in the Khayelitsha Stormwater Management Plan by Gibb) is $9.59\text{m}^3/\text{s}$ thus the contribution from this development is minor (3.13%).

5.4.2 POST-DEVELOPMENT RUNOFF

For the post-development scenario, the peak runoff in the vicinity of the Monwabisi resort increases to a fairly significant flow of $0.814\text{m}^3/\text{s}$. To limit this runoff to pre-development flow, a retention pond of approximately 3500m^3 will be required,

To the east of the Monwabisi resort an additional 1.803m³/s peak runoff will be generated (increasing from 0.173m³/s) that will have to be accommodated crossing Baden Powel Drive to the sea. To limit runoff here, a retention facility of around 9, 907m³ will be required at this point.

The above two facilities can be combined (when the area is shaped) to form a single detention facility to store 13, 500m³.

The alternative to providing the above retention facilities are to combine the flow at a point (via internal stormwater reticulation once developed), cross the Baden Powell Drive and discharge via 2 x 900ø pipes that will combined, handle 2.600m³/s. The implication here is that the discharge point is 200m upstream of the coastline and runoff will enter the sea (which will require environmental authorisation). This 2nd option is thus not recommended

At the waterbody (Pond_33) to limit runoff to pre-development flow, approximately 14, 399m³ of additional storage will be required. The existing storage volume is approx. 67822m³. According to the Khayalitsha SWMP the current attenuation of runoff of this pond is 10%, implying that additional attenuation will increase to 31% of the pond's capacity, thus sufficient storage appears to be available at this pond. No flooding of any surrounding infrastructure is expected as a result of higher ponds top water levels due to the additional runoff.

5.5 CONCLUSIONS

Following the investigation and findings of this report it can be concluded that:

- The topography of the site is supportive of this type of development (natural slopes are overall not too steep or flat i.e. supports gravity infrastructure),
- The town planning layout is suitable for the proper disposal of stormwater from the site with allowance to be made for detention storage on western side of the site.
- There is no need to upgrade existing bulk stormwater infrastructure for this site.
- Litter traps and stilling basins are to be provided to limit pollutants travelling downstream.

For and on behalf of:
BOSCH PROJECTS (PTY) LTD



L STREICHER Pr Tech Eng, Pr CPM
Project Manager

ANNEXURE A – PRE-DEVELOPMENT CATCHMENT RUNOFF DATA

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STORAGE NODES

SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation	Max (Rim) Elevation	Max (Rim) Offset	Initial Water Elevation	Initial Water Depth	Ponded Area	Evaporation Loss	Peak Inflow	Peak Lateral Inflow	Peak Outflow	Peak Exfiltration Flow Rate	Maximum HGL Elevation Attained	Maximum HGL Depth Attained	Average HGL Elevation Attained	Average HGL Depth Attained	Time of Maximum HGL Occurrence	Total Exfiltration Volume	Total Flooded Volume	Total Time Flooded	Total Retention Time
					(m)	(m)	(m)	(m)	(m)	(m²)		(cms)	(cms)	(cms)	(cmm)	(m)	(m)	(m)	(m)	(days hh:mm)	(1000-m³)	(ha-mm)	(minutes)	(seconds)
1	J14	-29473.14	-3771728.05	Infiltration Pond	10.00	11.00	1.00	10.00	0.00	0.00	0.00	0.05	0.05	0.05	0.00	10.03	0.03	10.01	0.01	0 13:01	0.00	0.00	0.00	0.00
2	J17	-29133.71	-3771305.13		17.50	19.50	2.00	17.50	0.00	0.00	0.00	0.08	0.08	0.05	0.00	18.76	1.26	18.10	0.60	0 14:27	0.00	0.00	0.00	0.00
3	J18	-28832.32	-3771433.14		12.50	14.50	2.00	12.50	0.00	0.00	0.00	0.07	0.00	0.00	0.00	13.16	0.66	12.68	0.18	1 00:00	0.00	0.00	0.00	0.00
4	J19	-29031.76	-3771587.92		7.50	10.00	2.50	7.50	0.00	0.00	0.00	0.18	0.18	0.17	0.00	7.52	0.02	7.51	0.01	0 13:26	0.00	0.00	0.00	0.00
5	Pond	-27958.12	-3771171.02		8.00	12.00	4.00	8.00	0.00	40701.59	0.00	0.90	0.59	0.22	0.00	8.13	0.13	8.06	0.06	0 17:24	0.00	0.00	0.00	0.00
6	Stor-05	-28878.19	-3771290.26		22.00	24.00	2.00	22.00	0.00	0.00	0.00	0.09	0.05	0.00	0.00	22.78	0.78	22.26	0.26	1 00:00	0.00	0.00	0.00	0.00
7	Stor-06	-28765.63	-3771366.35		22.00	24.00	2.00	22.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	23.00	1.00	22.38	0.38	0 23:37	0.00	0.00	0.00	0.00
8	Stor-07	-28661.03	-3771332.63		14.00	16.00	2.00	14.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	14.18	0.18	14.05	0.05	1 00:00	0.00	0.00	0.00	0.00
9	Stor-08	-28728.61	-3771250.73		17.00	19.00	2.00	17.00	0.00	0.00	0.00	0.10	0.10	0.03	0.00	18.01	1.01	17.47	0.47	0 15:34	0.00	0.00	0.00	0.00
10	Stor-09	-28549.59	-3771327.71		15.00	17.00	2.00	15.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	15.69	0.69	15.17	0.17	1 00:00	0.00	0.00	0.00	0.00
11	Stor-10	-28498.12	-3771104.81		17.00	19.00	2.00	17.00	0.00	0.00	0.00	0.12	0.12	0.00	0.00	18.25	1.25	17.53	0.53	1 00:00	0.00	0.00	0.00	0.00
12	Stor-11	-28390.70	-3771197.91		15.00	17.00	2.00	15.00	0.00	0.00	0.00	0.07	0.07	0.00	0.00	15.45	0.45	15.17	0.17	1 00:00	0.00	0.00	0.00	0.00
13	Stor-12	-28117.67	-3771343.82		13.00	15.00	2.00	13.00	0.00	0.00	0.00	0.05	0.05	0.00	0.00	13.55	0.55	13.21	0.21	1 00:00	0.00	0.00	0.00	0.00
14	Stor-13	-28331.61	-3771316.97		13.00	15.00	2.00	13.00	0.00	0.00	0.00	0.04	0.02	0.00	0.00	13.50	0.50	13.18	0.18	1 00:00	0.00	0.00	0.00	0.00
15	Stor-14	-28387.12	-3771098.24		12.00	14.00	2.00	12.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	13.17	1.17	12.45	0.45	1 00:00	0.00	0.00	0.00	0.00
16	Stor-15	-28782.83	-3771257.21		17.00	19.00	2.00	17.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	17.62	0.62	17.20	0.20	1 00:00	0.00	0.00	0.00	0.00

JUNCTIONS

SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation	Ground/Rim (Max) Elevation	Ground/Rim (Max) Offset	Initial Water Elevation	Initial Water Depth	Surcharge Elevation	Surcharge Depth	Ponded Area	Minimum Pipe Cover	Peak Inflow	Peak Lateral Inflow	Maximum HGL Elevation Attained	Maximum HGL Depth Attained	Maximum Surcharge Depth Attained	Minimum Freeboard Attained	Average HGL Elevation Attained	Average HGL Depth Attained	Time of Maximum HGL Occurrence	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
					(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m²)	(mm)	(cms)	(cms)	(m)	(m)	(m)	(m)	(m)	(m)	(days hh:mm)	(days hh:mm)	(ha-mm)	(minutes)
1	inlet	-27904.42	-3771299.27		8.00	10.00	2.00	8.00	0.00	10.00	0.00	0.00	0.00	0.22	0.00	8.13	0.13	0.00	2.87	8.05	0.05	0 17:25	0 00:00	0.00	0.00
2	J03	-28695.04	-3771424.83		21.00	23.00	2.00	21.00	0.00	23.00	0.00	0.00	1500.00	0.04	0.04	21.00	0.00	0.00	2.00	21.00	0.00	0 13:38	0 00:00	0.00	0.00
3	J04	-28606.43	-3771390.81		20.50	22.50	2.00	20.50	0.00	22.50	0.00	0.00	1500.00	0.01	0.00	20.50	0.00	0.00	2.00	20.50	0.00	0 13:44	0 00:00	0.00	0.00
4	J05	-28545.11	-3771398.42		20.00	22.00	2.00	20.00	0.00	22.00	0.00	0.00	1500.00	0.03	0.00	20.00	0.00	0.00	2.00	20.00	0.00	0 13:57	0 00:00	0.00	0.00
5	J06	-28334.00	-3771378.73		16.00	18.00	2.00	16.00	0.00	18.00	0.00	0.00	1500.00	0.04	0.04	16.01	0.01	0.00	1.99	16.00	0.00	0 12:50	0 00:00	0.00	0.00
6	J07	-28391.00	-3770951.02		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	1500.00	0.18	0.07	0.16	0.16	0.00	1.84	0.05	0.05	0 12:26	0 00:00	0.00	0.00
7	J08	-28183.30	-3771089.49		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	1500.00	0.38	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0 12:28	0 00:00	0.00	0.00
8	J09	-28272.30	-3771040.64		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	1500.00	0.52	0.52	0.16	0.16	0.00	1.84	0.05	0.05	0 12:28	0 00:00	0.00	0.00
9	J10	-27599.24	-3771125.79		30.00	32.00	2.00	30.00	0.00	32.00	0.00	0.00	1500.00	0.15	0.15	30.01	0.01	0.00	1.99	30.00	0.00	0 12:13	0 00:00	0.00	0.00
10	J11	-27879.77	-3771341.85		7.16	9.16	2.00	7.16	0.00	9.16	0.00	0.00	0.00	0.35	0.13	7.32	0.16	0.00	2.84	7.23	0.07	0 15:03	0 00:00	0.00	0.00
11	J12	-28084.74	-3771378.14		13.91	15.91	2.00	13.91	0.00	15.91	0.00	0.00	1500.00	0.05	0.02	13.92	0.01	0.00	1.99	13.91	0.00	0 12:42	0 00:00	0.00	0.00
12	J13	-29116.08	-3771180.21		30.00	32.00	2.00	30.00	0.00	32.00	0.00	0.00	1700.00	0.04	0.04	30.01	0.01	0.00	1.99	30.00	0.00	0 12:51	0 00:00	0.00	0.00
13	J15	-29251.61	-3771701.20		9.50	11.50	2.00	9.50	0.00	11.50	0.00	0.00	1700.00	0.12	0.07	9.51	0.01	0.00	1.99	9.50	0.00	0 13:00	0 00:00	0.00	0.00
14	J16	-28907.56	-3771526.66		15.00	17.00	2.00	15.00	0.00	17.00	0.00	0.00	1700.00	0.01	0.00	17.00	2.00	0.00	0.00	15.19	0.19	0 22:57	0 23:35	2.52	64.00

SUBBASINS

SN	Element ID	Description	Area	Drainage Node ID	Weighted Curve Number	Conductivity	Drying Time	Average Slope	Equivalent Width	Impervious Area	Impervious Area No Depression	Impervious Area Depression Depth	Impervious Area Manning's Roughness	Pervious Area Depression Depth	Pervious Area Manning's Roughness	Curb & Gutter Length	Rain Gage ID	Total Precipitation	Total Runon	Total Evaporation	Total Infiltration	Total Runoff	Peak Runoff	Time of Concentration
			(m²)			(mm/hr)	(days)	(%)	(m)	(%)	(%)	(mm)		(mm)		(m)		(mm)	(mm)	(mm)	(mm)	(mm)	(cms)	(days hh:mm:ss)
1	Sub A06		85418.68	J09	68.00	0.1500	7.00	4.0000	134.69	32.00	25.00	2.0000	0.1500	7.5000	0.1300	0.00	Rain Gage-01	86.27	0.00	0.0000	34.0730	43.99	0.52	0 02:03:21
2	Sub A07		30760.94	Pond	68.00	0.1500	7.00	8.0000	179.16	0.00	25.00	2.0000	0.3500	7.5000	0.1300	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	27.48	0.15	0 00:57:39
3	Sub A12		102409.06	J07	68.00	0.1500	7.00	2.3000	120.55	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	20.91	0.07	0 06:01:15
4	Sub A13		27071.72	Stor-05	68.00	0.1500	7.00	3.6000	107.56	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	27.60	0.05	0 02:32:12
5	Sub A14		16282.74	Stor-06	68.00	0.1500	7.00	3.6000	72.86	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	27.89	0.03	0 02:21:44
6	Sub A15		26541.72	Stor-15	68.00	0.1500	7.00	2.1000	51.63	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	23.76	0.02	0 04:34:39
7	Sub A16		10815.00	Stor-08	68.00	0.1500	7.00	3.7000	53.65	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.15	0.02	0 02:12:08
8	Sub A17		22224.05	Stor-08	68.00	0.1500	7.00	3.7000	112.65	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.19	0.05	0 02:10:26
9	Sub A18		13349.19	Stor-08	68.00	0.1500	7.00	3.7000	67.31	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.18	0.03	0 02:10:51
10	Sub A19		27286.21	J06	68.00	0.1500	7.00	3.7000	78.05	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	26.67	0.04	0 03:03:52
11	Sub A20		28962.45	Stor-10	68.00	0.1500	7.00	13.4000	164.96	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	29.39	0.12	0 01:22:40
12	Sub A21		18521.09	Stor-11	68.00	0.1500	7.00	10.1000	118.21	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	29.36	0.07	0 01:24:03
13	Sub A22		11459.43	Stor-13	68.00	0.1500	7.00	0.5000	150.00	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.08	0.02	0 02:14:34
14	Sub A23		18866.19	Stor-14	68.00	0.1500	7.00	1.7500	78.09	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	26.66	0.03	0 03:04:24
15	Sub A24		26055.90	Stor-12	68.00	0.1500	7.00	3.8000	105.80	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	27.72	0.05	0 02:27:49
16	Sub A25		19380.15	Pond	68.00	0.1500	7.00	1.7500	88.61	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	26.98	0.03	0 02:53:43
17	Sub A26		22723.13	Pond	68.00	0.1500	7.00	4.5000	252.25	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	29.53	0.10	0 01:16:51
18	Sub A27		41953.46	Pond	100.00	0.1500	7.00	0.5000	148.59	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	2.4920	68.32	0.19	0 04:54:51
19	Sub A28		40052.14	Pond	68.00	0.1500	7.00	4.0000	231.26	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.52	0.10	0 01:57:50
20	Sub A29		9073.77	J12	68.00	0.1500	7.00	0.5000	150.00	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.55	0.02	0 01:56:59
21	Sub A30		54163.60	Pond	68.00	0.1500	7.00	0.5000	150.00	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	21.54	0.04	0 05:41:45
22	Sub A31		51424.35	J11	68.00	0.1500	7.00	11.0000	172.77	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.46	0.13	0 02:00:24
23	Sub A32		57066.59	J10	68.00	0.1500	7.00	6.0000	266.69	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.51	0.15	0 01:58:28
24	Sub A33		35872.19	J13	68.00	0.1500	7.00	1.4200	102.38	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	24.73	0.04	0 04:05:23
25	Sub A34		55627.61	J17	68.00	0.1500	7.00	3.4000	150.00	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	26.32	0.08	0 03:15:23
26	Sub A35		57157.95	J03	68.00	0.1500	7.00	0.7000	127.82	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	21.24	0.04	0 05:51:13
27	Sub A36		193344.27	J19	68.00	0.1500	7.00	2.6000	340.10	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	23.79	0.18	0 04:33:38
28	Sub A37		69257.02	J15	68.00	0.1500	7.00	2.4000	141.08	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	24.36	0.07	0 04:16:39
29	Sub A38		56410.21	J14	68.00	0.1500	7.00	1.6200	138.69	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	24.31	0.05	0 04:17:58

ANNEXURE B – POST-DEVELOPMENT CATCHMENT RUNOFF DATA

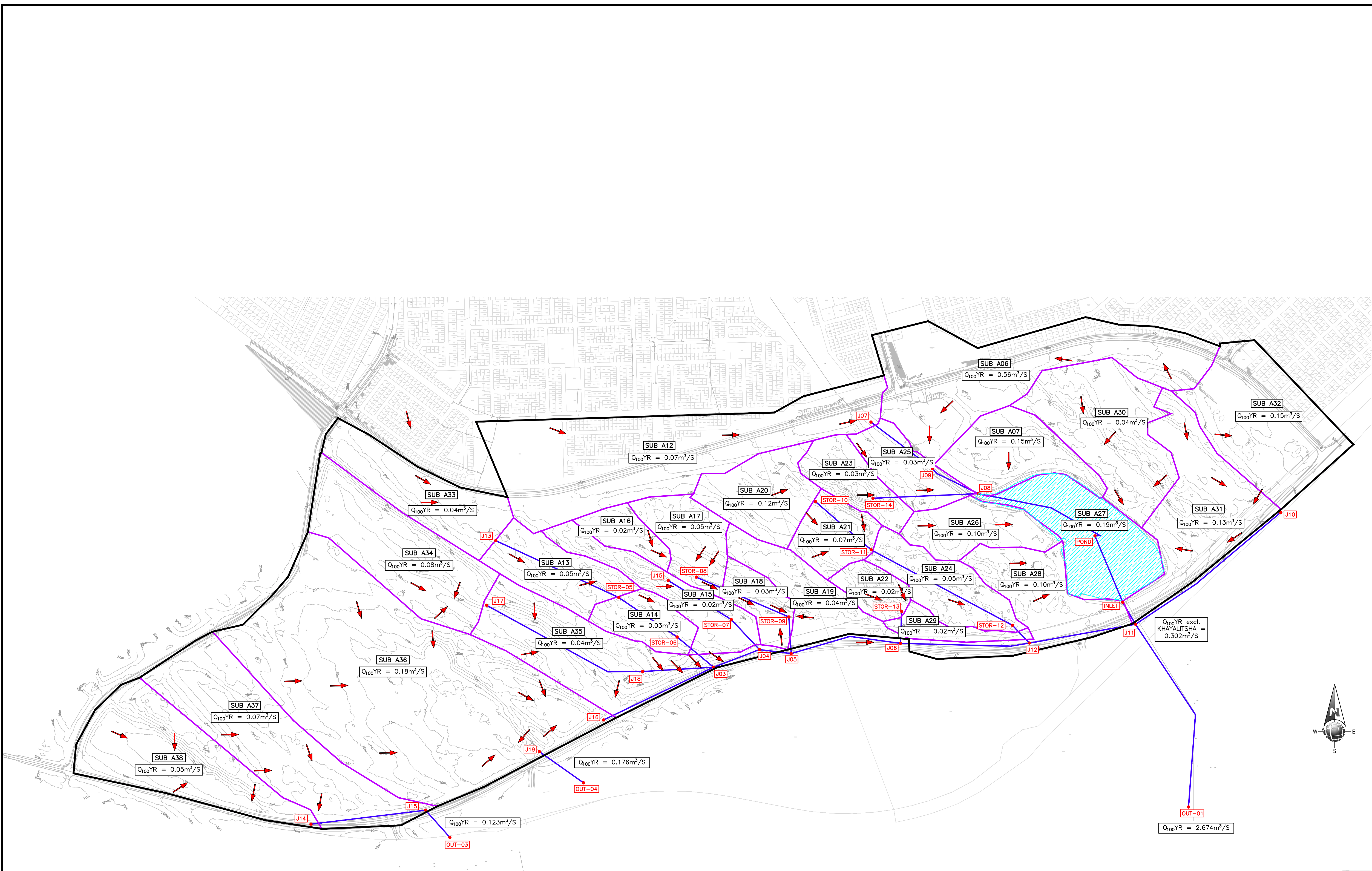
JUNCTIONS

SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation	Ground/Rim (Max) Elevation	Ground/Rim (Max) Offset	Initial Water Elevation	Initial Water Depth	Surcharge Elevation	Surcharge Depth	Ponded Area	Minimum Pipe Cover	Peak Inflow	Peak Lateral Inflow	Maximum HGL Elevation Attained	Maximum HGL Depth Attained	Maximum Surcharge Depth Attained	Minimum Freeboard Attained	Average HGL Elevation Attained	Average HGL Depth Attained	Time of Maximum HGL Occurrence	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
					(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m²)	(mm)	(cms)	(cms)	(m)	(m)	(m)	(m)	(m)	(m)	(days hh:mm)	(days hh:mm)	(ha-mm)	(minutes)
1	inlet	-27904.42	-3771299.27		8.00	10.00	2.00	8.00	0.00	10.00	0.00	0.00	0.00	0.30	0.00	8.16	0.16	0.00	2.84	8.11	0.11	1 00:00	0 00:00	0.00	0.00
2	J03	-28695.04	-3771424.83		21.00	23.00	2.00	21.00	0.00	23.00	0.00	0.00	1500.00	0.45	0.00	21.11	0.11	0.00	1.89	21.04	0.04	0 12:11	0 00:00	0.00	0.00
3	J04	-28606.43	-3771390.81		21.00	23.00	2.00	21.00	0.00	23.00	0.00	0.00	1500.00	1.14	0.74	21.05	0.05	0.00	1.95	21.01	0.01	0 12:08	0 00:00	0.00	0.00
4	J05	-28545.11	-3771398.42		20.00	22.00	2.00	20.00	0.00	22.00	0.00	0.00	1500.00	1.15	0.00	20.05	0.05	0.00	1.95	20.01	0.01	0 12:10	0 00:00	0.00	0.00
5	J06	-28334.00	-3771378.73		16.00	18.00	2.00	16.00	0.00	18.00	0.00	0.00	1500.00	1.61	0.52	16.08	0.08	0.00	1.92	16.02	0.02	0 12:10	0 00:00	0.00	0.00
6	J07	-28391.00	-3770951.02		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	1500.00	0.35	0.35	0.25	0.25	0.00	1.75	0.09	0.09	0 12:20	0 00:00	0.00	0.00
7	J08	-28183.30	-3771089.49		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	1500.00	1.17	0.00	0.01	0.01	0.00	1.99	0.00	0.00	0 12:20	0 00:00	0.00	0.00
8	J09	-28272.30	-3771040.64		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	1500.00	1.18	0.74	0.25	0.25	0.00	1.75	0.09	0.09	0 12:20	0 00:00	0.00	0.00
9	J10	-27599.24	-3771125.79		29.00	31.00	2.00	29.00	0.00	31.00	0.00	0.00	1500.00	0.63	0.63	29.02	0.02	0.00	1.98	29.01	0.01	0 12:06	0 00:00	0.00	0.00
10	J11	-27879.77	-3771341.85		7.16	9.16	2.00	7.16	0.00	9.16	0.00	0.00	0.00	3.62	0.56	7.90	0.74	0.00	2.26	7.39	0.23	0 12:34	0 00:00	0.00	0.00
11	J12	-28084.74	-3771378.14		13.91	15.91	2.00	13.91	0.00	15.91	0.00	0.00	1500.00	2.21	0.66	13.97	0.06	0.00	1.94	13.92	0.01	0 12:10	0 00:00	0.00	0.00
12	J13	-29138.17	-3771302.67		16.00	18.00	2.00	16.00	0.00	18.00	0.00	0.00	1500.00	1.13	1.13	16.07	0.07	0.00	1.93	16.02	0.02	0 12:06	0 00:00	0.00	0.00
13	J14	-29049.11	-3771586.73		9.00	11.00	2.00	9.00	0.00	11.00	0.00	0.00	1000.00	2.60	0.69	9.13	0.13	0.00	1.87	9.03	0.03	0 12:09	0 00:00	0.00	0.00
14	J15	-28918.60	-3771239.71		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	0.37	0.37	0.00	0.00	0.00	2.00	0.00	0.00	0 00:06	0 00:00	0.00	0.00
15	J16	-28829.54	-3771474.64		29.00	31.00	2.00	29.00	0.00	31.00	0.00	0.00	1500.00	0.45	0.45	29.03	0.03	0.00	1.97	29.01	0.01	0 12:06	0 00:00	0.00	0.00
16	J17	-28594.61	-3771139.14		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	0.43	0.43	0.00	0.00	0.00	2.00	0.00	0.00	0 00:06	0 00:00	0.00	0.00
17	J18	-28324.37	-3771002.38		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	1500.00	0.55	0.24	0.25	0.25	0.00	1.75	0.09	0.09	0 12:21	0 00:00	0.00	0.00
18	J19	-29564.56	-3771693.12		10.00	12.00	2.00	10.00	0.00	12.00	0.00	0.00	1000.00	0.82	0.82	10.27	0.27	0.00	1.73	10.07	0.07	0 12:08	0 00:00	0.00	0.00
19	Pond	-27958.12	-3771171.02	InfiltrationPond	8.00	12.00	4.00	8.00	0.00	12.00	0.00	40701.59	3500.00	2.65	1.72	12.32	4.32	0.32	0.00	10.25	2.25	0 19:15	0 12:09	1447.88	716.00

SUBBASINS

SN	Element ID	Description	Area	Drainage Node ID	Weighted Curve Number	Conductivity	Drying Time	Average Slope	Equivalent Width	Impervious Area	Impervious Area No Depression	Impervious Area Depression Depth	Impervious Area Manning's Roughness	Pervious Area Depression Depth	Pervious Area Manning's Roughness	Curb & Gutter Length	Rain Gage ID	Total Precipitation	Total Runon	Total Evaporation	Total Infiltration	Total Runoff	Peak Runoff	Time of Concentration
			(m²)			(mm/hr)	(days)	(%)	(m)	(%)	(%)	(mm)		(mm)		(m)		(mm)	(mm)	(mm)	(mm)	(mm)	(cms)	(days hh:mm:ss)
1	Sub A06		85418.68	J09	95.00	0.1500	7.00	4.0000	134.69	100.00	100.00	2.0000	0.1500	7.5000	0.1300	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	81.20	0.74	0 02:49:24
2	Sub A07		30760.94	Pond	95.00	0.1500	7.00	8.0000	179.16	100.00	100.00	2.0000	0.3500	7.5000	0.1300	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	83.38	0.41	0 01:44:27
3	Sub A12		102409.06	J07	95.00	0.1500	7.00	2.3000	120.55	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	70.44	0.35	0 06:36:15
4	Sub A25		19380.15	Pond	95.00	0.1500	7.00	1.7500	88.61	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	80.40	0.15	0 03:10:33
5	Sub A26		22723.13	Pond	95.00	0.1500	7.00	4.5000	252.25	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	84.00	0.36	0 01:24:17
6	Sub A27		41953.46	Pond	100.00	0.1500	7.00	0.5000	148.59	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	74.35	0.18	0 05:23:25
7	Sub A28		40052.14	Pond	95.00	0.1500	7.00	4.0000	231.26	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	82.59	0.45	0 02:09:16
8	Sub A29		9073.77	J12	95.00	0.1500	7.00	0.5000	150.00	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	82.62	0.10	0 02:08:19
9	Sub A30		54163.60	Pond	95.00	0.1500	7.00	0.5000	150.00	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	71.61	0.19	0 06:14:52
10	Sub A31		51424.35	J11	95.00	0.1500	7.00	11.0000	172.77	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	82.49	0.56	0 02:12:04
11	Sub A32		57066.59	J10	95.00	0.1500	7.00	6.0000	266.69	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	82.56	0.64	0 02:09:57
12	Sub A33		107498.29	J13	95.00	0.1500	7.00	3.0000	267.82	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	78.64	0.67	0 03:53:20
13	Sub A34		96171.76	J14	95.00	0.1500	7.00	3.0000	297.18	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	79.83	0.69	0 03:25:03
14	Sub A35		30532.38	J15	95.00	0.1500	7.00	3.0000	242.83	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	83.01	0.37	0 01:56:17
15	Sub A36		54549.65	J16	95.00	0.1500	7.00	3.0000	210.82	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	80.83	0.45	0 02:59:18
16	Sub A37		30767.08	J17	95.00	0.1500	7.00	3.0000	329.89	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	83.61	0.43	0 01:37:12
17	Sub A38		89241.73	J04	95.00	0.1500	7.00	3.0000	347.39	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	80.86	0.74	0 02:58:31
18	Sub A41		26938.68	J18	95.00	0.1500	7.00	3.0000	115.92	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	81.24	0.24	0 02:48:06
19	Sub A42		58605.85	J12	95.00	0.1500	7.00	3.0000	293.23	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	81.76	0.56	0 02:33:34
20	Sub A43		36285.59	J06	95.00	0.1500	7.00	3.0000	406.82	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	83.69	0.52	0 01:34:38
21	Sub A44		57802.86	J13	95.00	0.1500	7.00	3.3000	226.45	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	11.5750	65.09	0.46	0 02:37:33
22	Sub A45		80430.85	J19	95.00	0.1500	7.00	2.1000	247.72	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	11.5750	63.19	0.46	0 03:28:28
23	Sub A46		39808.62	J19	95.00	0.1500	7.00	3.7000	176.78	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	11.5750	65.65	0.36	0 02:21:13

ANNEXURE C – DRAWINGS



LEGEND

OVERLOAD FLOW PATH

CATCHMENT BOUNDARY

SUB-CATCHMENTS BOUNDARIES

SUB-CATCHMENTS NUMBER

JUNCTIONS

JUNCTION NUMBER

EXISTING DETENTION POND

1	INTERNAL REVIEW	JUN 21
REV.	BY	DESCRIPTION
		DATE

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BOSCH

PROJECTS

GLOBAL ENGINEERING SOLUTIONS

TYGERVALLEY CHAMBERS 1, 27 WILLIE VAN SCHOOR AVENUE,
BELLVILLE, 7530.
P.O. BOX 5090, TYGERVALLEY, 7536.
TELEPHONE: (021) 914 2756
E-mail: bpcT@boschprojects.co.za
www.boschprojects.co.za

ISO 9001:2015

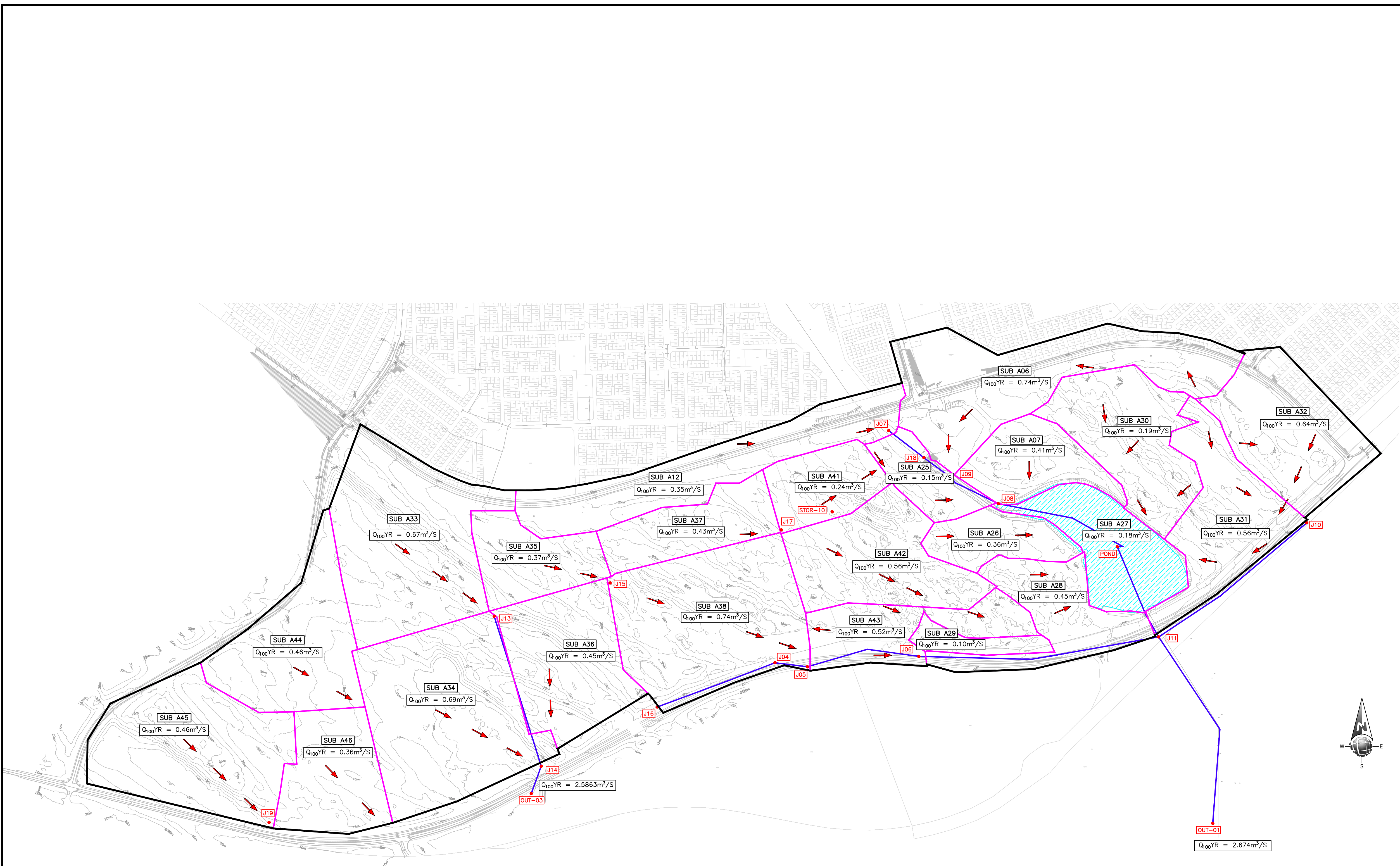
CERTIFIED

DESIGNED	LS	DRAWN	S.M
CHECKED	G.C	PROCESS ENGINEER	N/A
CIVIL ENGINEER	LS	STRUCTURAL ENGINEER	N/A
INSTRUMENT ENGINEER	N/A	ELECTRICAL ENGINEER	N/A
MECHANICAL ENGINEER	N/A		

APPROVED	PROJECT MANAGER	DIRECTOR
----------	-----------------	----------

CITY OF CAPE TOWN
ENKANINI HOUSING DEVELOPMENT
PRE-DEVELOPMENT SUBCATCHMENT RUNOFF

SCALE 1:4000	DATE JUN 2021
DRAWING NUMBER 9002/15/34/RSD/001	REVISION 1



LEGEND

OVERLOAD FLOW PATH

CATCHMENT BOUNDARY

SUB-CATCHMENTS BOUNDARIES

SUB A30

SUB-CATCHMENTS NUMBER

J10

JUNCTIONS

JUNCTION NUMBER

EXISTING DETENTION POND

1	INTERNAL REVIEW	JUN 21
REV.	BY	DESCRIPTION
		DATE

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GLOBAL ENGINEERING SOLUTIONS

TYGERVALLEY CHAMBERS 1, 27 WILLIE VAN SCHOOR AVENUE,
BELLVILLE, 7530.
P.O. BOX 5090, TYGERVALLEY, 7536.
TELEPHONE: (021) 914 2756
E-mail: bpcT@boschprojects.co.za
www.boschprojects.co.za

CERTIFIED

ISO 9001:2015

DESIGNED	LS	DRAWN	S.M
CHECKED	G.C	PROCESS ENGINEER	N/A
CIVIL ENGINEER	LS	STRUCTURAL ENGINEER	N/A
INSTRUMENT ENGINEER	N/A	ELECTRICAL ENGINEER	N/A
MECHANICAL ENGINEER	N/A		

APPROVED	PROJECT MANAGER	DIRECTOR
----------	-----------------	----------

CITY OF CAPE TOWN
ENKANINI HOUSING DEVELOPMENT
POST-DEVELOPMENT SUBCATCHMENT RUNOFF

SCALE 1:4000	DATE JUN 2021
DRAWING NUMBER 9002/15/34/RSD/002	REVISION 1

June 2021



CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

Making progress possible. Together.

City of Cape Town

ENKANINI SOUTH GREENFIELD HOUSING DEVELOPMENT

Bulk Stormwater Services Assessment - Draft

PROJECT N^o 9002/015/34

June 2021

CITY OF CAPE TOWN

ENKANINI SOUTH GREENFIELD HOUSING DEVELOPMENT

BULK STORMWATER SERVICES ASSESSMENT - DRAFT

JUNE 2021

BOSCH PROJECTS N^o: 9002/014/008	DATE: June 2021	REPORT STATUS: Draft		
CARRIED OUT BY: Bosch Projects Pty Ltd PO Box 27158 Greenacres 6057 Tel: 041 363 0598 Fax: 041 363 7646		COMMISSIONED BY: Directorate: Human Settlements City of Cape Town 12th Floor, Cape Town Civic Centre Cape Town 8001 Tel: 27 21 400 2329 Fax: 27 21 425 2685		
AUTHOR: Mr Lourens Streicher		CLIENT CONTACT PERSONS: Mr G Hanekom/W Davids		
SYNOPSIS: Enkanini South Housing Development Bulk services Assessment				
FUNCTION: Civil Engineering (Services)				
© COPYRIGHT: Bosch Projects (Pty) Ltd 				
QUALITY VERIFICATION This report has been prepared under the control of the Bosch Projects Quality Management System which meets the requirements of ISO 9001:2008 as independently certified by international auditors.				
Verification	Capacity	Name	Signature	Date
By Author	Project Manager	L Streicher		24 June 2021
Checked by	Project Director	O Mia		
Authorised by	Project Director	O Mia		
Received by	City of Cape Town	G Hanekom/W Davids		

CITY OF CAPE TOWN
RUSTHOFF CEMETERY
STORMWATER MANAGEMENT PLAN – REVISION 1

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CITY OF CAPE TOWN
RUSTHOFF CEMETERY
STORMWATER MANAGEMENT PLAN

1. INTRODUCTION

1.1 DESCRIPTION OF THE DEVELOPMENT

The Enkanini South Greenfields Housing Development consist of approximately 110 ha area situated to the south of Khayalitsha (see locality plan).

It is bordered by Mew Way to the North, Baden Powell to the south and Oscar Mpetha Road to the west.

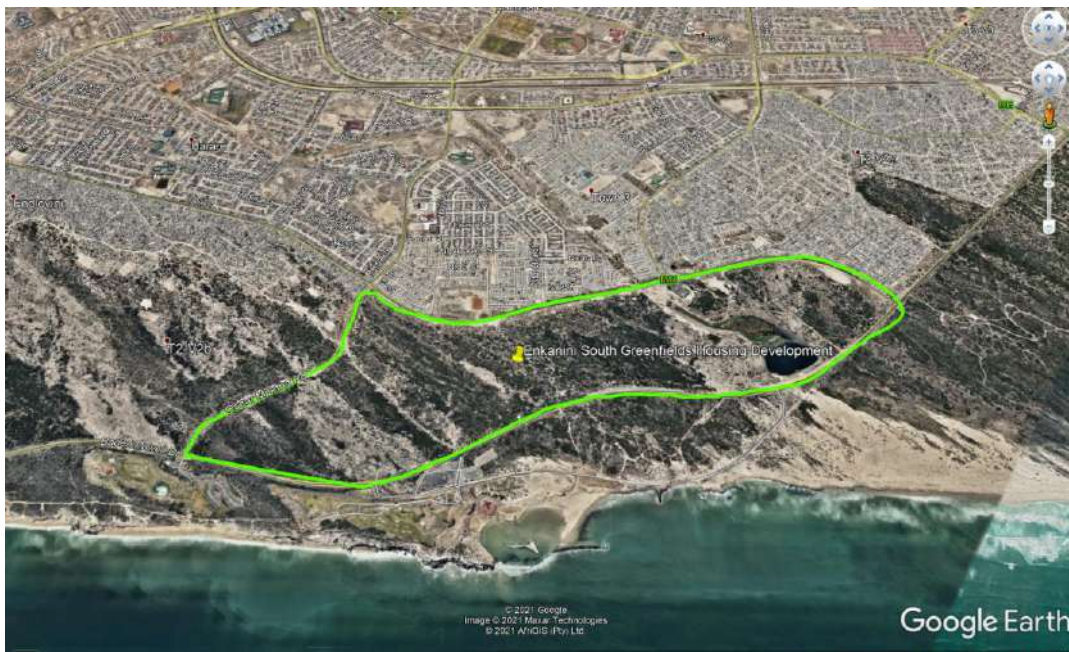


Figure 1: Locality Plan

The intention of the City of Cape Town is to develop this greenfields area in a dense low-cost housing development with associated public open spaces (POS), business and institutional sites. In terms of the NEMA Regulations and DEDEA requirements, confirmation of the adequacy of the existing bulk services are required before consideration can be given for the development to continue. The purpose of this report thus is to review the existing bulk infrastructure and confirm the adequacy (or shortcomings) thereof.

1.2 DEVELOPMENT PLAN

The proposed development footprint (up to the latest available layout dated 9 June 2021 is as follows:

Enkanini South Development Planning	
Land Use	No. of Units
Residential sites	5431
PWO/ECD	8
Public Open Spaces (POS)	11
Business/Commercial	7
Res/Small Business	288
School/Institutional	4
Stormwater Pond	1
	5750

Due to the small development footprint of 110ha, residential units will be small (less than 80m²).

1.3 SOURCES OF INFORMATION

The source of information are listed below:

- Neighbourhood Planning Design Guide, referred to in this report as the “Updated Red Book”, 2018
- SANRAL Road Drainage Manual 6th Edition, 2013,
- Design Rainfall Estimation in South Africa, JC Smithers & RE Schulze, 2002,
- National Water Act (Act 36 of 1998),
- National Environmental Conservation Act (Act 107 of 1998),
- Policy for development control near watercourses, CoCT, 2002,
- Management of Urban Stormwater Impacts Policy, CoCT Roads and SW Department, 2009,
- The South African Guidelines for Sustainable Drainage Systems, Armitage et al, WRC Report No. TT 558/13, 2013, and
- The Vegetation of South Africa, Lesotho and Swaziland, Mucina, L., & Rutherford, M.C., 2006.
- Draft Scoping Report – proposed Housing Development on Erf RE/18370 and RE/18332, Khayalithsa, WC (Draft), June 2021, and
- Khayalithsa Stormwater Management Plan, Appendix I (as received from W Davids).

1.4 CURRENT USE & TOPOGRAPHICAL FEATURES OF THE SITE

The land is covered with vegetation and bare shale/rock outcrops noticeable from aerial photography and observations on site.

The land also has a number of low-lying areas or “pond features” that does not have a natural runoff route which could possibly account for the limited stormwater services found downstream in Baden Powell Drive (as it acts as ponding facilities). Overall though the land slope is fair i.e. ranging from 1% to 4% in some places.

From the draft scoping report by Sillito Environmental Consulting the following is relevant:

“The study area contains Cape Flats Dune Strandveld, an Endangered vegetation type. Over half of the study area has been disturbed and at least half has been lost to the establishment of informal housing (Highly degraded habitat). Other areas have been disturbed by dumping, sand mining, animals grazing and most significantly clearing of vegetation for housing.. These areas are degraded but have good rehabilitation potential and are of Medium sensitivity. There are two large areas within the site that contain semi-intact vegetation. However, these areas are still under pressure from further illegal occupation. These areas are in a conservation-worthy condition and have high sensitivity”.

To the east of the development there is a large natural detention pond area, referred to as “Pond 33” in the Khayelitsha Stormwater Management Plan.

1.5 GEOLOGICAL FEATURES

A freshwater site assessment by the Freshwater Consulting Group (FCG) indicated no wetlands on site with the exception of an artificial wetland on the eastern border of the site. No significant other features of noticeable consideration are identified to be on the site.

1.6 LEGAL REQUIREMENTS

The provision and management of stormwater on site for development purposes is governed by two main acts:

- National Water Act (36 of 1998) which deals which deals with pollution control and the protection of existing watercourses, and

- National Environmental Management Act (NEMA, 107 of 1998) which deals with compliance and duty of care and remediation to the existing environment.

Typically authorisation by DEDAT will only be granted if evidence is provided that adequate bulk services are in place to support the development.

1.7 LOCAL AUTHORITY REQUIREMENTS

In terms of the CoCT's policy on the Management of Urban Stormwater Impacts (2009), it is a requirement that undesirable impacts of stormwater runoff be minimised by the use of "*water sensitive urban design principles*" to urban planning and stormwater management. This is typically achieved by utilising "Best Management Practices (BMPs)" to remove, reduce and retard post-development runoff flows.

The CoCT's policy dictates the on-site reduction of post-development pollutants with 80% for suspended solids (SS) and a 45% reduction in total phosphorous (TP) for a ½ year storm event and a reduction of the rate and quantity of runoff to the 1 in 50 year storm event interval.

Further specific requirements are:

- Provision of low flow channels next to sports fields where these are used as detention facilities,
- Extensive use of litter traps and stilling basins to intercept pollutants. This will need to be done as far as possible at the source level.

1.8 ON-SITE STORMWATER MANAGEMENT

The overall development's bulk and internal stormwater infrastructure will be operated and maintained by the City of Cape Town.

2. EXISTING STORMWATER INFRASTRUCTURE

The most predominant infrastructure is the following:

- 1) A main stormwater outfall channel and culvert (2m x 0.9m culvert close to the intersection of Lindela Road and Mew Way that drains runoff to Pond 33
- 2) "Pond 33", a large detention pond situated on the eastern side of the development.

- 3) A network of catchpits and pipes crossing Mew Way to the north (spaced approx. at 80m intervals (it appears that the network of catchpits are to drain Mew Way itself.
- 4) A similar sized network of catchpits and pipes crossing Oscar Mpetha to the west.

The site itself contains no stormwater infrastructure.

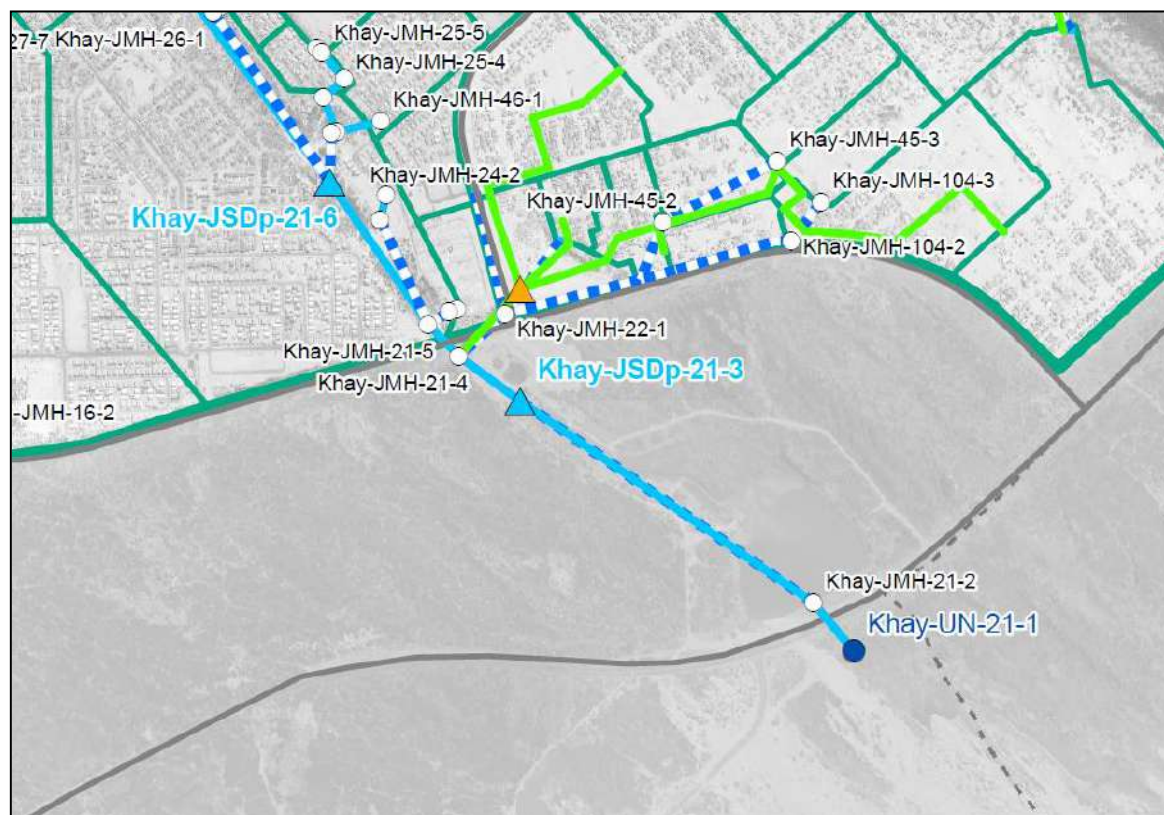


Figure 2: Existing Bulk Stormwater Infrastructure

From the Eastern Catchment High Level Master Plan undertaken by Gibb for the Khayalithsha area it does not appear that upstream runoff is expected to drain overland to the study area, implying that the Baden Powell Road is a watershed between the north and south catchment areas. Cognisance is taken of the overland link to Pond 33.

3. EXCLUSIONS

The stormwater assessment report provides a holistic overview of the impact of development on site from a stormwater perspective including the availability of bulk stormwater infrastructure and is not intended for design development use. For design development of more comprehensive and detailed stormwater model will be required.

4. MAJOR IDENTIFIED RISKS

The proposed development will have certain impacts of which some may affect the natural flow and quality of run-off water. Sound stormwater management can limit the negative impacts and enhance the positive impacts, to produce the best result possible.

The major risks applicable to this development are as follows:

4.1 POTENTIAL FLOODING AS A RESULT OF HARDENING

The development of the area will result in increased “hardening” of the area (i.e. increased impermeable surface areas), especially considering the small size of residential erven (less than 80m³) and associated high coverage. This will result in significant increased overland runoff that will have to be catered for. Potential risks include downstream flooding in the vicinity of Baden Powell Drive.

As the site is now from a topology perspective, the presence of a number of low lying areas and increased hardening will likely lead to increased ponding on these areas.

4.2 EROSION

An increase in runoff will result in the increased likelihood of erosion. To reduce erosion it is recommended that runoff be routed away from direct discharge at embankments and not be concentrated at points of discharge.

4.3 POLLUTION

The development of the site will increase the risk of pollution in the form of hydrocarbons from vehicles and total suspended solids (TSS) from domestic waste. In addition pollution from construction materials for the proposed development and associated facilities is also a potential risk.

4.4 SEDIMENTATION

Accumulated material on hardened surfaces can lead to a build-up of transported material to the stormwater discharge outlets. This material normally contains the bulk of the pollutants.

4.5 ENVIRONMENTAL IMPACTS

One artificial wetland was identified on the eastern part of the site (which was as a result of the creation of the temporary transit area (TRA) – see report by Sillito Environmental Consulting. The report did conclude that the wetland is isolated, small, degraded and not connected to any groundwater sources and as such had limited environmental value.

5. CONCEPT HYDROLOGY MODEL

5.1 STORMWATER SYSTEM

To assess the ability of the existing stormwater infrastructure to adequately cater for the development, a conceptual stormwater model for the pre-development and post-development scenario was created.

In terms of the CoCT's Roads and Stormwater Department's Policy requirements, cognisance of the system's ability to handle a 1 in 50-year storm event was considered with a risk review of storms of a higher magnitude (i.e. 1 in 100-year).

A Best Management Practice (BMP's) approach was followed with the key objectives being:

- Run-off control at source,
- The prevention of pollution, and
- Prevention of erosion.

5.2 FEASABILITY INVESTIGATION MODELLING LIMITATIONS AND ASSUMPTIONS

For this assessment the following limitations and assumptions were made in this report:

- The runoff from sub-catchment is theoretically calculated using widely accepted design methodologies.
- The stormwater model developed for this assessment is conceptual in nature and detail design layout might differ in certain areas.
- Should there be subsequent changes to the development layout, these must be taken into account and runoff recalculated before commencing with detail designs of the stormwater system.

5.3 CONCEPT STORMWATER MODELLING PARAMETERS

5.3.1 RAINFALL DATA

The following SAWS rainfall station data in the vicinity of the development were considered.

Table 1: SAWS Rainfall Station Data

Station Name	Station No.	Records (Yrs)	MAP (WRC) (mm)
EERSTERIVIER (BOS)	0021330_W	81	522
ZEEKOEVLEI	0005034_W	39	607
KUILSRIVIER	0021326_W	35	566
LONG ACRES	0021357_W	22	566
RONDEVLEI	0004874_W	47	724
BELLVILLE (BOS)	0021235_W	51	476
Avg.			577

The following Point Intensity rainfall data was used for the development {(based on the Rational Method (Midgeley & Pitman (HRU 2/78) generally used in South Africa:

Table 2: Point Intensity

Station	EERSTERIVIER (BOS) 0021330_W					
MAP	522mm					
Rainfall	Intensity Duration (mm/h)					
Storm Duration (hrs)	Point Intensity (mm/h) 1/2 Yrs.	2 Yrs	5 Yrs	10 Yrs	50 Yrs	100 Yrs
0.18	25.6	34.4	46.1	54.7	76.1	86.3

5.3.2 DESIGN STORM FREQUENCIES

The following design storm frequency was used:

- Minor stormwater system: 1 in 2 year frequency (the proposed development is low risk and a smaller design return period is suggested).
- Major stormwater system/pollution control: 1 in 10 & 50 year frequency. Building floor levels to be above the 1:100 year flood level. Cognisance is to be taken of risks for a 1:100 year flood event.

5.3.3 RUNOFF GENERATION

For the purpose of this investigation, the SCS method of runoff calculation was used. Runoff was calculated using the Autodesk Storm and Sanitary Sewer Analysis software.

Parameters used in the model are as follows:

Table 3: SWMM modelling parameters

Hydrology Method	SWMM
Distribution Curve	SA SCS Type 2
Link Routing	Kinematic Wave
Pre-development Weighted SCS Curve No.	Various (Refer to Annexure
Post-development Weighted SCS Curve No.	Various
Conduit Manning's roughness factor	0.015
Stream Manning's roughness factor	0.032 (streambanks 0.040)

The SCS curve numbers adopted for the development are based on the SCS Urban Hydrology for Small watersheds, 2nd Ed. June 1986, SCS Curve Number Table for various land uses. The adopted values were based on a Hydrological Soil Group A/B based on the extensive coverage of sandy material.

Category A/B soils typically have typically high infiltration rates with low stormflow potential.

The adopted SCS CN for the pre-development scenario is as follows:

- Desert shrub – good condition – 68
- Waterbodies - 100

The adopted SCS CN for the post-development scenario is as follows:

- Residential development – 95
- Waterbodies - 100

The high CN for the developed areas are due to the high coverage expected from the small residential sites (< 80m²).

5.4 CATCHMENT HYDROLOGY RESULTS

Annexure A contains a tabulated summary of expected runoff flows for the pre-development scenario. The expected pre-development flows for the various sub catchments are indicated on dwg. **P9002/015/034/SW001 (Annexure C)**.

The anticipated runoff for the 1:100 year storm event for the post-development sub catchments is shown in **Annexure B**.

Dwg. P9002/015/034/SW002 (in Annexure C) shows potential runoff for the post-development catchments for the 1:100 year storm event.

5.4.1 PRE-DEVELOPMENT INTERPRETATION

From the pre-development model the expected runoff during major storm events are relatively low. From **Dwg P9002/015/034/SW001** the expected peak runoff for a 1:100 year event to the east of the Monwabisi Resort is in the region of $0.123\text{m}^3/\text{s}$.

The low runoff at this point which does not have a natural point of discharge due to the flat topography next to Baden Powell Drive is expected as it contains a number of low-lying areas that retain runoff.

Close to the 2nd resort the pre-development runoff is $0.173\text{m}^3/\text{s}$ for the pre-development scenario - again fairly minor as expected due to the presence of low lying areas.

Further east the expected peak runoff that contributes from the study area to the existing waterbody is $0.302\text{m}^3/\text{s}$. The peak inflow from upstream areas to this waterbody (referred to as "Pond_33" in the Khayelitsha Stormwater Management Plan by Gibb) is $9.59\text{m}^3/\text{s}$ thus the contribution from this development is minor (3.13%).

5.4.2 POST-DEVELOPMENT RUNOFF

For the post-development scenario, the peak runoff in the vicinity of the Monwabisi resort increases to a fairly significant flow of $0.814\text{m}^3/\text{s}$. To limit this runoff to pre-development flow, a retention pond of approximately 3500m^3 will be required,

To the east of the Monwabisi resort an additional 1.803m³/s peak runoff will be generated (increasing from 0.173m³/s) that will have to be accommodated crossing Baden Powell Drive to the sea. To limit runoff here, a retention facility of around 9, 907m³ will be required at this point.

The above two facilities can be combined (when the area is shaped) to form a single detention facility to store 13, 500m³.

The alternative to providing the above retention facilities are to combine the flow at a point (via internal stormwater reticulation once developed), cross the Baden Powell Drive and discharge via 2 x 900Ø pipes that will combined, handle 2.600m³/s. The implication here is that the discharge point is 200m upstream of the coastline and runoff will enter the sea (which will require environmental authorisation). This 2nd option is thus not recommended

At the waterbody (Pond_33) to limit runoff to pre-development flow, approximately 14, 399m³ of additional storage will be required. The existing storage volume is approx. 67822m³. According to the Khayalitsha SWMP the current attenuation of runoff of this pond is 10%, implying that additional attenuation will increase to 31% of the pond's capacity, thus sufficient storage appears to be available at this pond. No flooding of any surrounding infrastructure is expected as a result of higher ponds top water levels due to the additional runoff.

5.5 CONCLUSIONS

Following the investigation and findings of this report it can be concluded that:

- The topography of the site is supportive of this type of development (natural slopes are overall not too steep or flat i.e. supports gravity infrastructure),
- The town planning layout is suitable for the proper disposal of stormwater from the site with allowance to be made for detention storage on western side of the site.
- There is no need to upgrade existing bulk stormwater infrastructure for this site.
- Litter traps and stilling basins are to be provided to limit pollutants travelling downstream.

For and on behalf of:
BOSCH PROJECTS (PTY) LTD



L STREICHER Pr Tech Eng, Pr CPM
Project Manager

ANNEXURE A – PRE-DEVELOPMENT CATCHMENT RUNOFF DATA

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ANNEXURE B – POST-DEVELOPMENT CATCHMENT RUNOFF DATA

ANNEXURE C – DRAWINGS

Enkanini South Housing Development

Phase 1 Geotechnical Investigation

Report Prepared for

Bosch Projects (Pty) Ltd

Report Number 571322

Report Prepared by



June 2021

Enkanini South Housing Development Phase 1 Geotechnical Investigation

SRK Consulting (South Africa) (Pty) Ltd.

The Administrative Building
183 Main Road
Albion Springs
Rondebosch
7700
South Africa

e-mail: capetown@srk.co.za

website: www.srk.co.za

Tel: +27 (0) 21 659 3060

SRK Project Number 571322

June 2021

Compiled by:

John Brown Pr Sci Nat
Principal Engineering Geologist

Email: jbrown@srk.co.za

Reviewed by:

Bruce Engelsman Pr Eng Pr CPM
Principal Engineer

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Appendices

Appendix A: Soil Profiles

Appendix B: Photographs

Appendix C: Dynamic Probe Light (DPL) Plots

Appendix D: Laboratory Test Results

Disclaimer

The opinions expressed in this Report have been based on the information supplied to SRK Consulting (South Africa) (Pty) Ltd (SRK) by Bosch Projects (Pty) Ltd. The opinions in this Report are provided in response to a specific request from Bosch Projects to do so. SRK has exercised all due care in reviewing the supplied information. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate.

1 Introduction

SRK Consulting (South Africa) (Pty) Ltd (SRK) was appointed by Bosch Projects (Pty) Ltd to undertake a Phase 1 Geotechnical Investigation for the proposed 89 Ha Enkanini South residential development located in Khayelitsha, Cape Town.

The geotechnical investigation was carried out in accordance with the National Department of Housing document titled “Geotechnical Site Investigations for Housing Developments” Generic Specification GFSH-2 September 2002.

The aim of the Phase 1 Geotechnical Investigations is to establish the nature of the underlying soils to assist with the township planning and layout. In particular, to determine the suitability of the underlying soils for use as earthworks construction materials, the likely excavatability of materials and the general suitability as founding material for the houses.

The location of the Enkanini South site is shown in **Figure 1-1**.



Figure 1-1: Location of the 89 Ha Enkanini South site

1.1 Terms of Reference

The general terms of reference for the Phase 1 Geotechnical Investigation are as follows:

- The excavation of test pits in accordance with the requirements as set out in the GFSH-2 Specification for housing developments. Test pits to be excavated to cover the whole site except within the waste and stormwater reservation along the drainage course.
- Establish the nature and engineering properties of the underlying soils to inform engineering designs.
- The test pits to be profiled according to accepted geotechnical practice.
- Dynamic Probe Light (DPL) penetrometer tests to be conducted at the location of all test pits to determine the soil consistency.
- Representative soil samples to be recovered for soil classification purposes and to assess the suitability of the materials for use as construction materials.

- Assessment of the groundwater condition based on observations made within the test pits.
- Highlight any potentially problematic soil or ground conditions.
- Assess the excavatability of the materials and to map any areas where rock outcrop is exposed.
- Provide general recommendations in terms of earthworks, suitability of soils for bulk earthworks operations, general founding conditions both within in situ material and engineered platforms.
- Identify any constraints to development and make recommendations for further geotechnical investigation should this be required based on the findings.

2 Location and Site Description

The Enkanini South site is 89 Ha in extent and occupies historically undeveloped land adjacent to the Khayelitsha residential area. The Enkanini South site is located between Baden Powell Drive to the south, Mew Way to the north, and Oscar Mpetha Road to the west.

The site is characterised by a sand dune topography with prominent high linear sand dunes orientated in a SE-NW direction (which is the main summer prevailing wind direction). High sand dunes are interspersed with dune slacks (valleys) in between the linear dunes.

A drainage course and a water retention dam are present over the eastern part of the site (designated as a Waste and Stormwater Reservation on the development plan).

Some low fynbos-type vegetation is present, but alien vegetation is currently the dominant vegetation type.

Most of the site is currently occupied by informal housing structures. Informal dwellings are particularly dense near the northern boundary of the site.

The layout of the site is shown in Figure 2-1.

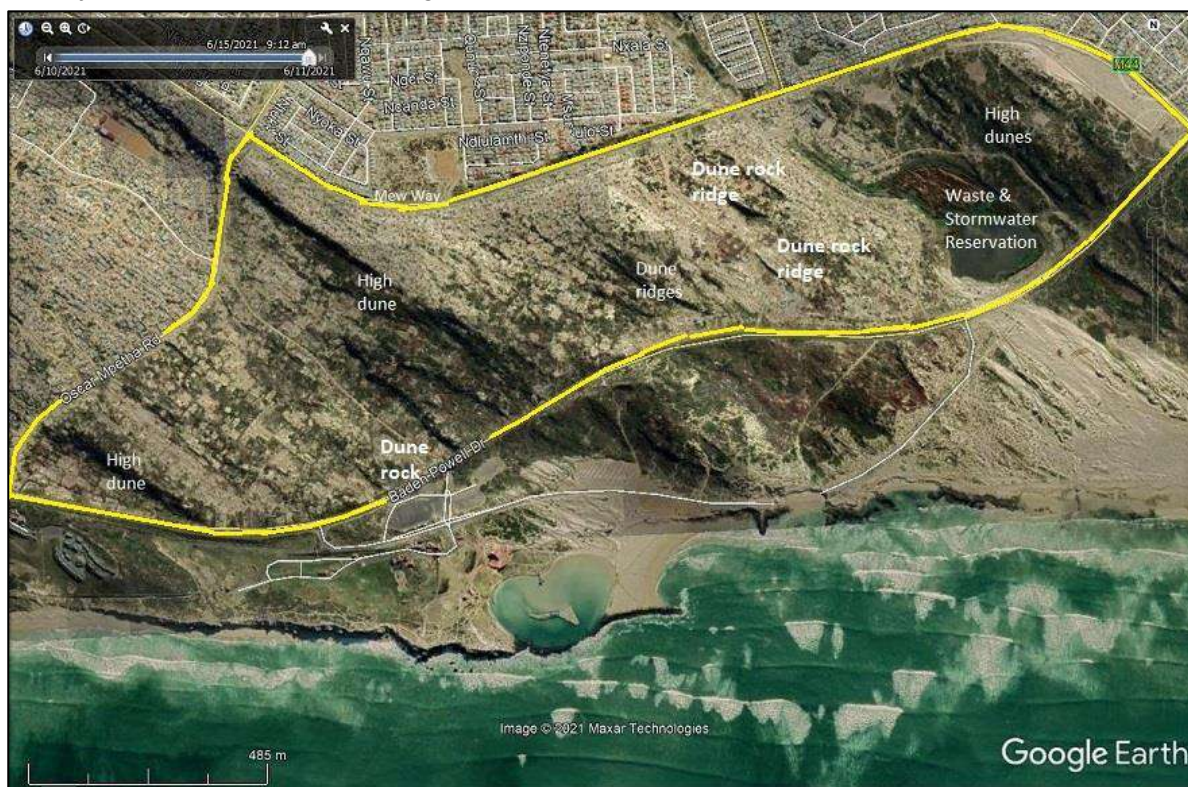


Figure 2-1: Google Earth Image showing linear sand dunes and informal housing

General photographs of the site are shown below.

Photo 1: General view of site from the east looking across the site to the west



Photo 2: General view of undulating sand dunes eastern side of site (TP57)



Photo 3: General view of site occupied by informal dwellings



Photo 4: TP22 excavated close to edge of steep dune



Photo 5: Valley between steep dunes (TP12)



Photo 6: Isolated prominent dune rock hill near TP40



3 Fieldwork and Laboratory Investigations

The Phase 1 Geotechnical Investigation involved the following fieldwork:

- The investigation of the soil profile at 58 positions spread across the whole site.
- Of the 58 test positions, 5 positions were not accessible to the excavator (either due to the presence of informal dwellings or due to the steepness of some of the sand dunes).
- A total of 67 Dynamic Probe Light (DPL) penetrometer tests were conducted at the location of all test pits (as well as at inaccessible positions). DPL tests were generally extended to a depth of about 2 m to 3 m below surface, but were extended in high sand dune certain areas to a depth of between about 3.0 m and 5.0 m below surface (either using extension rods or by conducting tests within the test pits at a depth of about 1.5 m below surface).
- The test pits were profiled according to accepted geotechnical practice.
- The test pits were photographed.
- Representative soil samples were recovered for laboratory testing for soil classification and to assess the suitability of the soils for use as engineered fill (grading analyses, Atterberg Limits and Mod/CBR tests).
- The groundwater condition was noted within the test pits (none encountered).

Figure 3-1 and **Figure 3-2** indicate the extent of the Enkanini South site and indicates the positions of the test pits and the DPL positions. A handheld GPS was used to record the test positions.

The test results are included in the following appendices:

Appendix A: Soil profiles

Appendix B: Photographs of the test pit position and soil profiles.

Appendix C: DPL penetrometer test results.

Appendix D: Laboratory test results.

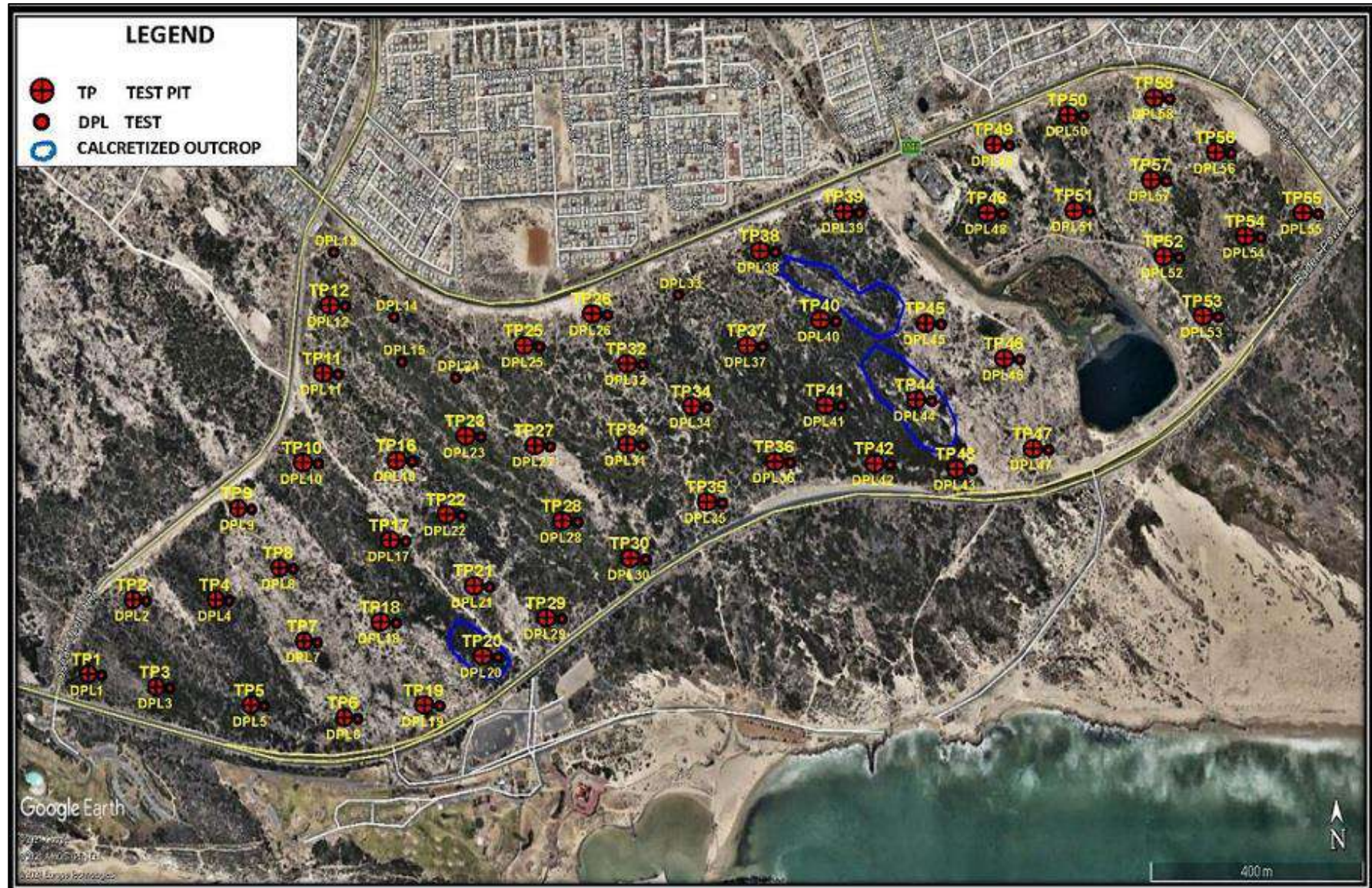


Figure 3-1: Site layout showing vegetation (pre-occupation), positions of test pits and DPL tests, and dune rock outcrop areas

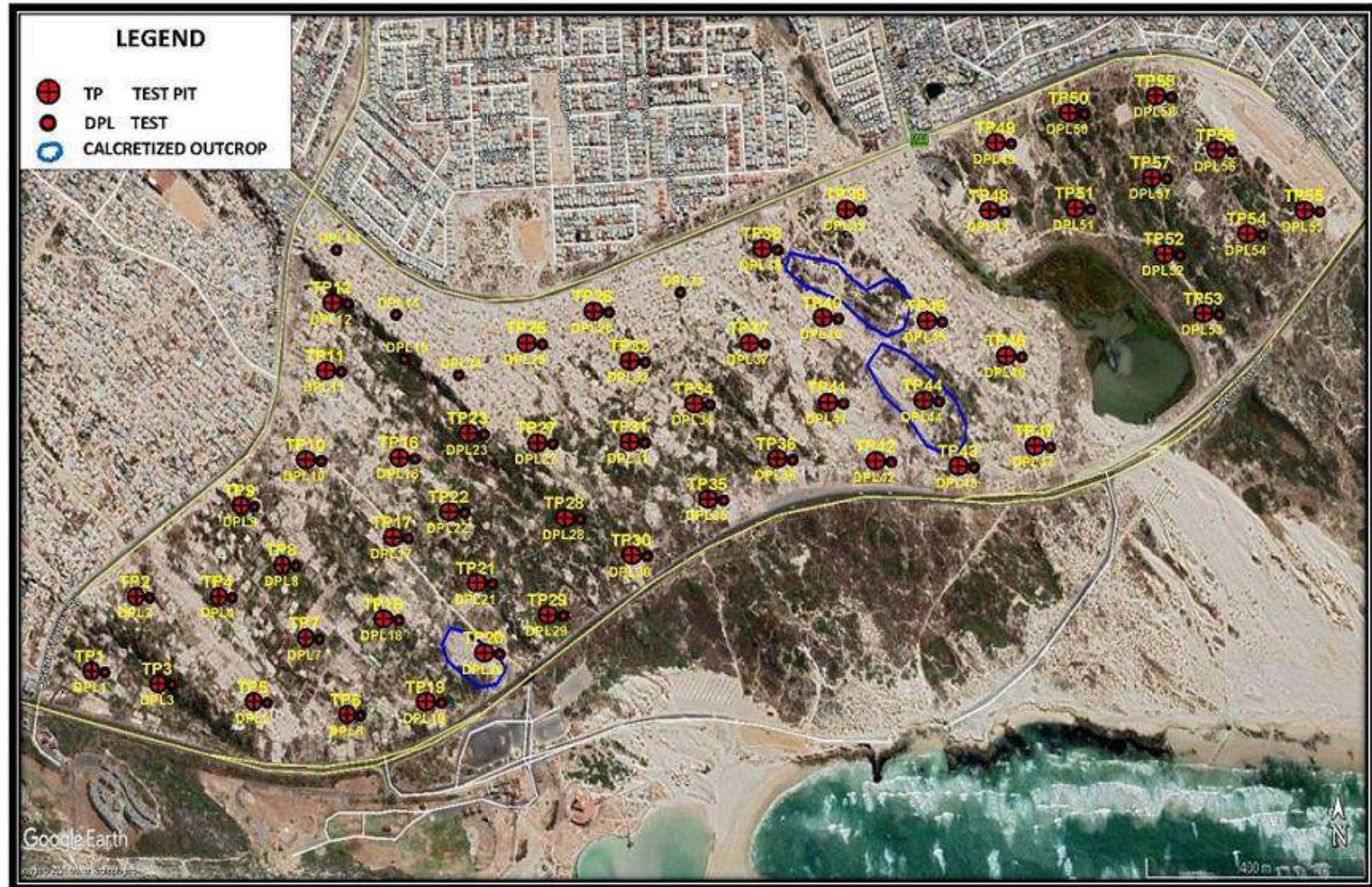


Figure 3-2: Site layout post dwelling occupation showing location of test pits, DPL tests and dune rock outcrop areas

4 Geological Description

4.1 Regional Geology

The published 1: 50 000 geological map of the area (Cape Town 3418 BA) (**Figure 4-1**) indicates the linear nature of the sand dunes (Qsr) orientated in a SE-NW direction. The geological map also indicates strongly calcretised zones broadly described as dune rocks (Qcb /Qc = calcrete and/or limestone). The geological map indicates that weathered Malmesbury Group rocks (Nt) occurs at a depth of about 24 m below surface in the area.

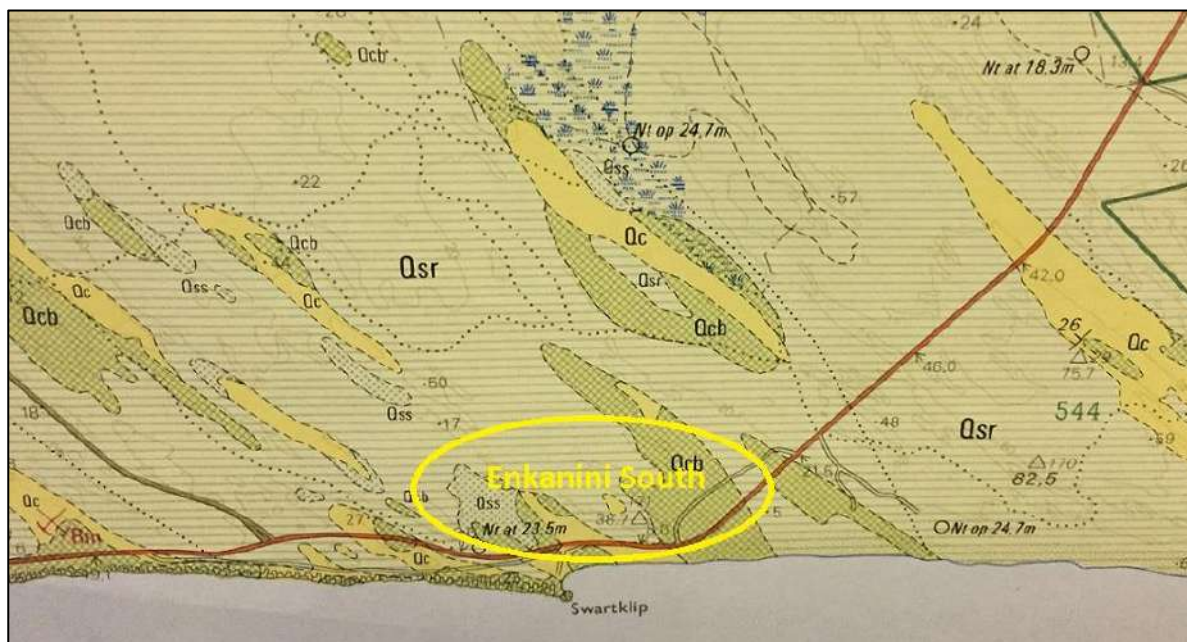
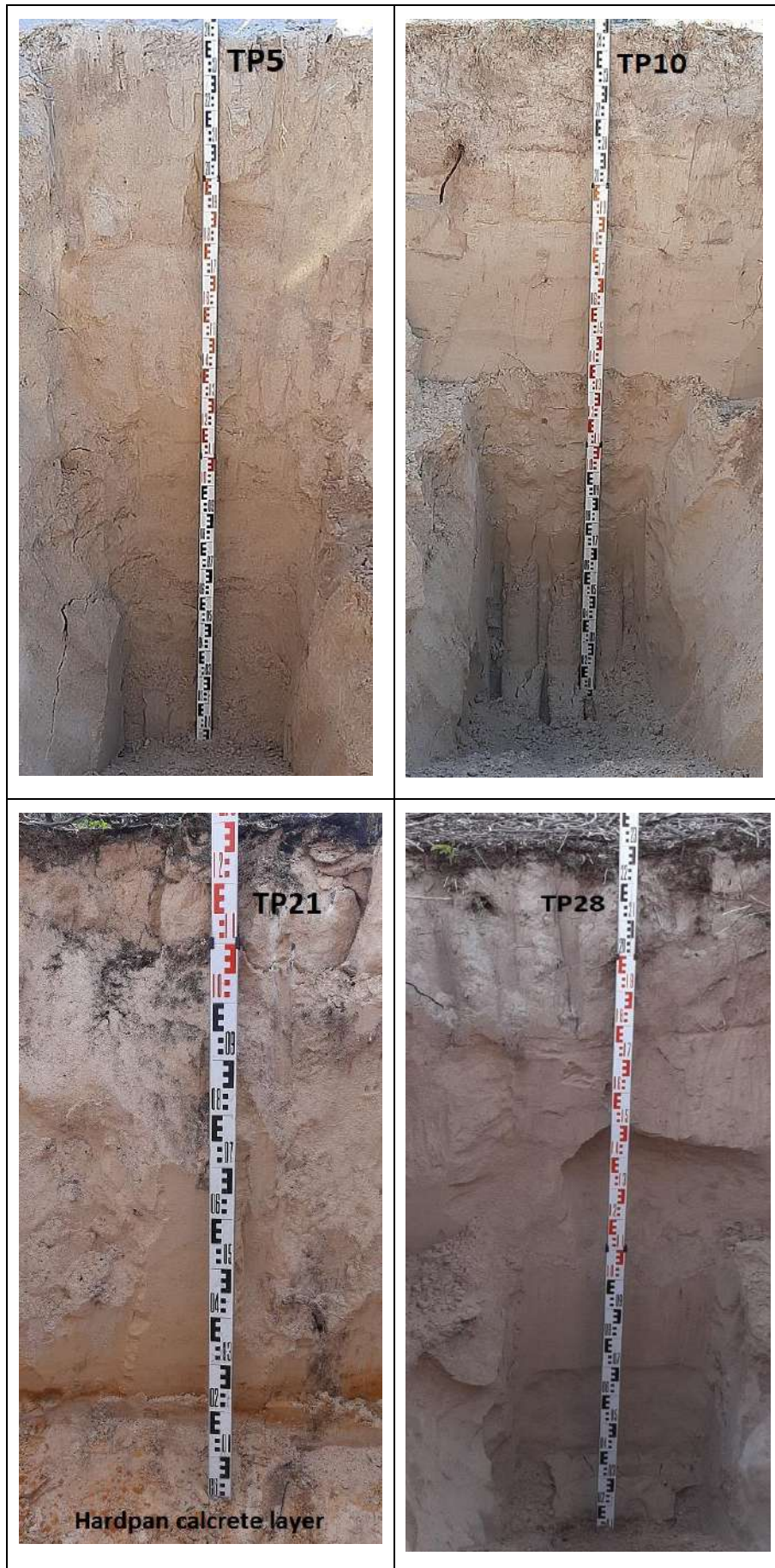


Figure 4-1: Regional Geological Map showing location of the Kraaifontein Roads Depot

4.2 Soil Profile

The test pits excavated at the site indicate that the soil profile consists of granular fine to medium Aeolian sand containing abundant coarse shell fragments and traces of silt and clay (where calcretised). The sand is of marine origin (beach sand) which has been blown inland with the prevailing strong SE wind (during the summer months). Typical longitudinal and undulating sand dunes occur at the site. DPL penetrometer tests indicate that the sand profile extends to a depth of at least 5 m below surface within the dune areas (and probably extends much deeper). Some of the higher sand dunes are exposed and are prone to wind erosion. However, others appear to be much older and more stable as they have been well cemented with calcium carbonate leached out of shell fragment. Slight calcretisation normally occurs deeper down the soil profile with some calcrete concretions and even hardpan calcrete layers randomly present within the profile. A few areas were mapped where very soft rock quality “dune rock” or weak sandstone occurs forming prominent ridges (Photo 6).

A sample of photographs of typical soil profiles present at the site are shown in Figure 4-2. The profiles are mostly fine to medium sand with some weakly and strongly calcretised layers shown.



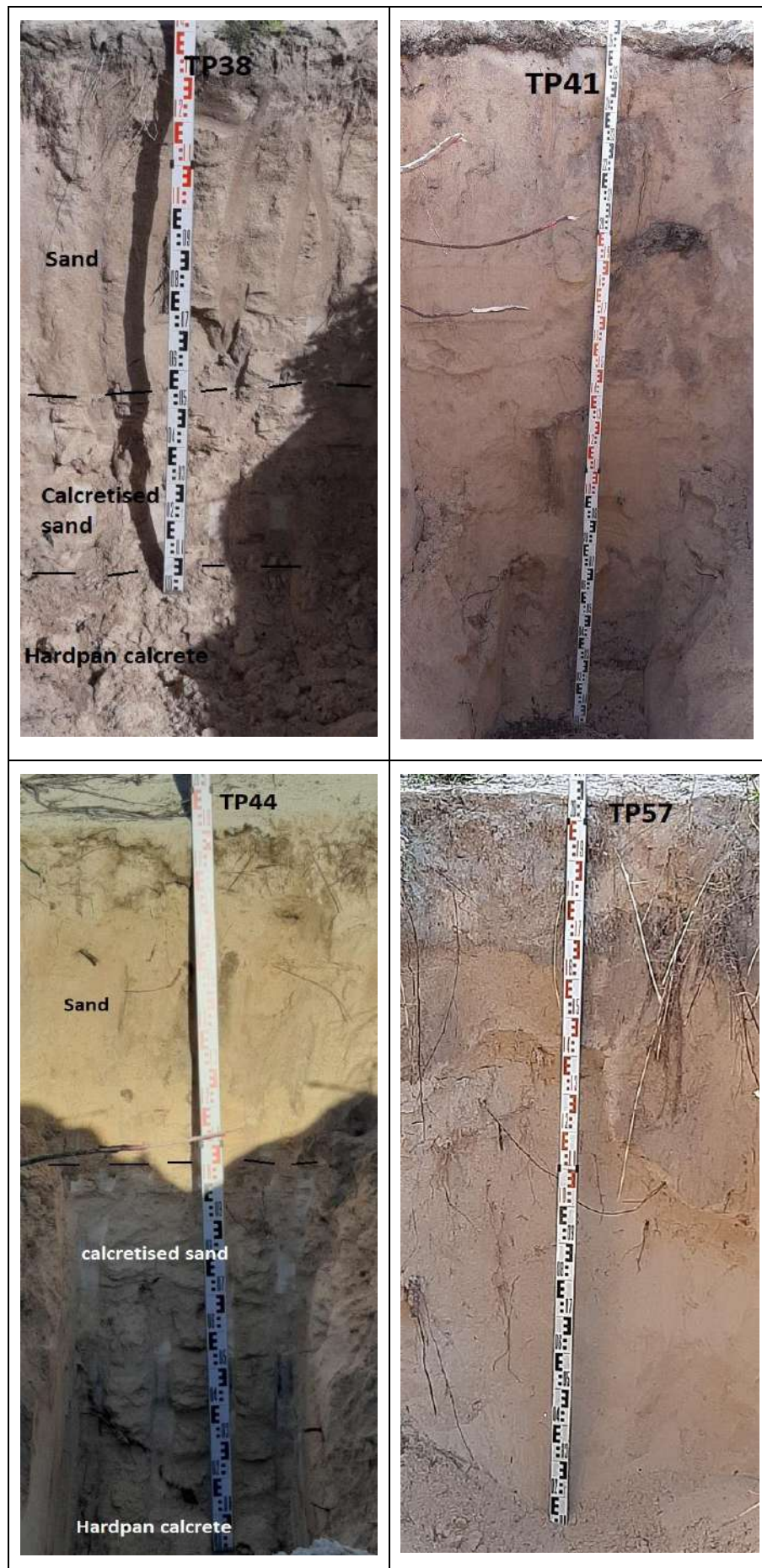


Figure 4-2: Typical soil profile photographs

The materials at the site essentially consist of the following:

Fill

Very minor fill (sand with plastic) was locally encountered near informal dwellings and appears to have been mainly placed to level building sites and for access tracks. Where present, the fill is about 0.3 m to 0.4 m thick and should not have much of a bearing on the development of the township (once any plastic is removed the sand can be recompacted).

Fine to medium SAND - Aeolian

By far the majority of the test pit profiles, which were generally excavated down to a depth of 2.5 m to 3.0 m below surface, encountered non-cohesive fine to medium sand containing shell fragments. The laboratory test results indicate traces of clay and silt. The sand is normally of *loose* consistency down to a depth of about 1 m, and below this depth the consistency improves to *medium dense* or even *dense*.

Calcretised SAND - Aeolian

The sand profile tends to become slightly calcretised with increasing depth due to weak cementation of calcium carbonate leached out of the shell fragments. The degree of calcretisation varies widely across the site and was only encountered in certain profiles. The laboratory test results indicate that the calcretised sand has a slightly higher clay and silt content (less than 5%). The calcretised sand is competent and is usually of *dense* consistency. The calcretised sand is considered to be excavatable.

Hardpan calcrete

With progressive cementation of the sand, calcrete concretions and even hardpan cobbles or layers of calcrete may have developed within the soil profile. The occurrence of hard calcrete concretions or hardpan calcrete appears to be random across the site. In most places, it should be possible to excavate through the calcretised layer using appropriate plant (bulldozers). It is possible that some oversized calcrete boulders may not be excavatable during bulk earthworks, but these can normally be broken down using mechanical means.

Dune rock (weak sandstone)

A few localised areas were identified where dune rock (Aeolian sand cemented to *very soft rock* quality) was identified. Some of the areas of dune rock are obvious on site as they form high ridges with exposed sandstone outcrop evident. It is also possible that shallow dune rock may be encountered within other areas not exposed as outcrop (or subsequently buried by windblown sand).

The detailed soil profiles and selected photographs are included in Appendices A and B respectively.

4.3 Groundwater condition

Seepage of groundwater was not encountered within any of the test pits excavated to a maximum depth of about 2.5 m to 3.0 m below surface at the site. The underlying Aeolian sand profile tends to be highly permeable which results in the rapid downward percolation of rainwater. It is possible that downward percolation of rainwater could be retarded by the presence of calcretised layers that may randomly be present within the soil profile. It is therefore possible that isolated perched water tables could be present depending on the depth of excavation.

Groundwater problems are not expected to impact the planned earthworks at the site (but this will depend on the level of excavation). The drainage course and the dam area are exceptions and groundwater seepage can be expected to occur at relatively shallow depth close to the low-lying drainage area.

5 Laboratory Test Results

Representative soil samples were recovered from the test pits across the site and were submitted to a SANAS accredited soil laboratory for soil classification purposes (Grading Analyses and Atterberg Limits), representative samples were tested for Mod/CBR compaction properties. The laboratory tests are used to assess the general engineering properties of the soils.

The laboratory results are summarized in Tables 5-1 and 5-2.

Table 5-1: Summary of Laboratory Test Results - Soil Grading and Classification

Test Pit	Depth (m)	Soil Type	Grading Analysis				LS %	LL %	PI %	USCS Class.	Pot. Exp.
			Clay %	Silt %	Sand %	Gravel %					
TP1	0.4 – 0.9	Beige speckled brown, slightly clayey silty, fine to medium calcretised SAND.	2	3	93	2	0.0	NP	NP	SP	LOW
TP8	0.6 – 1.0	Off-white speckled brown, fine to medium SAND.	1	0	99	0	0.0	NP	NP	SP	LOW
TP9	0.3 – 0.8	Off-white, fine to medium calcretised SAND.	3	1	96	0	0.0	NP	NP	SP	LOW
TP20	0.8 – 1.2	Off-white, fine to medium calcretised SAND, some calcrete gravel	4	1	83	12	0.0	NP	NP	SW-SM	LOW
TP22	0.2 – 1.0	Light greyish beige, fine to medium gritty SAND.	1	1	97	1	0.0	NP	NP	SP	LOW
TP25	0.4 – 1.0	Light beige, fine to coarse gritty SAND.	1	1	96	0	0.0	NP	NP	SP	LOW
TP27	1.4 – 1.6	Dark grey, fine to medium gritty SAND.	2	1	93	4	0.0	NP	NP	SP	LOW
TP34	0.5 – 0.8	Light greyish beige, fine to medium SAND.	1	1	98	0	0.0	NP	NP	SP	LOW
TP39	0.3 – 0.9	Light beige, fine to medium SAND.	1	0	97	2	0.0	NP	NP	SP	LOW
TP41	1.0 – 1.3	Off-white, fine to medium calcretised SAND.	2	2	94	2	0.0	NP	NP	SP	LOW
TP46	0.5 – 1.0	Light beige, fine to coarse gritty SAND.	1	1	98	0	0.0	NP	NP	SP	LOW
TP54	0.5 – 1.5	Light beige, fine to medium SAND.	1	1	98	0	0.0	NP	NP	SP	LOW
TP57	0.6 – 1.2	Light beige, fine to medium SAND.	2	2	96	0	0.0	NP	NP	SP	LOW

LL = Liquid Limit

PI = Plasticity Index

LS = Linear Shrinkage

NP/SP = Non/Slightly Plastic

Pot. Exp. = Potential Expansiveness (vd Merwe Classification)

Table 5-2: Compaction Properties and TRH 14 Material Classification

Test Pit	Depth (m)	Soil Type	CBR @					PI %	Mod AASHTO Density kg/m ³	OMC %	TRH 14 Class.
			100 %	98 %	95 %	93 %	90 %				
TP9	0.3 – 0.8	Off-white, fine to medium calcretised SAND.	13	11	9	8	7	NP	1611	12.4	G9
TP20	0.8 – 1.2	Off-white, fine to medium calcretised SAND, some calcrete gravel.	30	23	14	11	7	NP	1725	12.4	G8
TP25	0.4 – 1.0	Light beige, fine to coarse gritty SAND.	12	11	9	8	7	NP	1591	12.1	G9
TP39	0.3 – 0.9	Light beige, fine to medium SAND.	15	14	10	8	6	NP	1665	12.3	G9
TP46	0.5 – 1.0	Light beige, fine to coarse gritty SAND.	15	14	12	10	8	NP	1648	12.1	G9
TP54	0.5 – 1.5	Light beige, fine to medium SAND.	11	10	8	7	6	NP	1554	12.5	G9

CBR = Californian Bearing Ratio

SP = Slightly Plastic

OMC = Optimum Moisture Content

TRH = Road Materials Classification

6 Geotechnical Evaluation

6.1 Potentially problematic soils

The following potentially problematic soils have been identified within South Africa: expansive clays, soft clays, dispersive soils, pedogenic horizons and collapsible soils. The presence of made ground (fill) is also potentially problematic.

The soils at the site consist of a thick profile of Aeolian sand which, in general, may be potentially of loose consistency down to a depth of about 1 m and the near-surface soils are therefore moderately compressible and in situ compaction will be required across the site.

None of the underlying soils are potentially compressible.

There are some localised areas where *very soft rock* quality dune rock is present. Some of these areas can be easily identified in outcrops but some areas may not have been identified where not exposed at surface (whether this may be potentially problematic will depend on the proposed platform excavation levels).

6.2 Engineering and material characteristics

The following soil types are present at the site:

1. **AEOLIAN SAND** – The bulk of the material underlying the site consists of poorly graded fine to medium sand. With reference to the summarised laboratory test results presented in Tables 5-1 and 5.2 indicate fairly uniform quality materials which are suitable as subgrade and selected material (TRH 14 Material classification is G9). The Aeolian sand forms good construction material for the construction of bulk earthworks platforms.
2. **CALCRETISED SAND** – Calcretised sand is likely to be encountered deeper down the profile in some places. The calcretised sand varies from weakly cemented to highly calcretised. The calcretised sand is generally of dense or very dense consistency, but it is expected that most of the calcretised sand can be broken down once excavated using a heavy grid or pad foot roller. The calcretised sand tends to have a slightly higher clay and silt content and will therefore be

slightly more sensitive to the moisture content (during compaction) which should be at or near the optimum moisture content. The calcretised sand also is expected to classify as either G8 or G9 depending on the degree of calcretisation.

3. **HARDPAN CALCRETE or DUNE ROCK** – It is likely that patches of hardpan calcrete will be encountered within bulk excavations. The calcrete is likely to be quite variable and may occur as hard calcrete gravel and cobbles or slabs which it is expected can be relatively easily excavated using bulldozers. It is expected that much of the calcrete can be broken down using mechanical plant but some of the larger boulders may need to be mechanically broken down into smaller pieces and then put through a crusher. If this is found to be the case, good quality construction materials can probably be produced (e.g. subbase quality material for road construction).

Excavation and crushing of dune rock can be similarly undertaken to produce better quality construction material for roads. However, it should be further investigated whether the two main dune rock ridges should be retained as public open spaces, as excavation, removal and crushing of the rock will be challenging.

6.3 Slope stability and erosion

The high longitudinal sand dunes that cross the site have very steep side slopes and they are marginally stable where vegetated. Removal of the vegetation results in wind erosion of the sand and the creation of unstable (undercut) slopes. Bulk earthworks at the site will substantially flatten these slopes and overall slope stability will not be a concern. Measures must however be taken to prevent sand erosion due to wind once the platforms have been created.

Excavations for service trenches will be very unstable due to the absence of cohesion in the sand, and all trenches must be battered back to a safe angle or shored.

6.4 Excavation classification

The majority of the bulk excavation work at the site will classify as “SOFT” excavation (according to SANS 1200D) to at least the depths achieved within the test pits and DPL penetrometer tests. In a few of the test pits, the TLB excavator refused on hardpan calcrete but it is likely that a 30-ton track excavator will be able to remove the calcrete layers and boulders (“INTERMEDIATE” excavation).

An unknown is the feasibility of removing the two main dune rock hills which are present at the locations indicated in Figures 3-1 and 3-2. A photograph of the two dune rock ridges is shown in Photo's 6 and 7.

Photo 7: Northern and southern dune rock hills



It is considered possible to remove the two main dune rock ridges using heavy earth moving equipment (bulldozers) and pneumatic breakers to break down large blocks. An important risk factor to consider is that blasting may be required if the rock mass is found to be massive.

6.5 Impact of the geotechnical character on site development

The undulating sand dune topography of the site and the occurrence of prominent high linear sand dunes and valleys between the dunes has a significant impact on the requirements for development of the site for residential purposes. The site will require an extensive bulk earthworks operation to be undertaken in order to provide an evenly graded site. The aeolian sand and moderately calcretised sand at the site is considered suitable for use as construction material for the required building platforms. A possible constraint and unknown is the feasibility of removing the two main dune rock hills which it appears have been earmarked as development areas. Removal of the dune rock hills, if this is planned, is a risk in terms of excavatability and potential cost implications. This may affect the planned layout of the township.

6.6 Foundation recommendations

The site in its current form cannot be developed into a formal residential township due to the uneven topography of the site.

Establishment of a residential township will require extensive bulk earthworks to be conducted at the site. It is envisaged that a balanced cut to fill township design is possible as the materials at the site are generally considered suitable as construction materials.

A risk factor is the occurrence of possible localised calcrete zones and the presence of the two main dune rock hills (in terms of excavatability). The depth of excavation required at a particular location will have a bearing on the ease of excavation and possible requirement to crush some of the calcrete.

It is envisaged that the following construction procedure will be required for the construction of the earth works platforms:

- All vegetation needs to be removed from the site. It is not envisaged that any soil will have to be removed to spoil (no topsoil present) but need to rake out roots.
- It will be very important to undertake in situ compaction of all areas (depressions) that will be filled as the upper approximately 1 m of the profile tends to be of loose consistency. The sand can be effectively compacted in situ using a heavy vibratory roller (but will require the soils to be well watered).
- Compaction of sand (from the higher lying areas) within the lower lying parts of the site must be undertaken in layers and compacted to 100% Mod AASHTO density in about 250 mm layers (depending on the plant used). Testing of compaction levels must be carried out according to normal civil engineering practices.
- Provided that the bulk earthworks have been carried out according to specification, it will be possible to construct housing units using conventional strip foundations or concrete rafts at shallow depth below surface. Foundations can be designed based on an allowable ground bearing capacity of at least 100 kPa. An additional phase of foundation checking using extensive DPL penetrometer testing will be required prior to foundation approvals.

7 Residential Site Class Designation

In terms of the National Department of Housing's Generic Specification GFSH-2, dated September 2002, titled "Geotechnical Site Investigations for Housing Developments", housing development sites are classified according to the Residential Site Class Designation, shown in Figure 7-1, which is based on the soil profile type present at the site.

Based on the current profiles encountered at the site, the near-surface Aeolian sand classifies as "*Compressible and Potentially Collapsible Soils*" due to the *loose* consistency of the sand. The Residential Site Class Designation for the Enkanini South site is therefore assessed to be "**C2**", that is, the range of settlement is expected to be greater than 20 mm. The isolated dune rock ridges identified at the site classify as "**R**".

Table 7-1: Residential Site Class Designation (after Watermeyer and Tromp (1992) and the Joint Structural Division)

TYPICAL FOUNDING MATERIAL	CHARACTER OF FOUNDING MATERIAL	EXPECTED RANGE OF TOTAL SOIL MOVEMENT (mm)	ASSUMED DIFFERENTIAL MOVEMENT (%OF TOTAL)	SITE CLASS
Rock (excluding mud rocks which may exhibit swelling to some depth)	STABLE	NEGLIGIBLE	-	R
Fine grained soils with moderate to very high plasticity (clay, 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 gravely soils	COMPRESSIBLE AND POTENTIALLY COLLAPSIBLE SOILS	<5 5 – 10 >10	75% 75% 75%	C C1 C2
Fine grained soils (clayey silts and clayey sands of low plasticity), sands, sandy and gravely soils	COMPRESSIBLE SOILS	<10 10 – 20 >20	50% 50% 50%	S S1 S2
Contaminated soils, controlled fill, dolomitic areas, landslip, landfill, marshy areas, marine waste fill, mining subsidence, reclaimed areas, uncontrolled fill, very soft silts / silty clays	VARIABLE	VARIABLE		P

Prepared by

SRK Consulting - Certified Electronic Signature
 **srk consulting**
571322 Enkanini S. Geotech/44370/Report
8184-7784-1230-BROW-25/06/2021
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John Brown Pr Sci Nat

Principal Engineering Geologist, Partner

Reviewed by

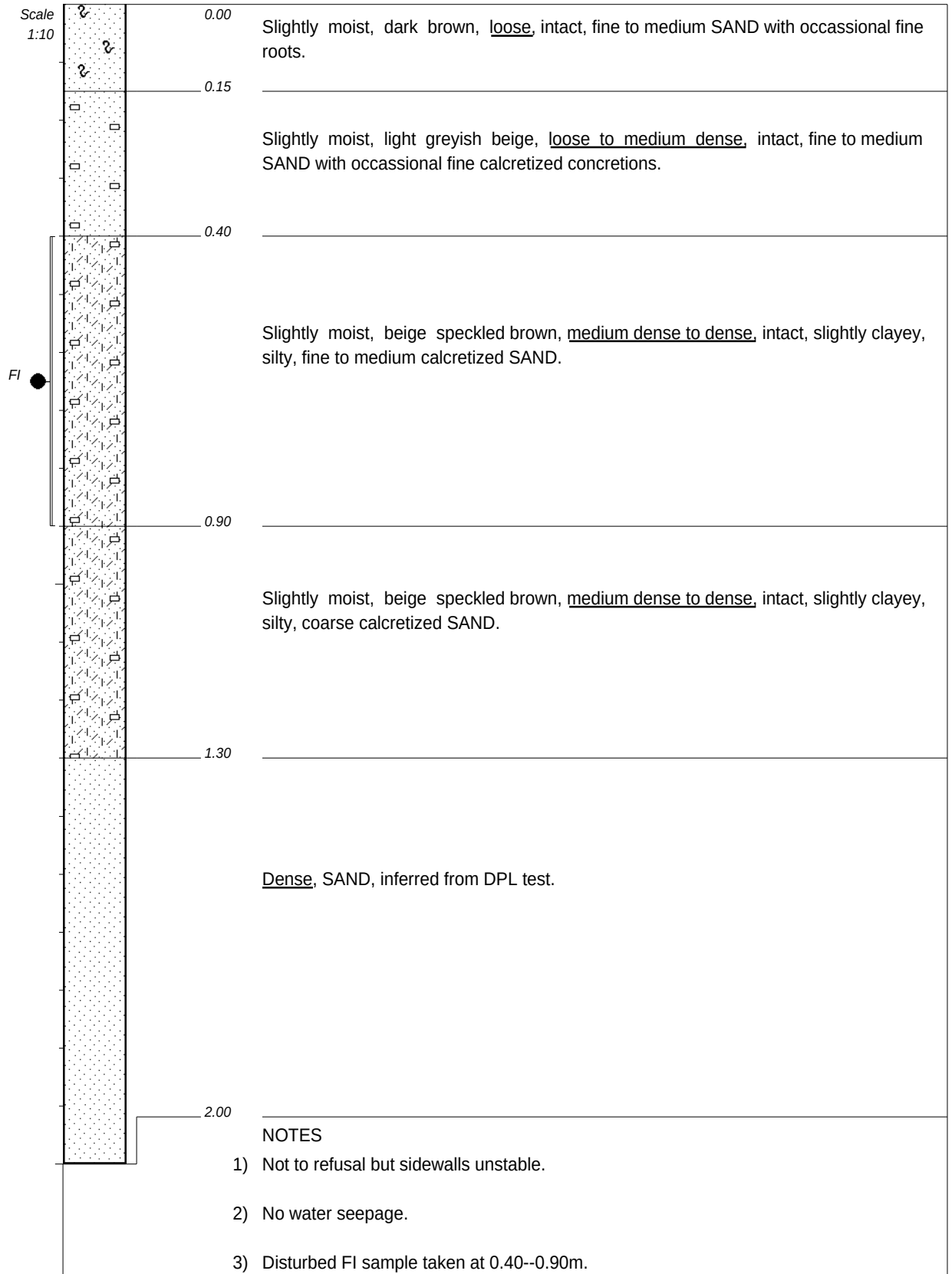
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Bruce Engelsman Pr Eng, PR CPM
Principal Engineer, Partner

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

Appendices

Appendix A: Soil Profiles

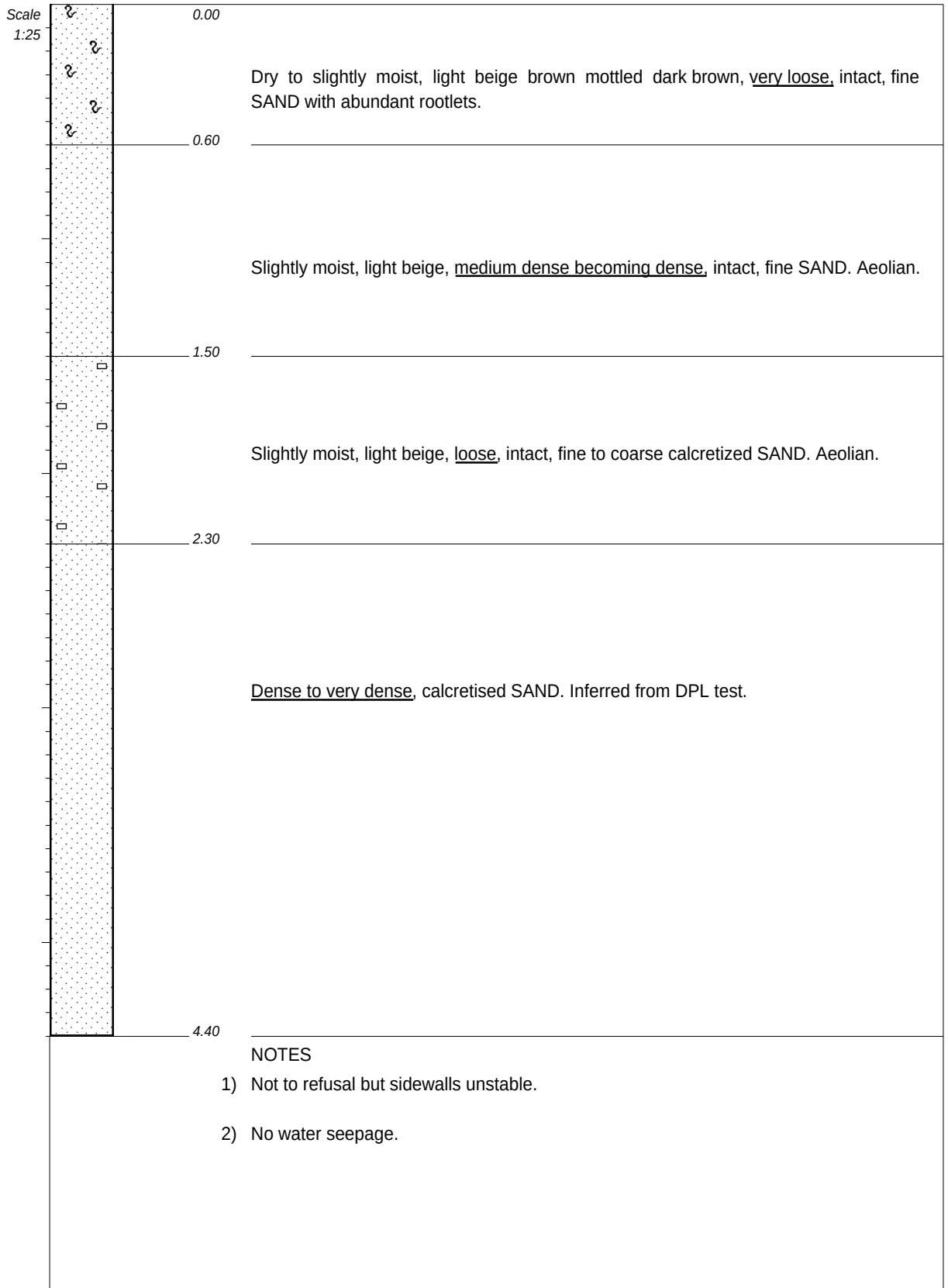


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Y-COORD : 0029884

HOLE No: TP1

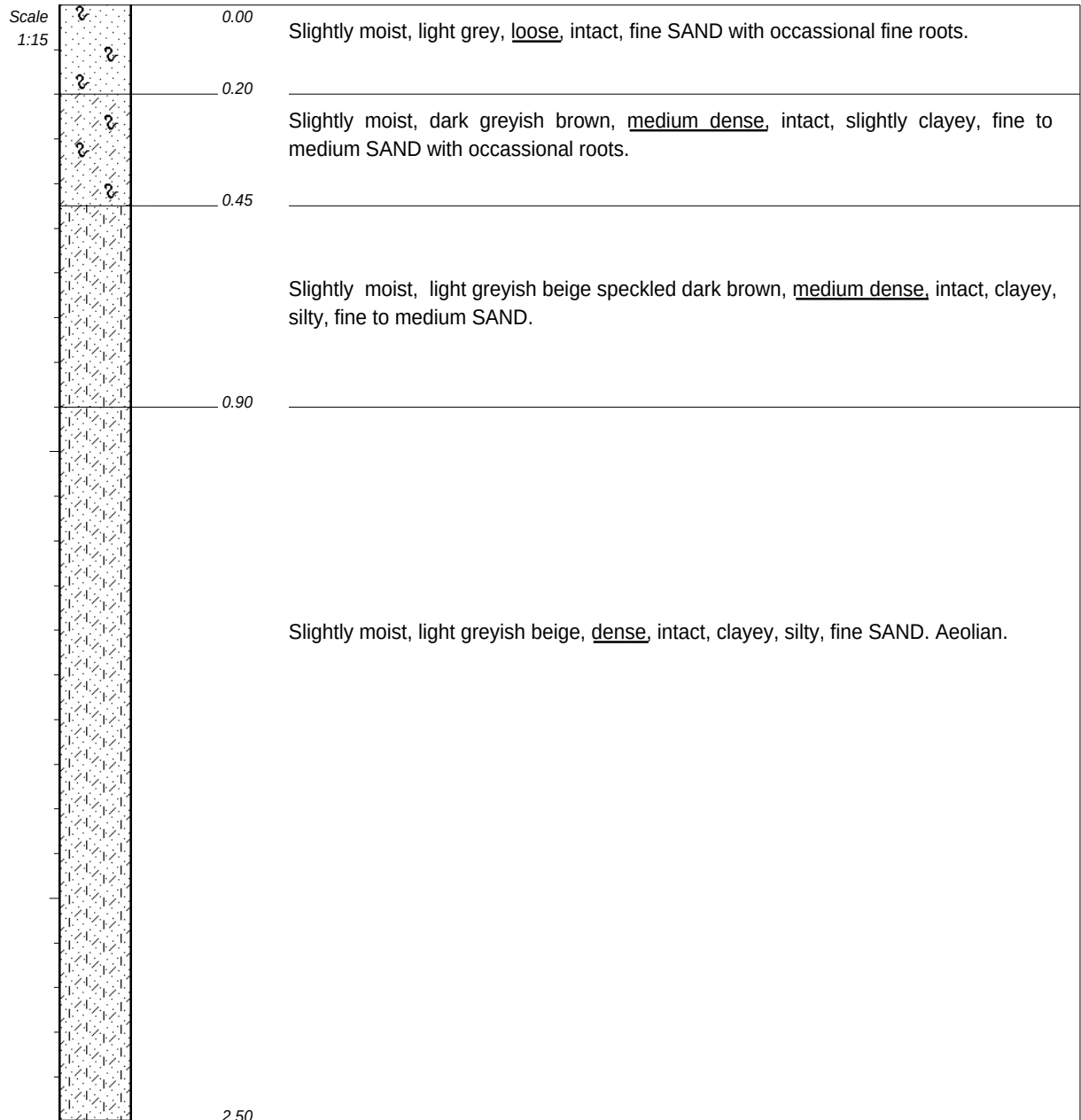


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ELEVATION : WGS 84
X-COORD : 3771479
Y-COORD : 0029792

HOLE No: TP2



NOTES

- 1) Not to refusal but sidewalls unstable.
- 2) No water seepage.

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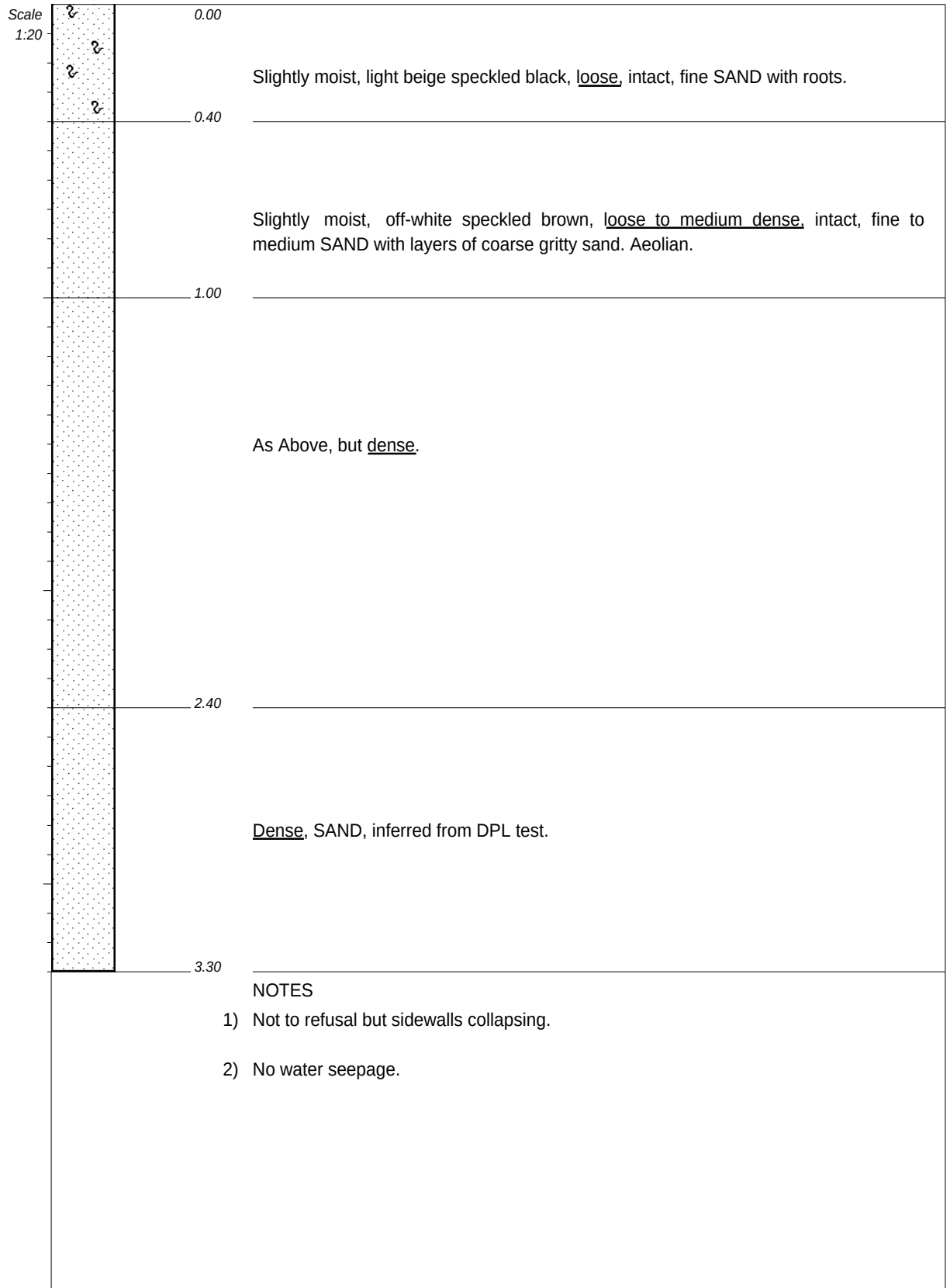
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X-COORD : 3771611
Y-COORD : 0029746

HOLE No: TP3



CONTRACTOR : Amanzi Plant Hire
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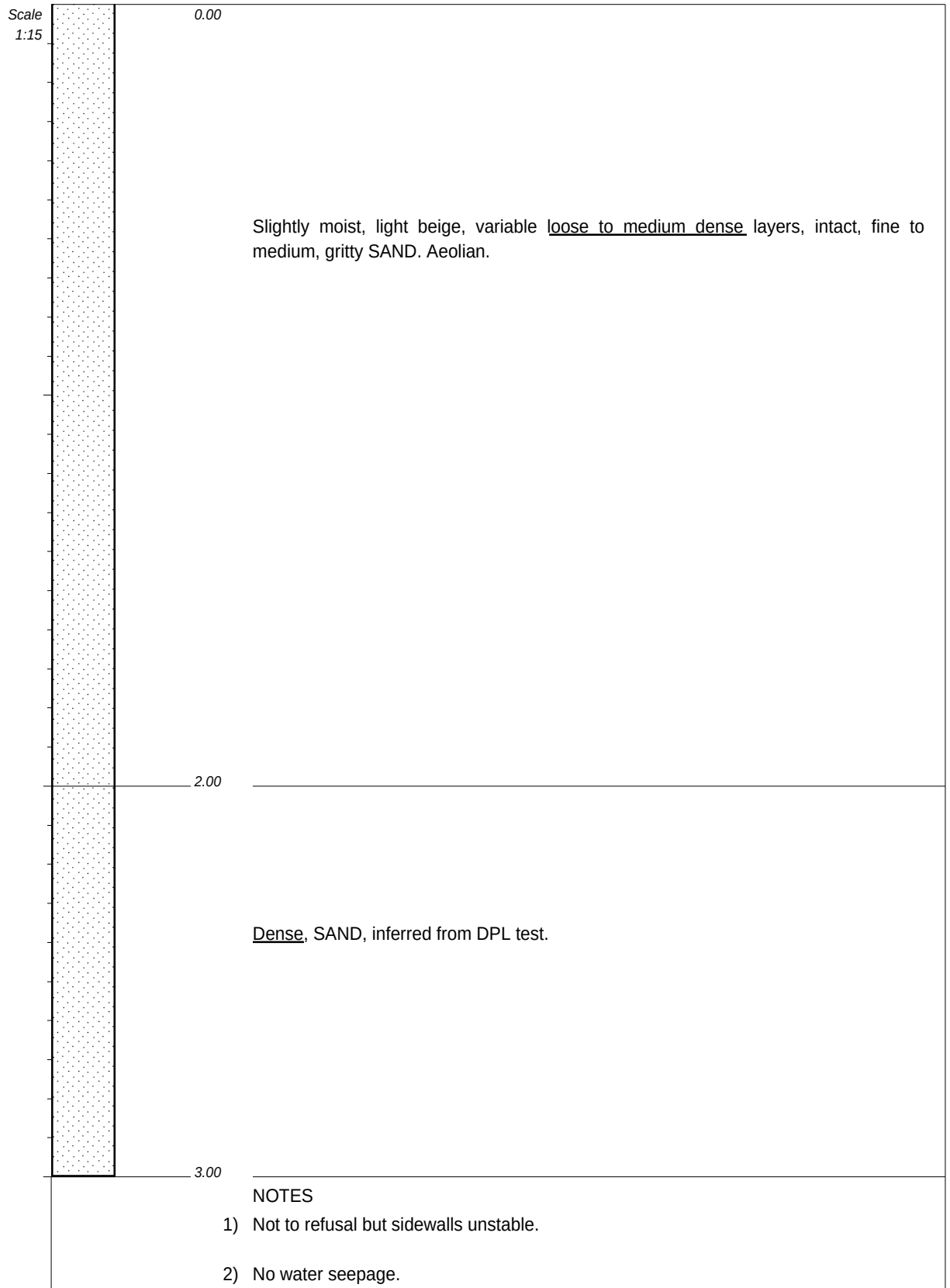
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ELEVATION : WGS 84
X-COORD : 3771481
Y-COORD : 0029654

HOLE No: TP4



CONTRACTOR : Amanzi Plant Hire
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DRILLED BY : Madiba
PROFILED BY : AN/JB
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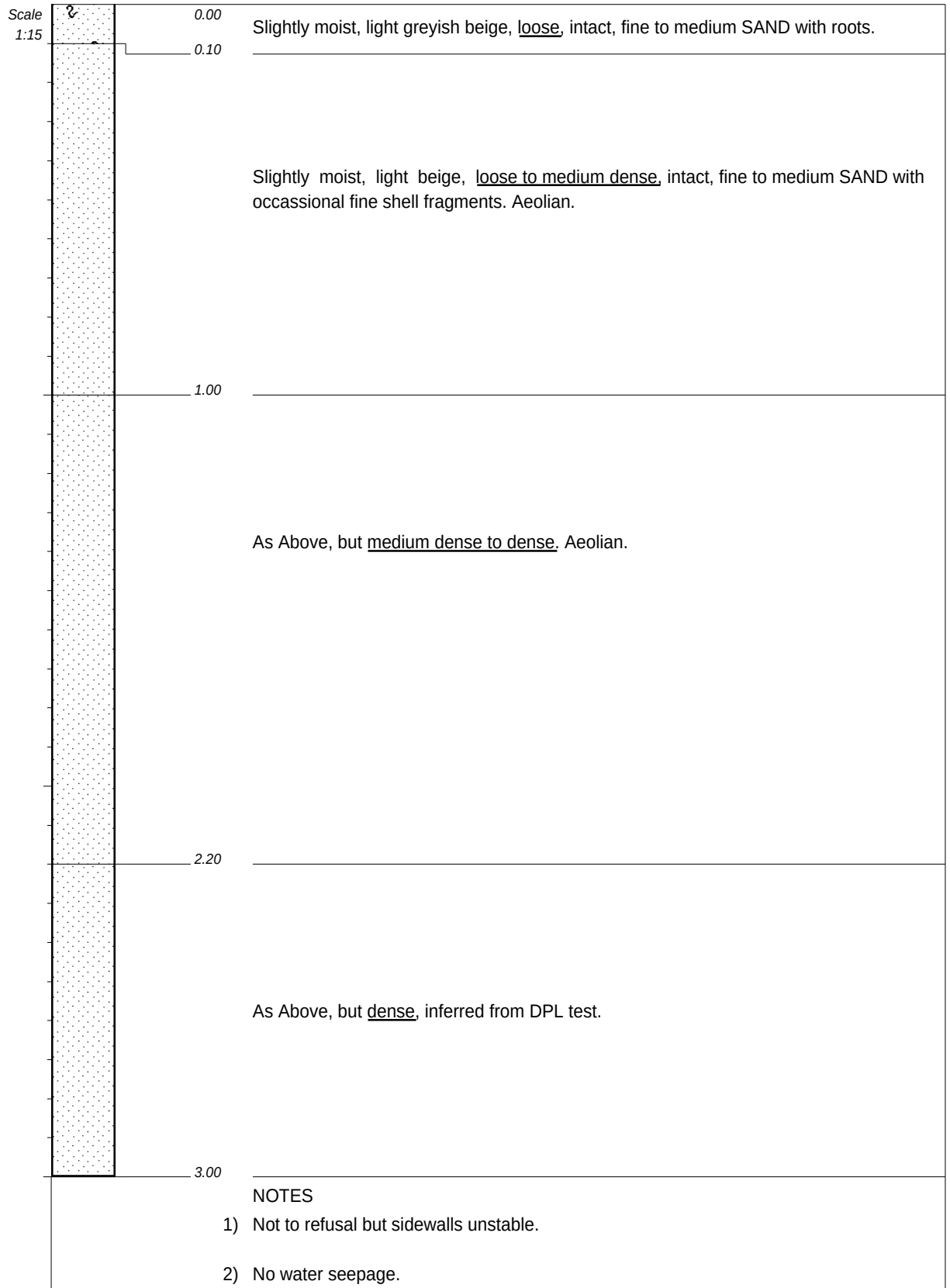
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X-COORD : 3771644
Y-COORD : 0029576

HOLE No: TP5



CONTRACTOR : Amanzi Plant Hire
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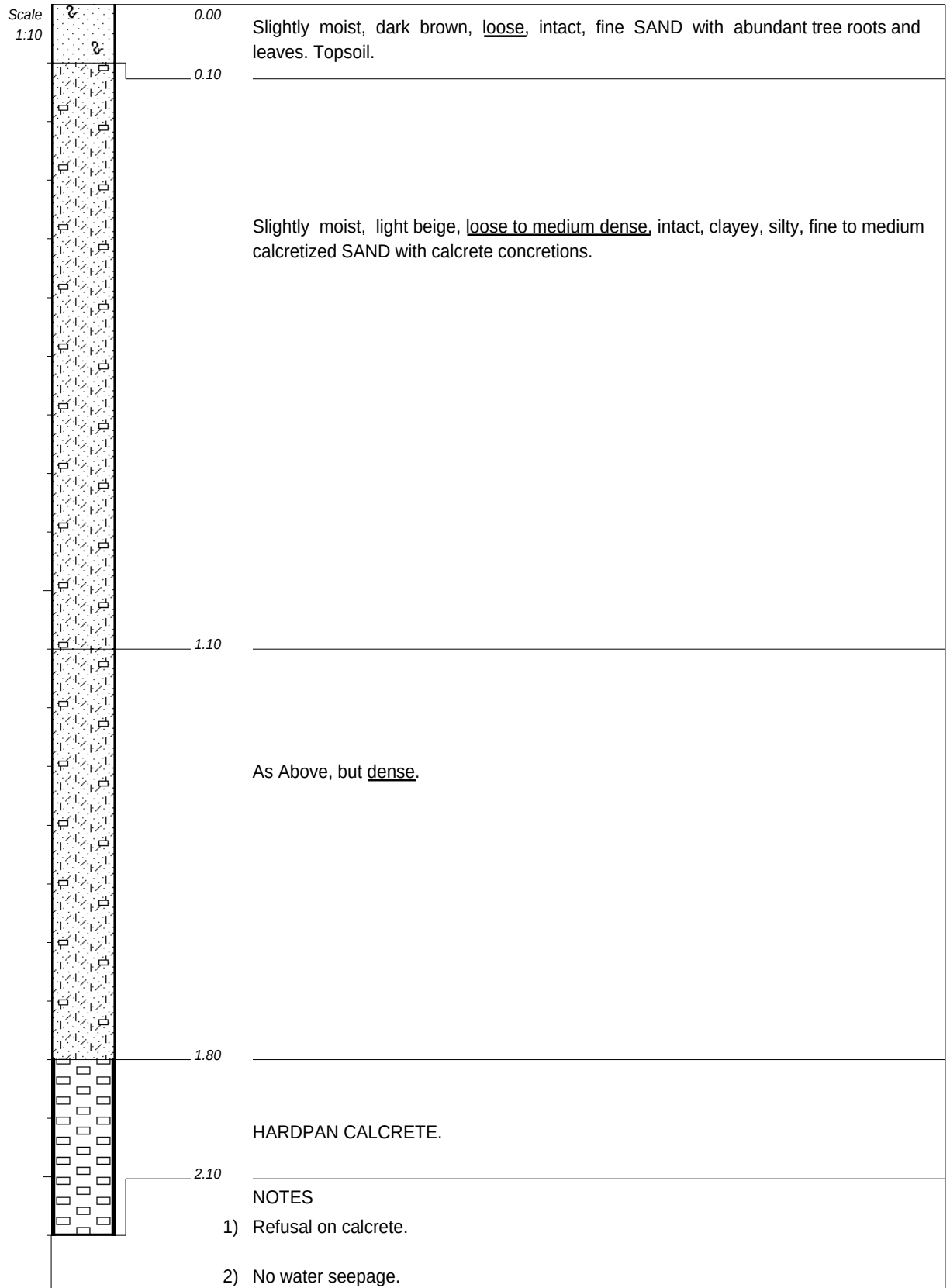
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Y-COORD : 0029373

HOLE No: TP6



CONTRACTOR : Amanzi Plant Hire
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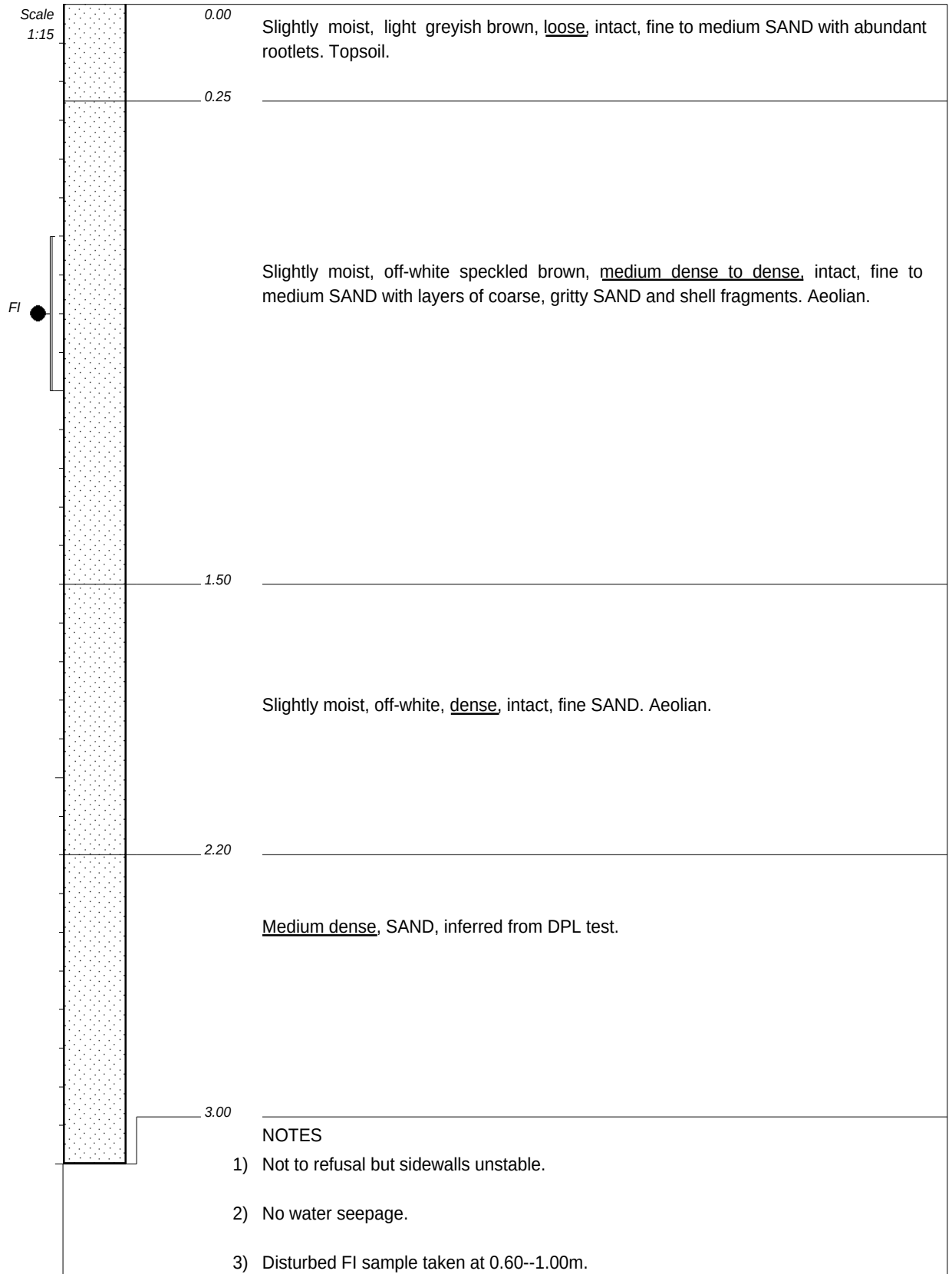
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Y-COORD : 0029482

HOLE No: TP7



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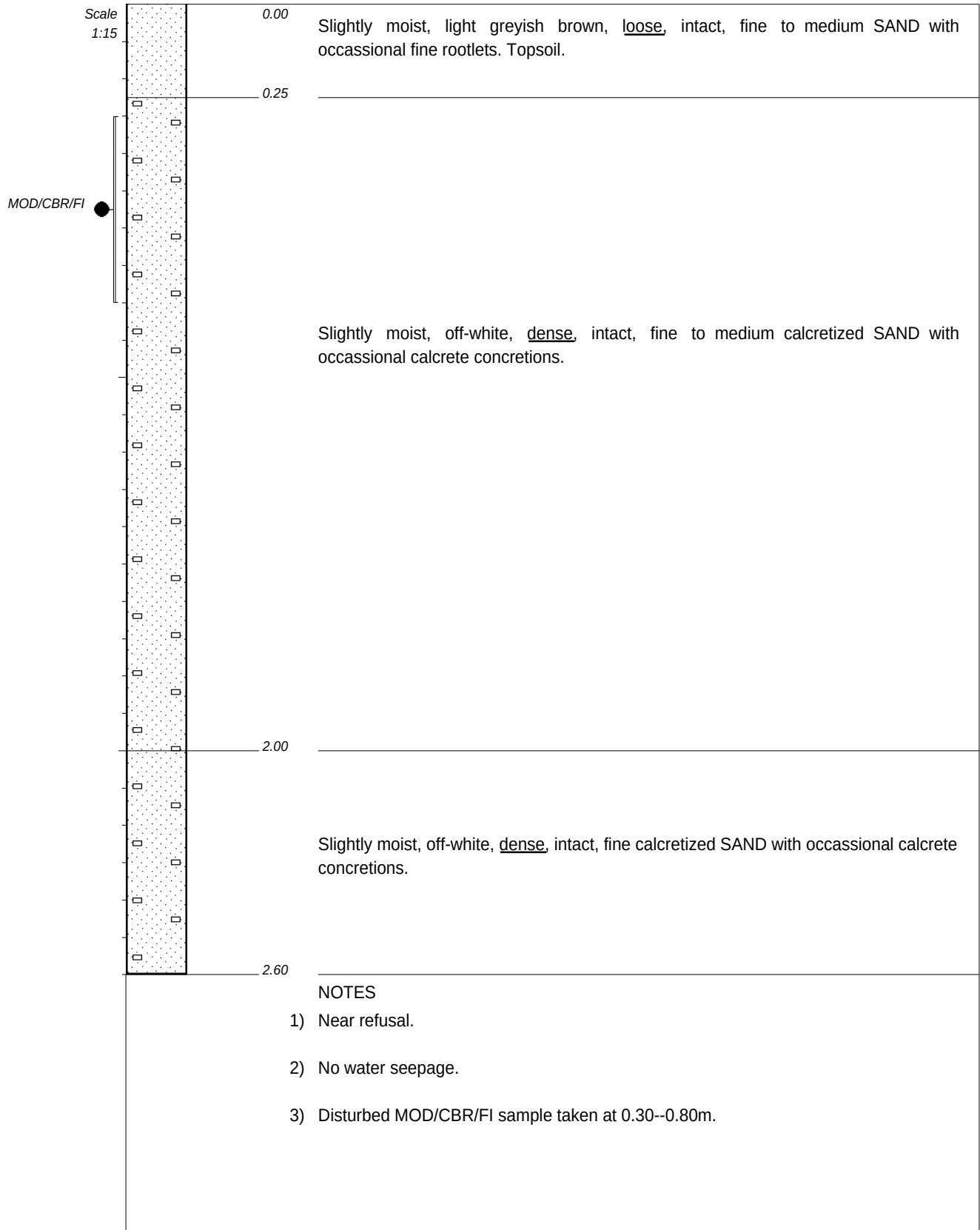
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ELEVATION : WGS 84
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Y-COORD : 0029490

HOLE No: TP8



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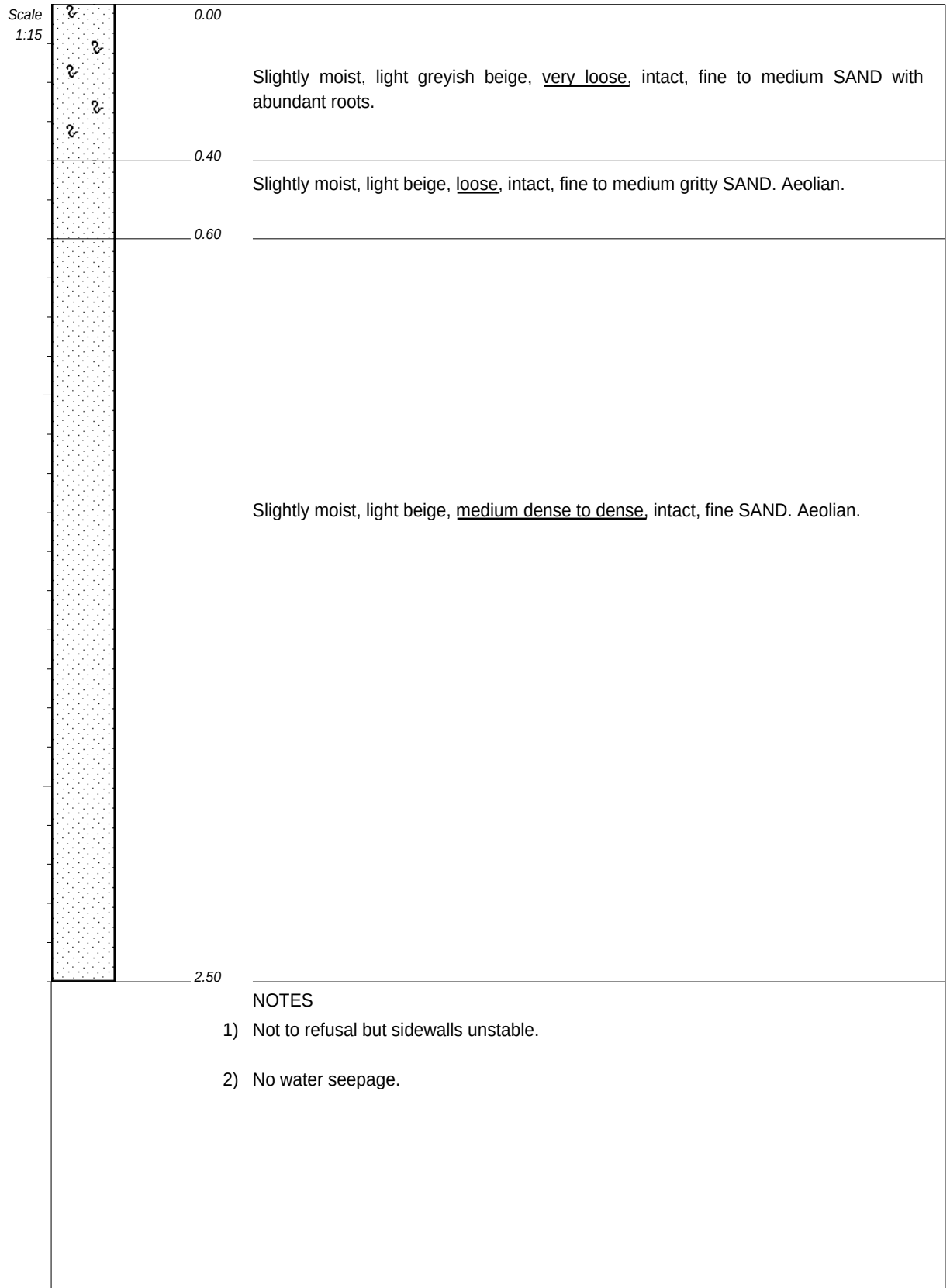
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HOLE No: TP9

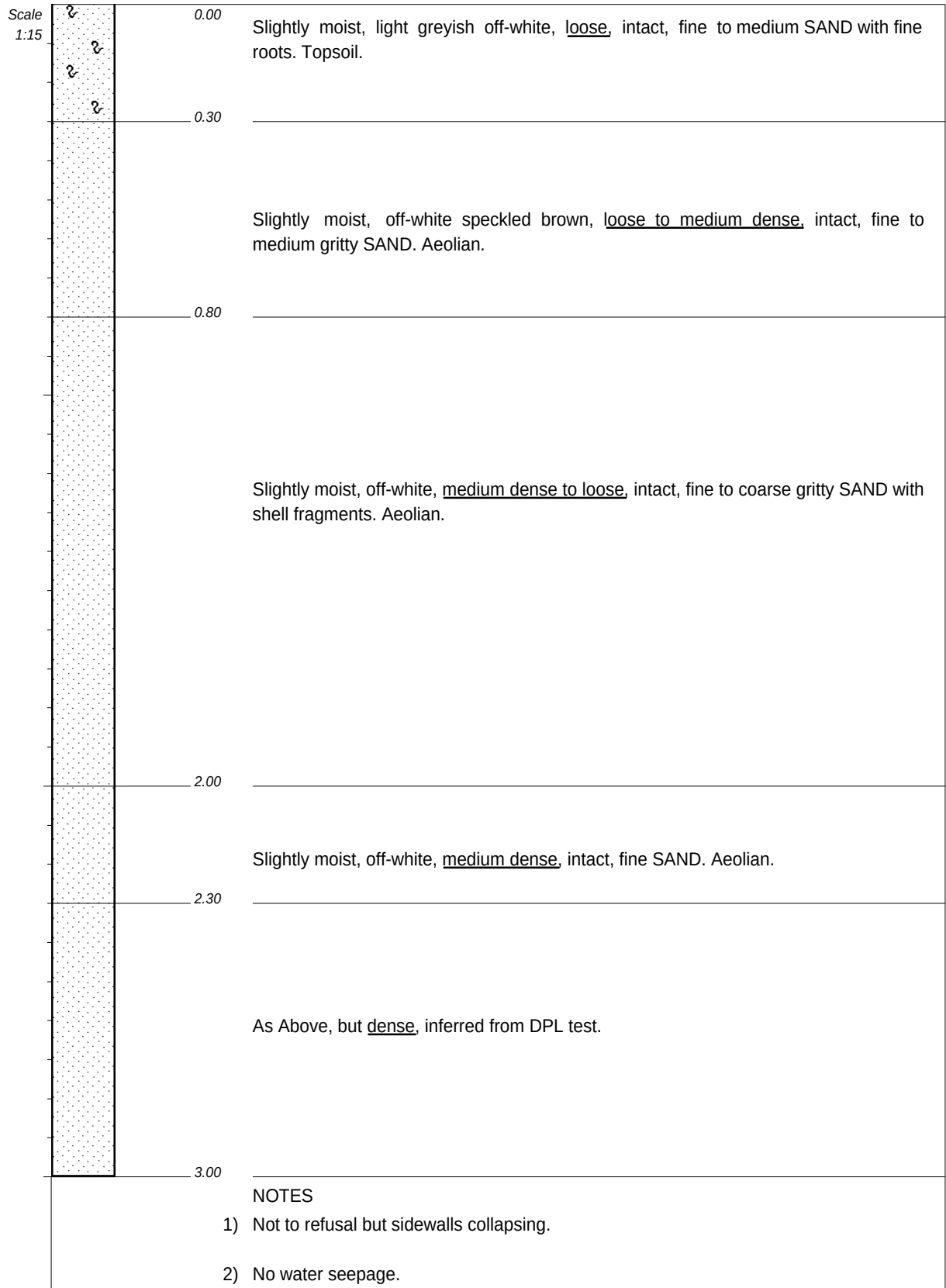


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ELEVATION : WGS 84
X-COORD : 3771299
Y-COORD : 0029459

HOLE No: TP10



CONTRACTOR : Amanzi Plant Hire
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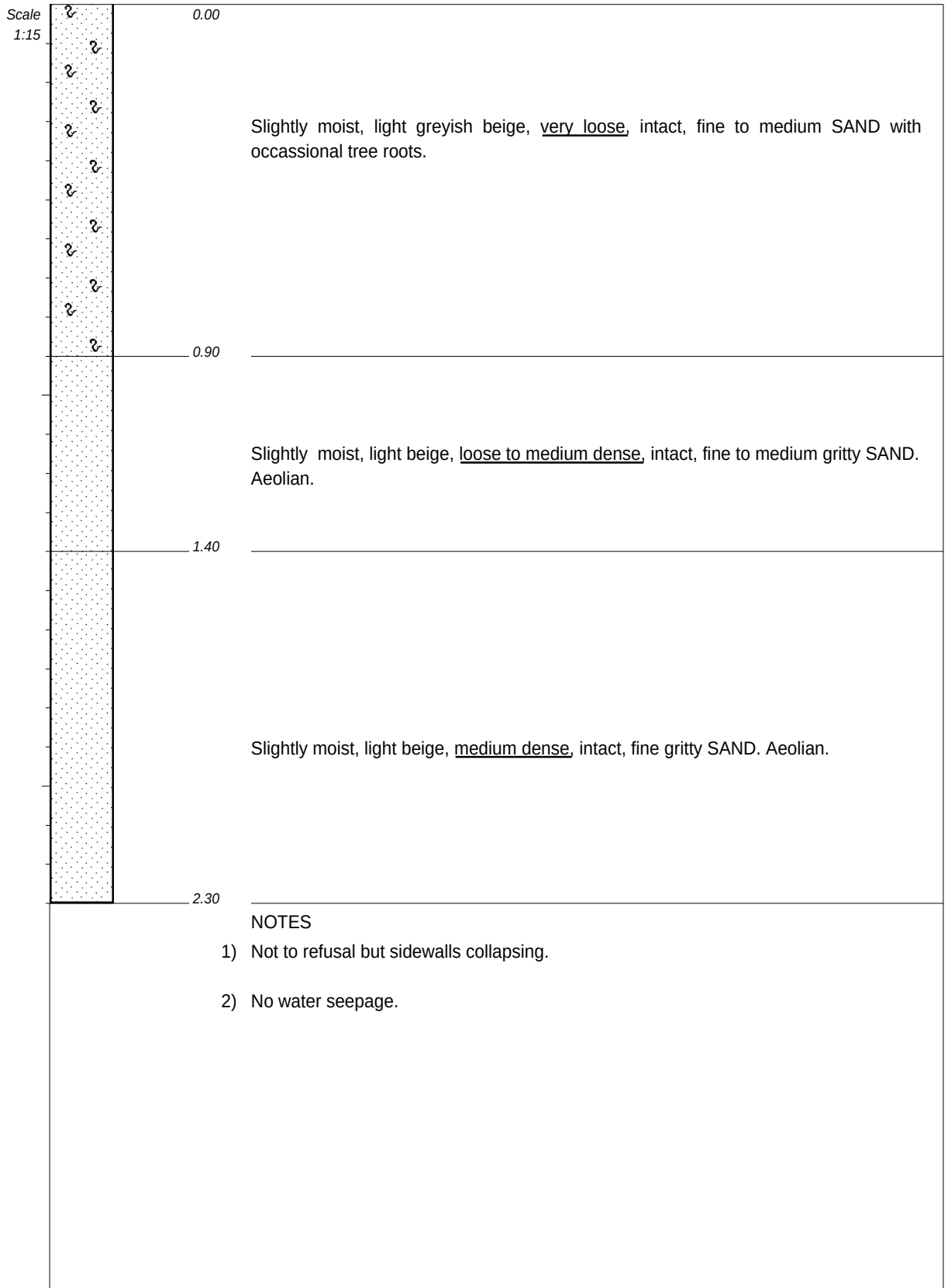
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X-COORD : 3771188
Y-COORD : 0029424

HOLE No: TP11



CONTRACTOR : Amanzi Plant Hire
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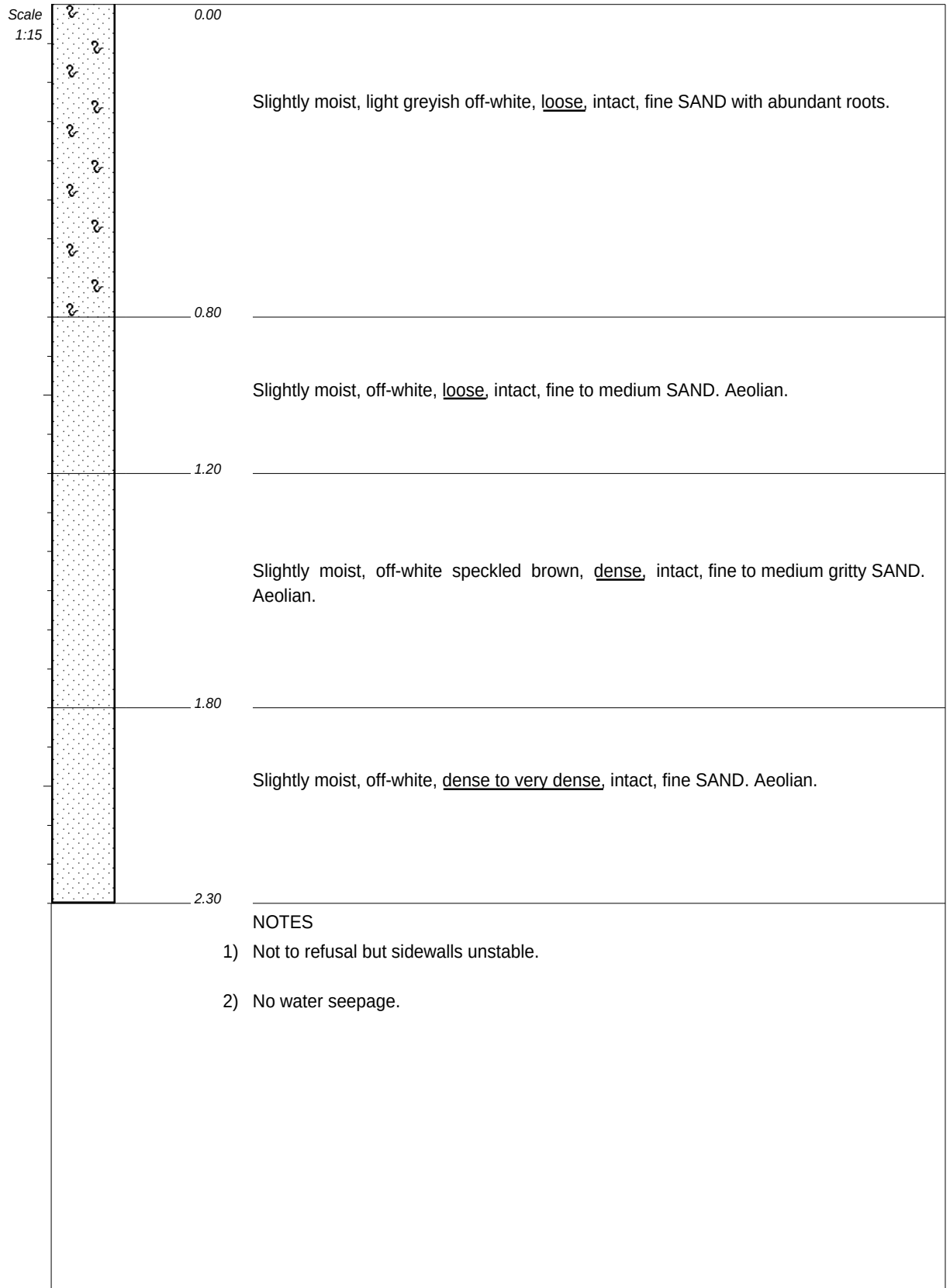
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ELEVATION : WGS 84
X-COORD : 3771083
Y-COORD : 0029417

HOLE No: TP12



CONTRACTOR : Amanzi Plant Hire
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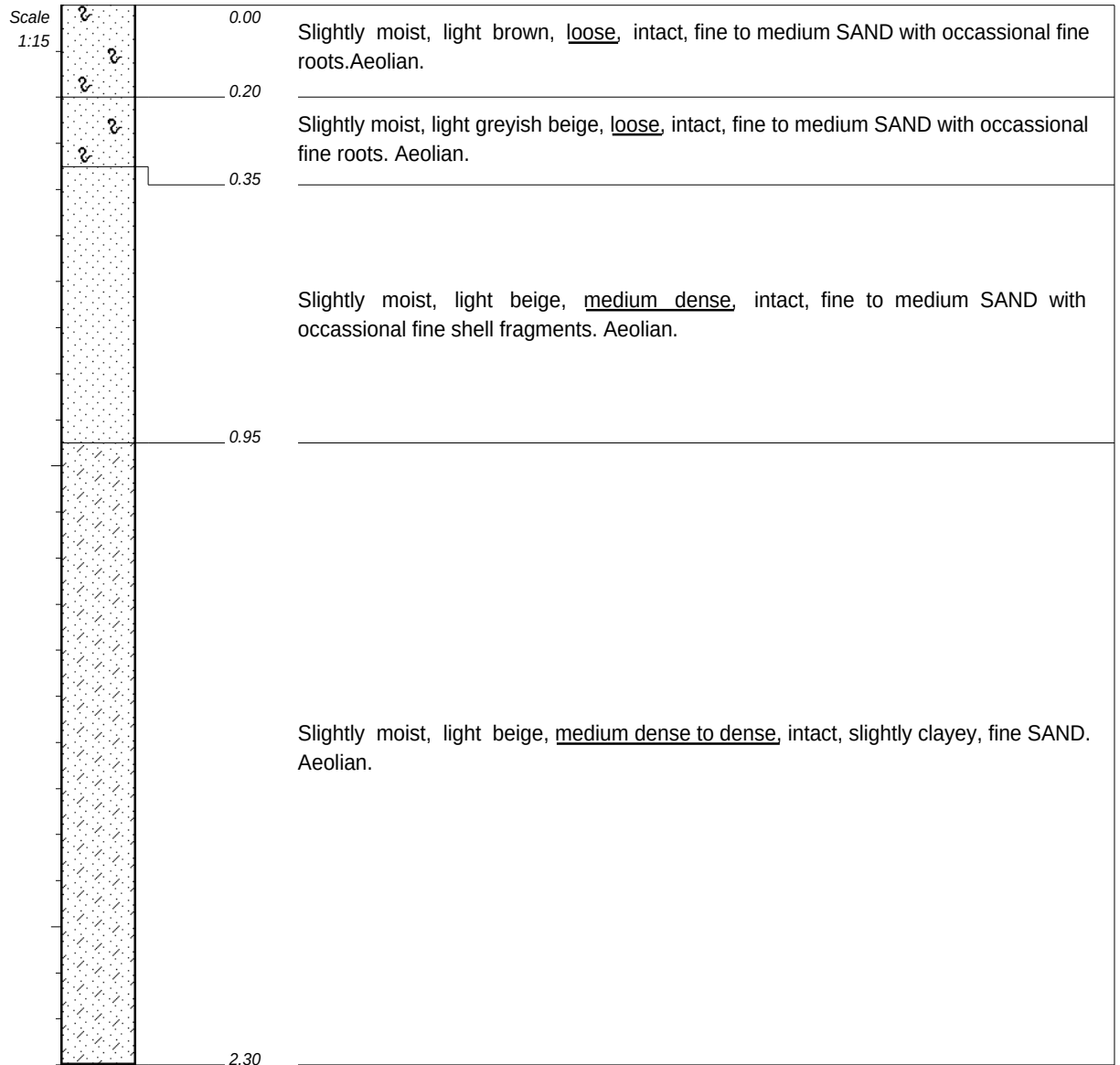
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ELEVATION : WGS 84
X-COORD : 3771298
Y-COORD : 0029301

HOLE No: TP16



NOTES

- 1) Not to refusal but sidewalls unstable.
- 2) No water seepage.

CONTRACTOR : Amanzi Plant Hire
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DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

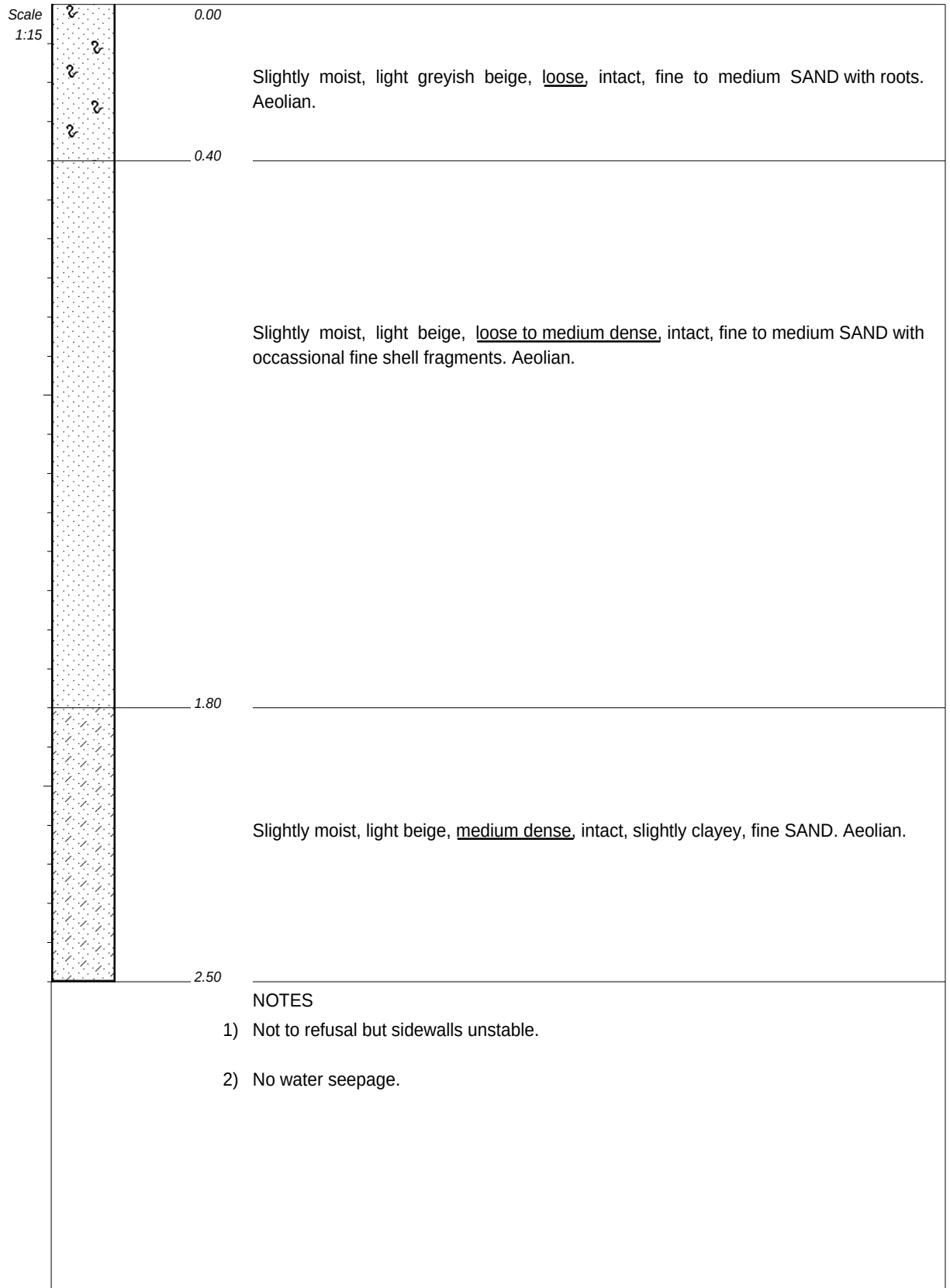
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ELEVATION : WGS 84
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Y-COORD : 0029318

HOLE No: TP17

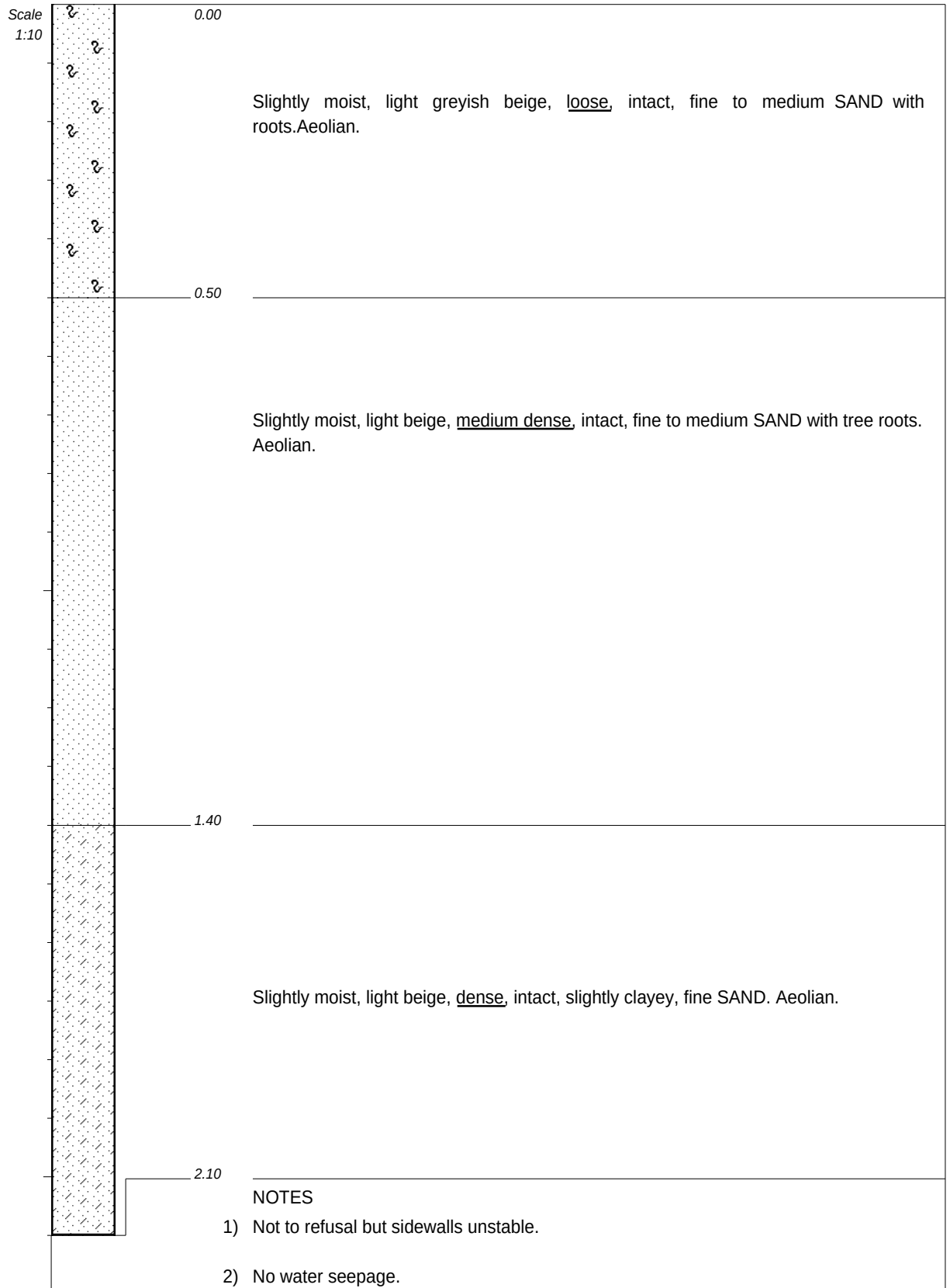


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PROFIED BY : AN/JB
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SETUP FILE : STANDARD.SET

INCLINATION : VERTICAL
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ELEVATION : WGS 84
X-COORD : 3771539
Y-COORD : 0029313

HOLE No: TP18



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

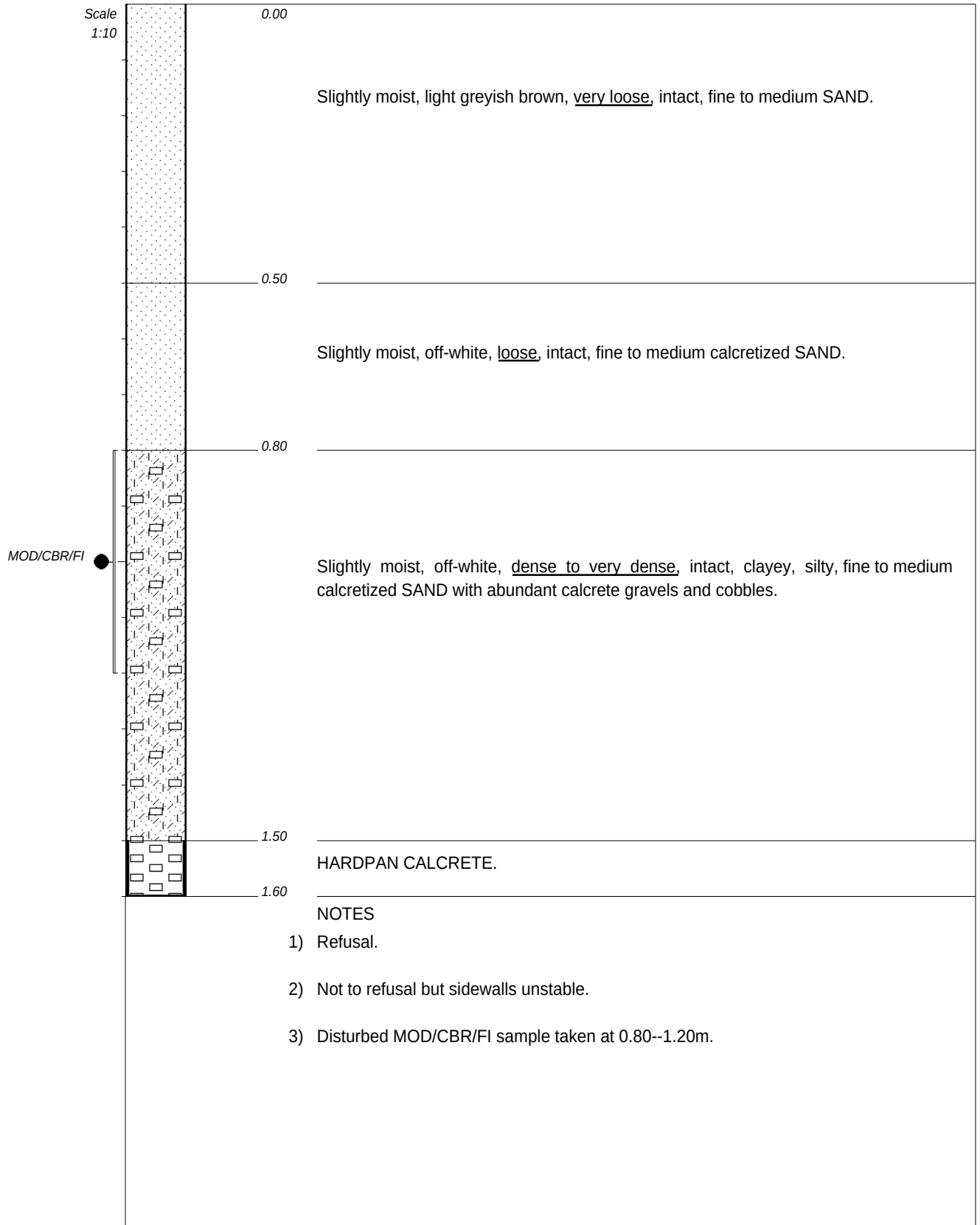
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771659
Y-COORD : 0029261

HOLE No: TP19



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

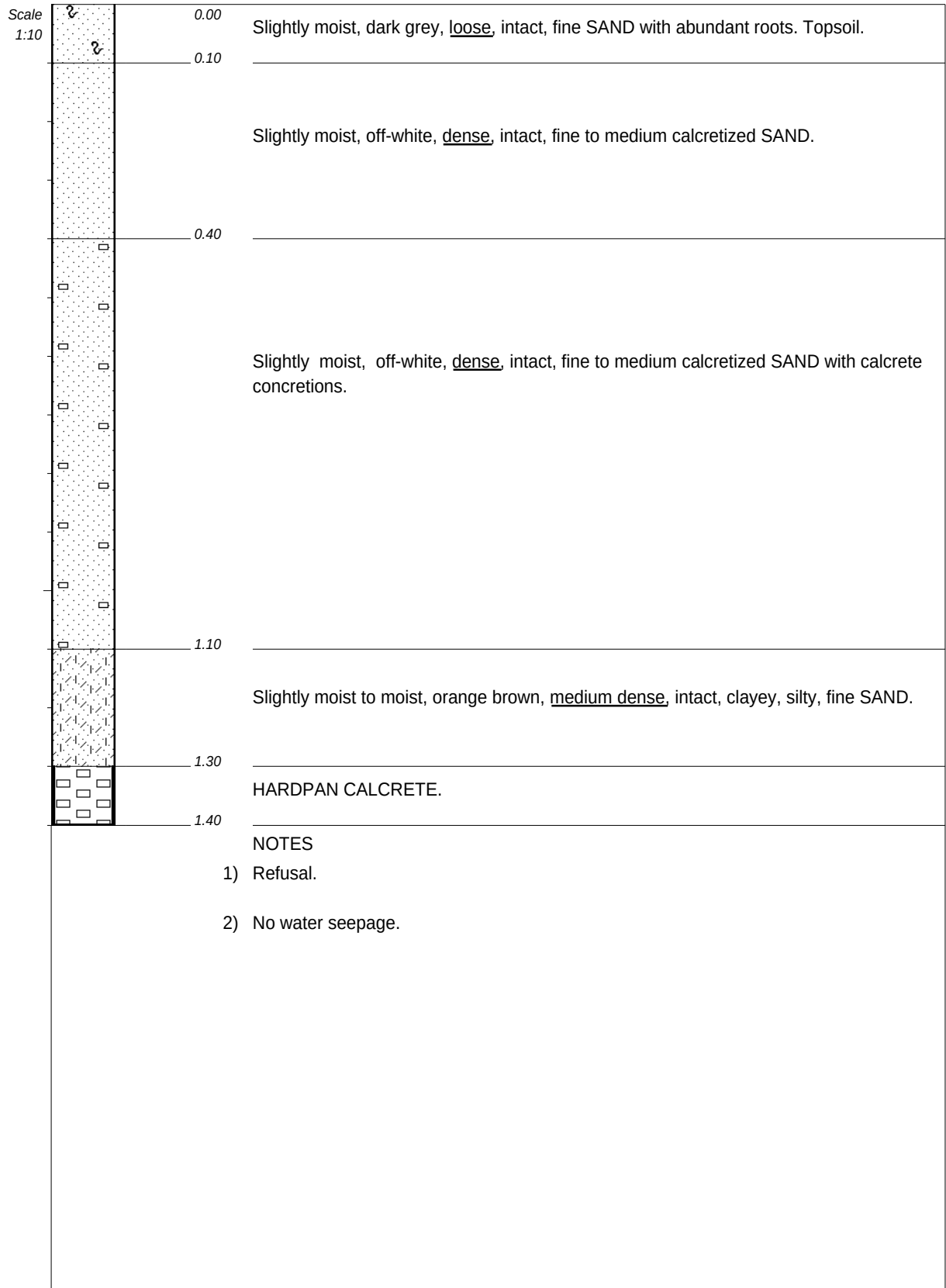
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771603
Y-COORD : 0029176

HOLE No: TP20



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

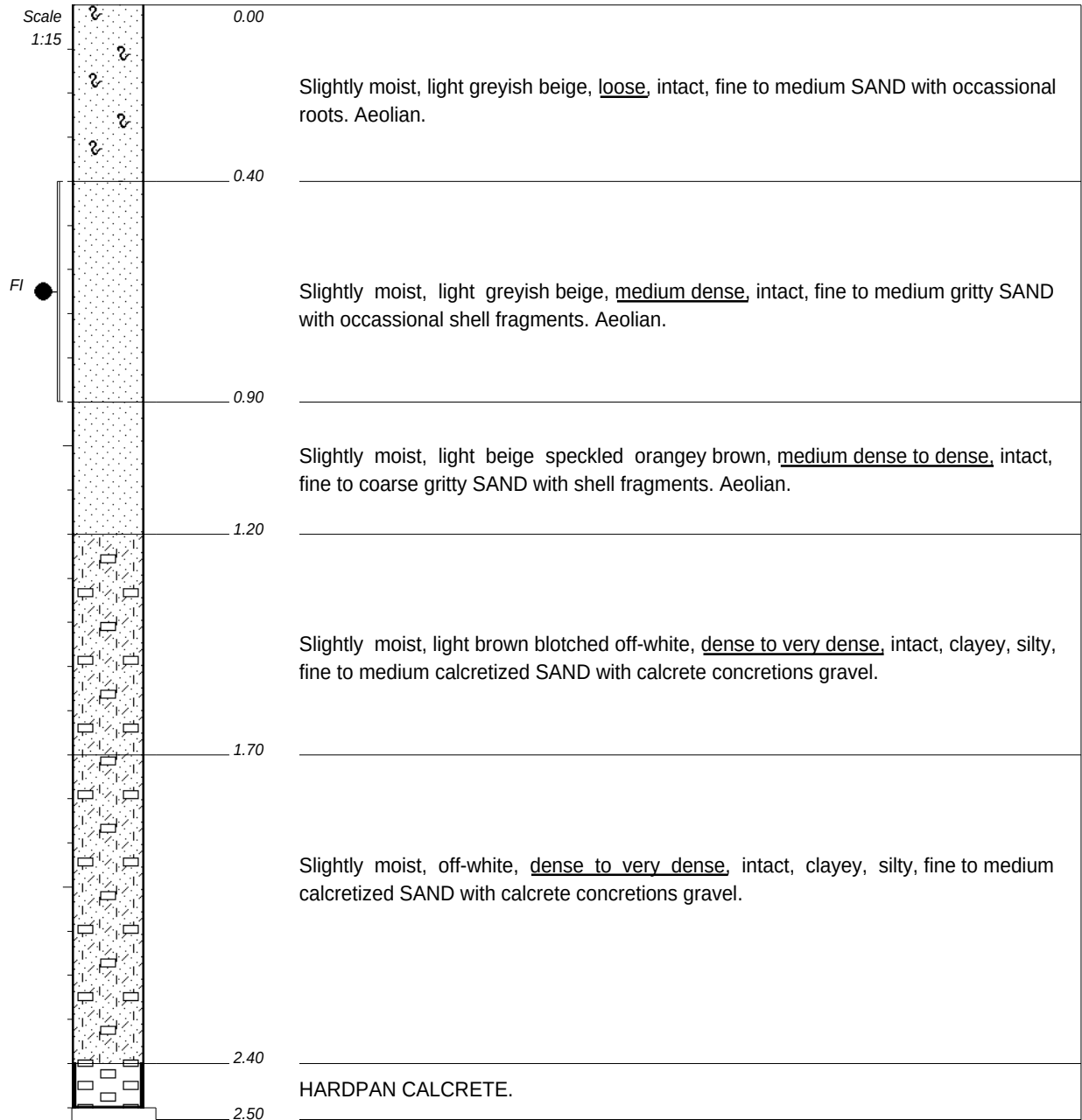
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771483
Y-COORD : 0029167

HOLE No: TP21



NOTES

- 1) Refusal.
- 2) No water seepage.
- 3) Disturbed FI sample taken at 0.40--0.90m.

CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

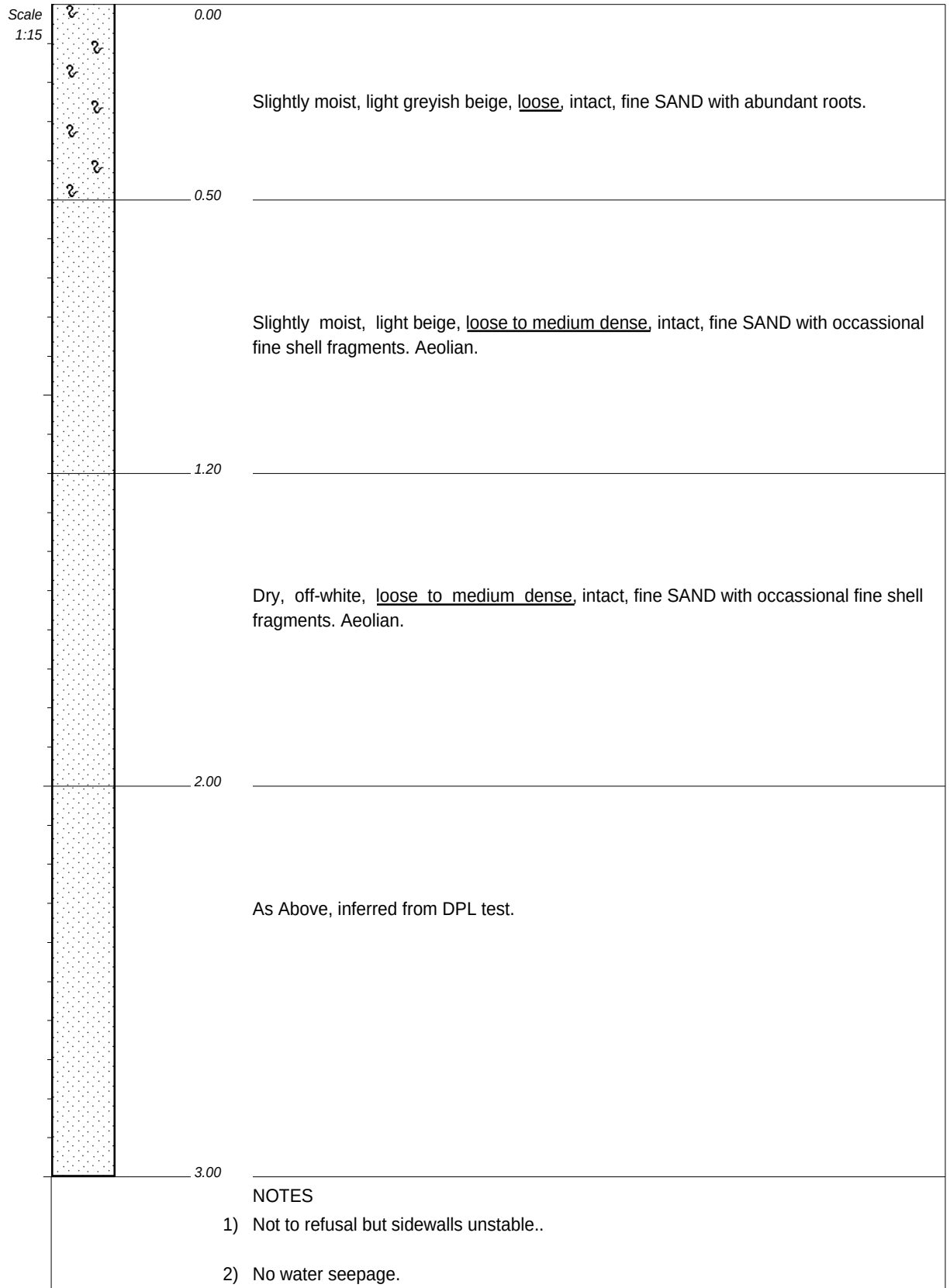
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771394
Y-COORD : 0029218

HOLE No: TP22



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFILED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

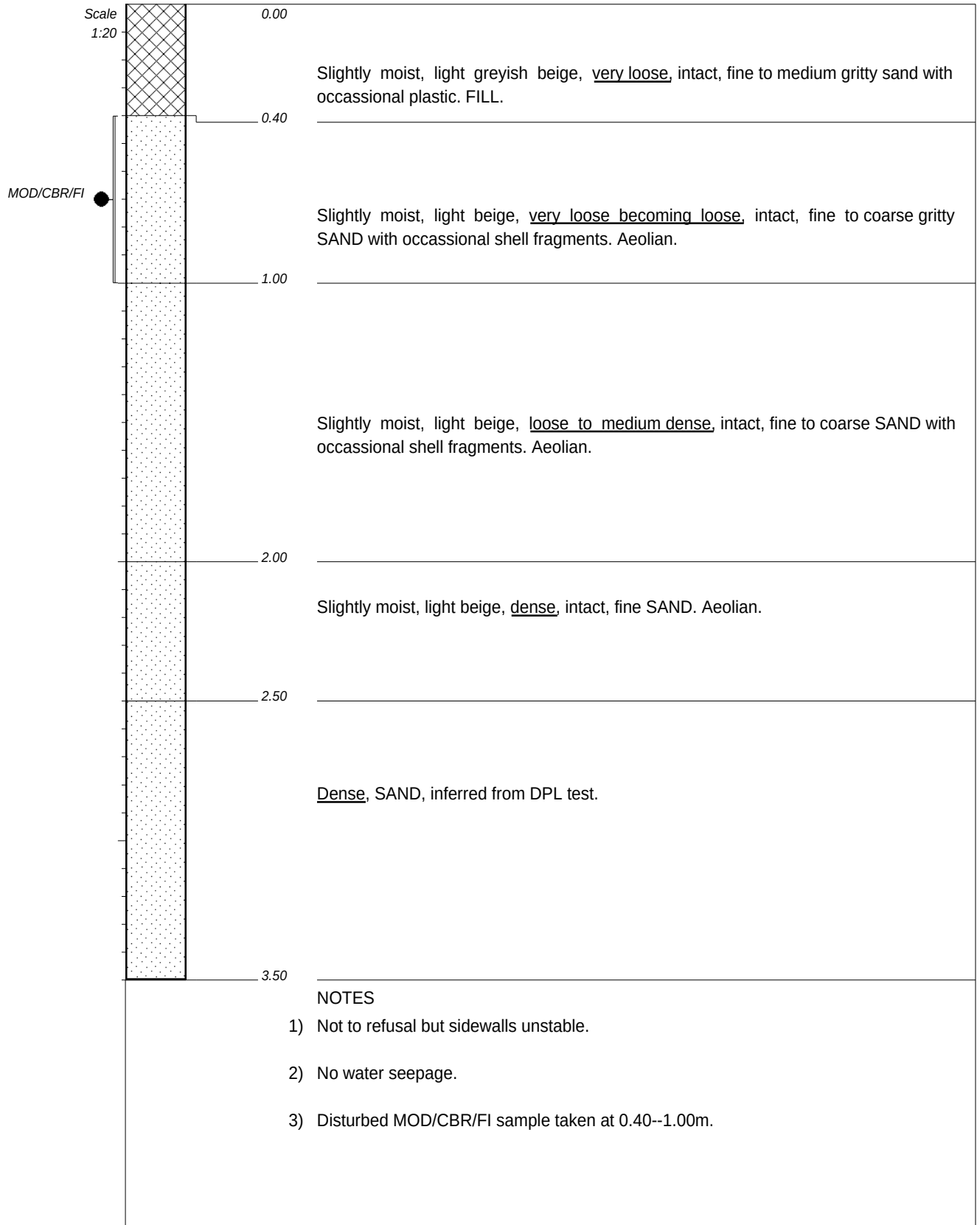
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771271
Y-COORD : 0029209

HOLE No: TP23

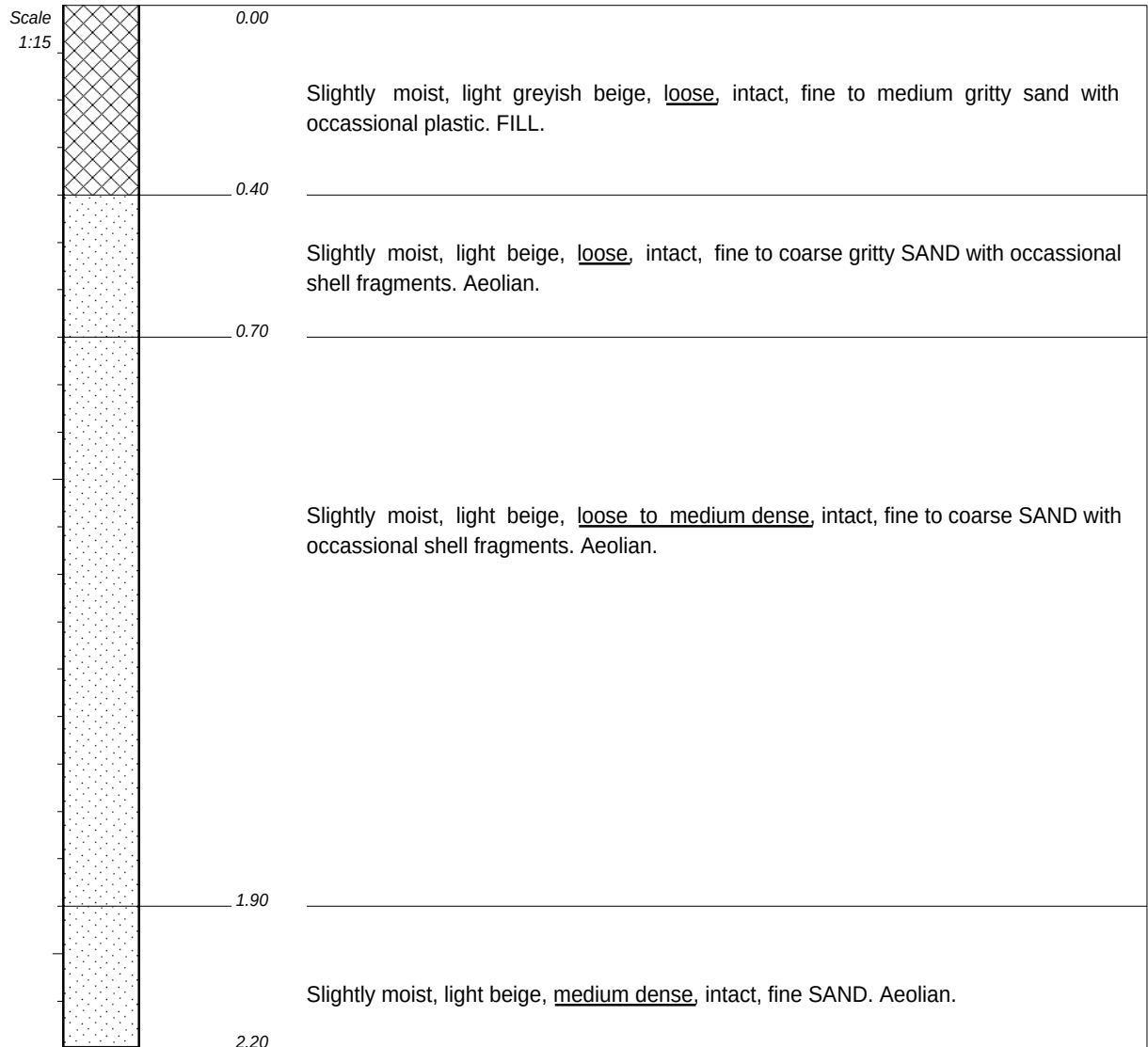


CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

INCLINATION : VERTICAL
DIAM :
DATE :
DATE : 17 May 2021
DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771153
Y-COORD : 0029045

HOLE No: TP25



NOTES

- 1) Not to refusal but sidewalls unstable.
- 2) No water seepage.

CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

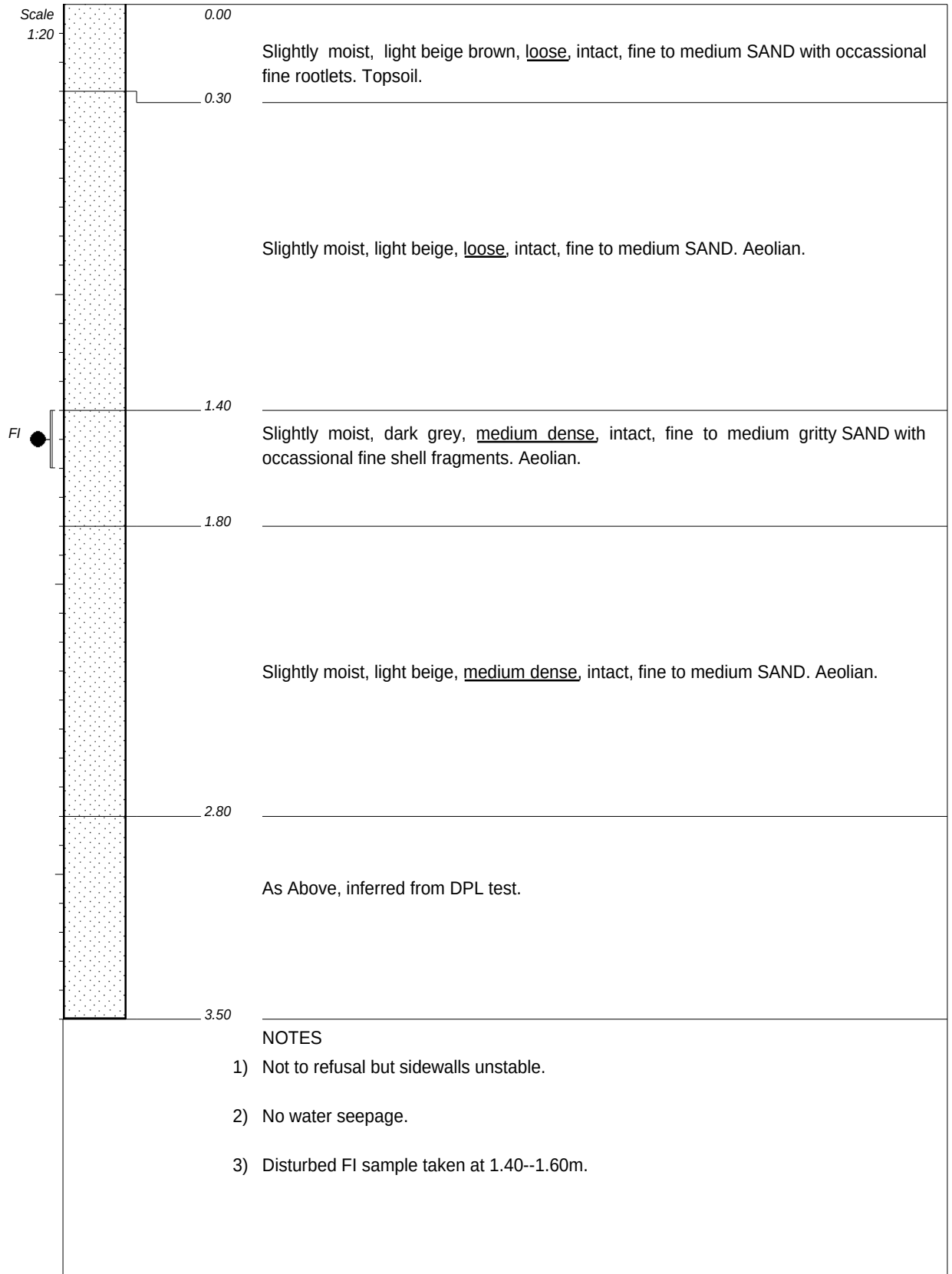
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771109
Y-COORD : 0028927

HOLE No: TP26

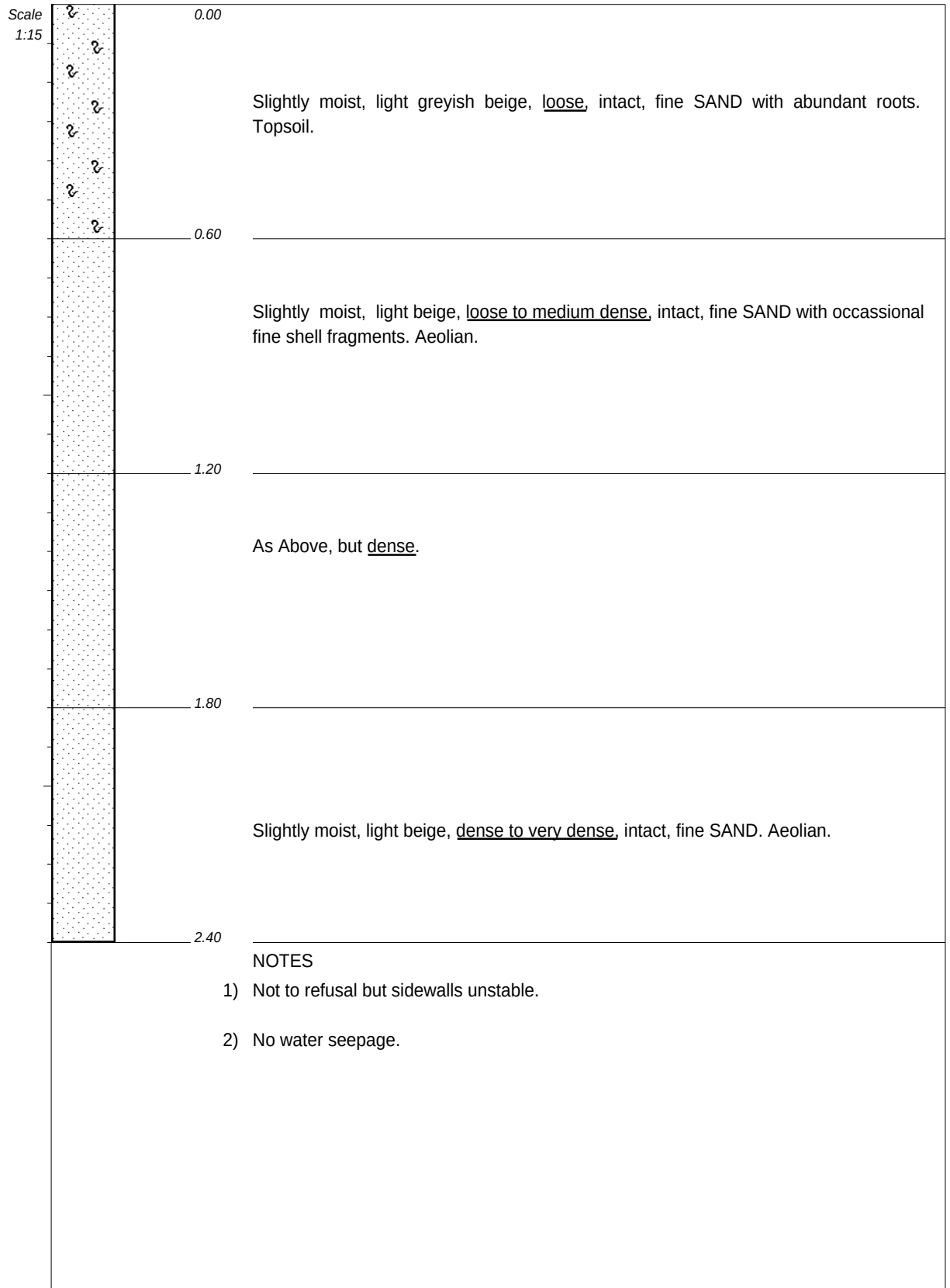


CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

INCLINATION : VERTICAL
DIAM :
DATE :
DATE : 17 May 2021
DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771260
Y-COORD : 0029054

HOLE No: TP27

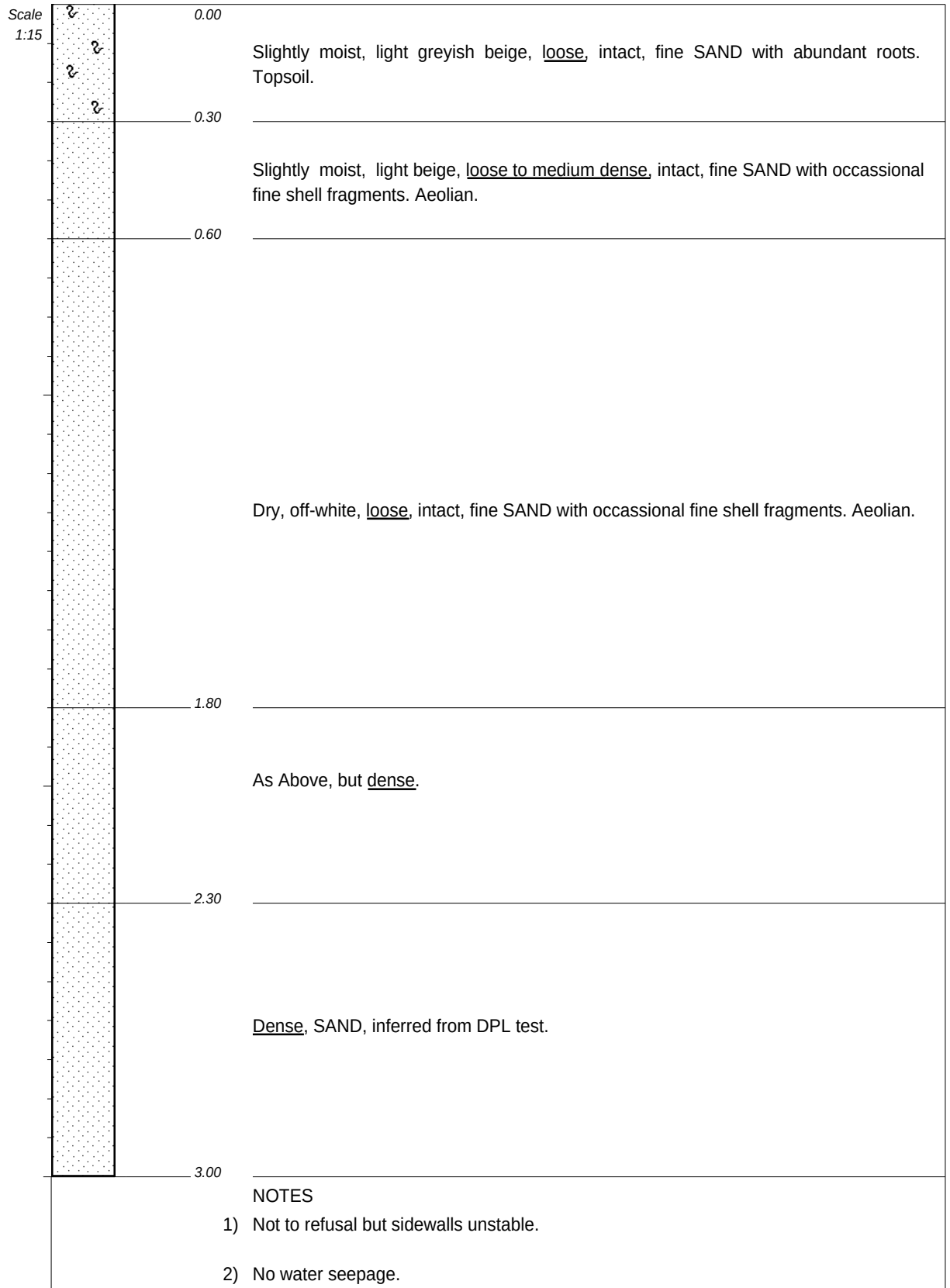


CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

INCLINATION : VERTICAL
DIAM :
DATE :
DATE : 17 May 2021
DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771405
Y-COORD : 0028987

HOLE No: TP28

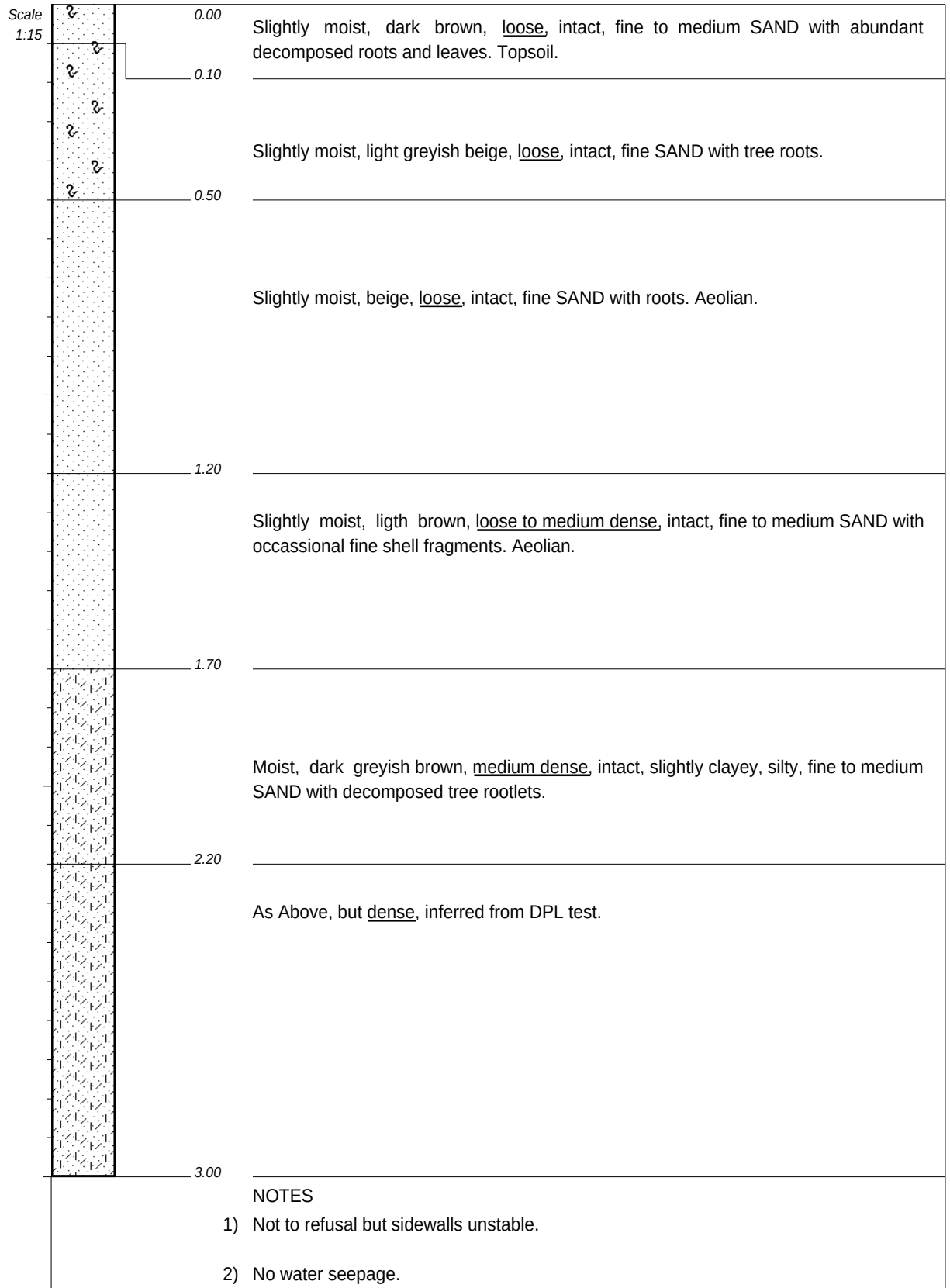


CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

INCLINATION : VERTICAL
DIAM :
DATE :
DATE : 17 May 2021
DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771535
Y-COORD : 0029018

HOLE No: TP29



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

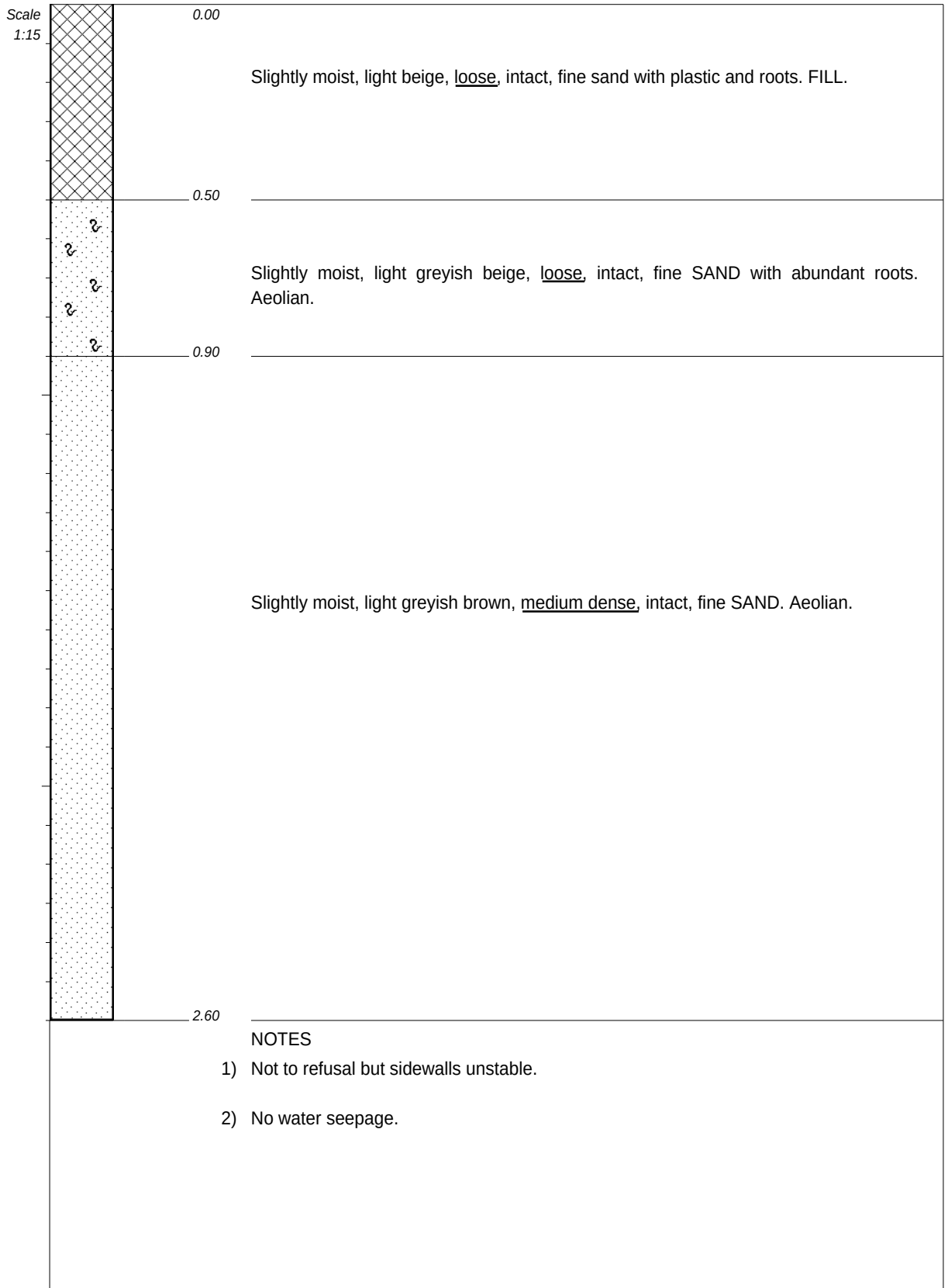
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771454
Y-COORD : 0028867

HOLE No: TP30

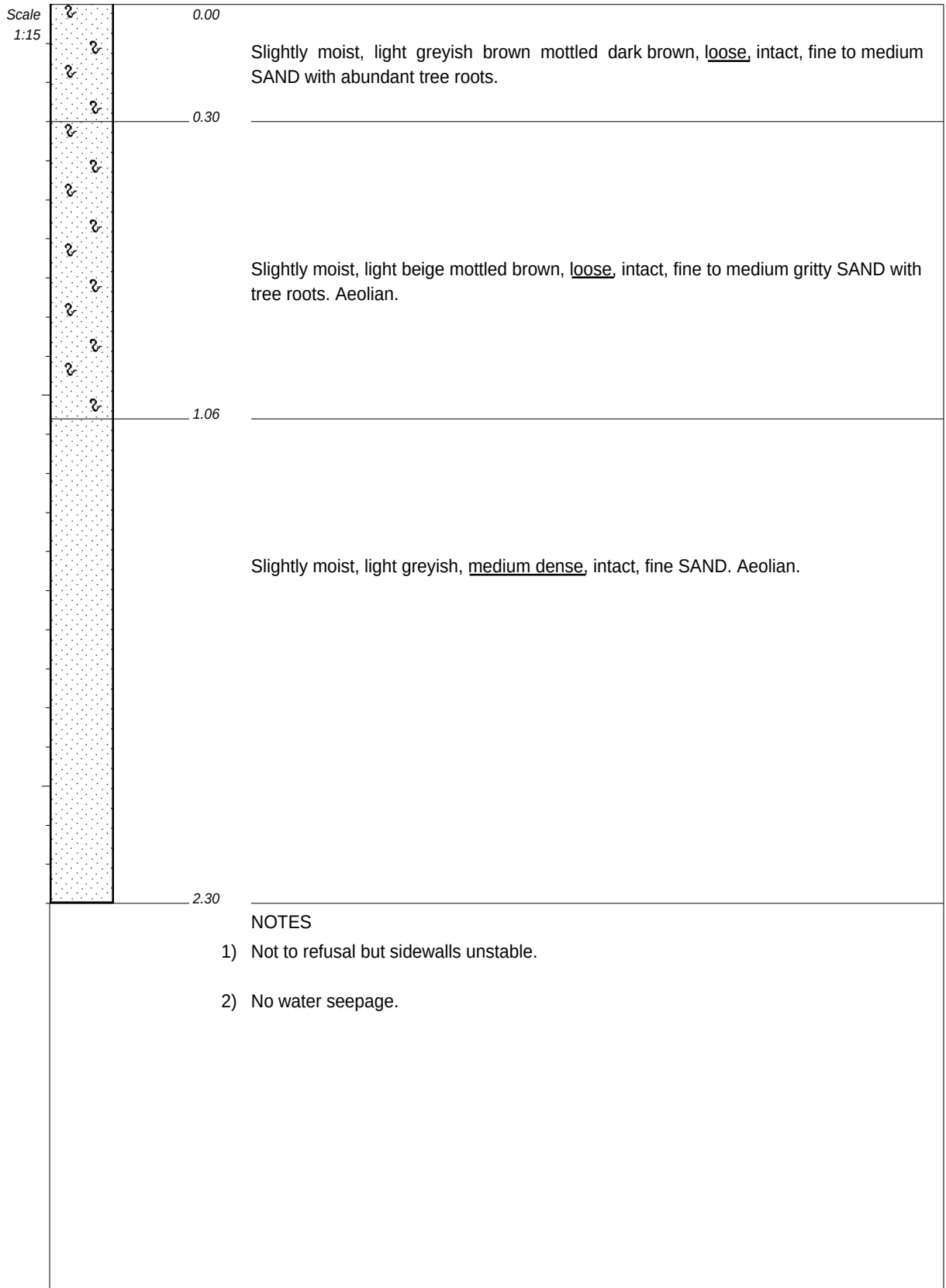


CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

INCLINATION : VERTICAL
DIAM :
DATE :
DATE : 17 May 2021
DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771306
Y-COORD : 0028859

HOLE No: TP31



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

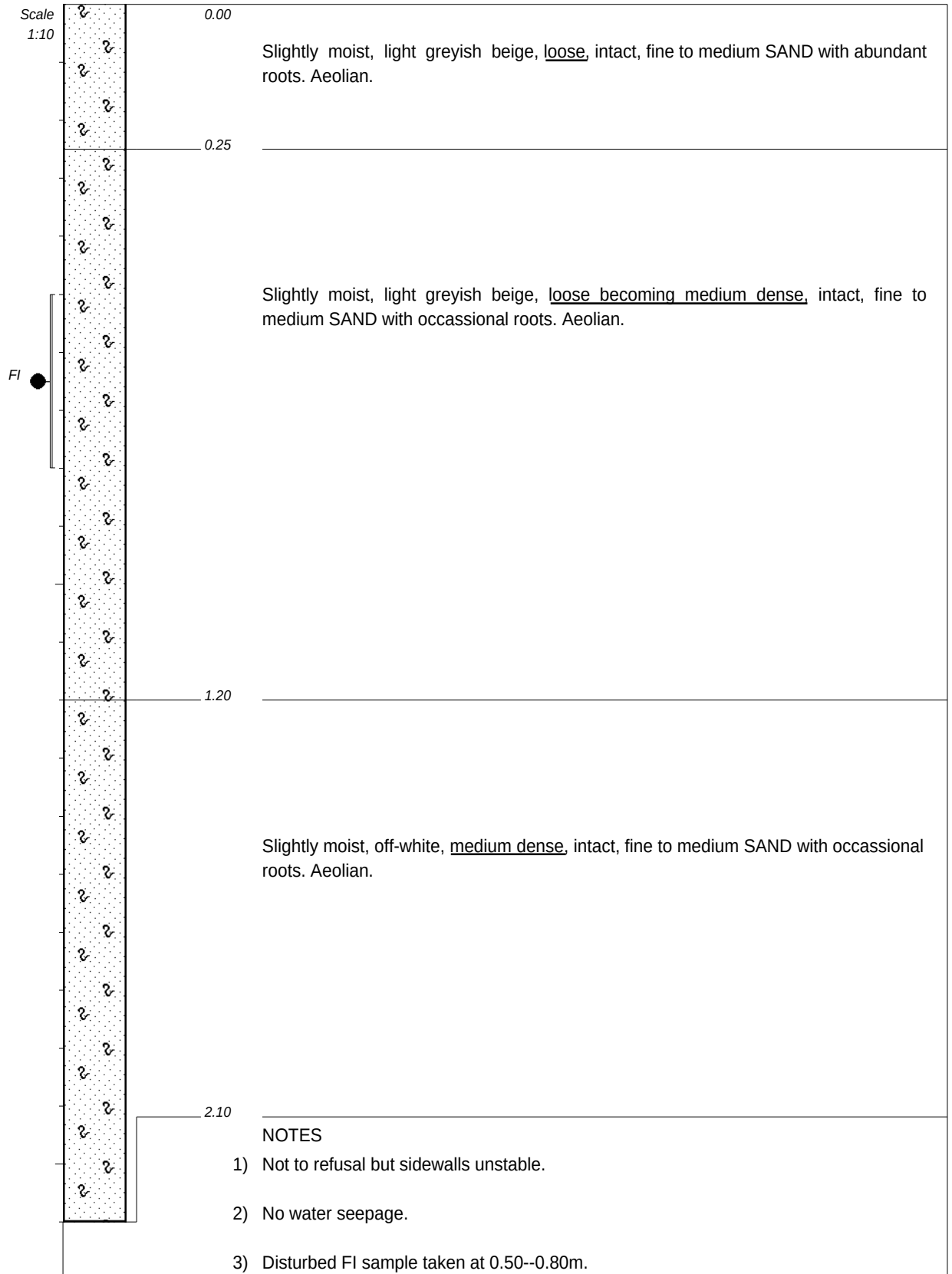
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771180
Y-COORD : 0028855

HOLE No: TP32



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

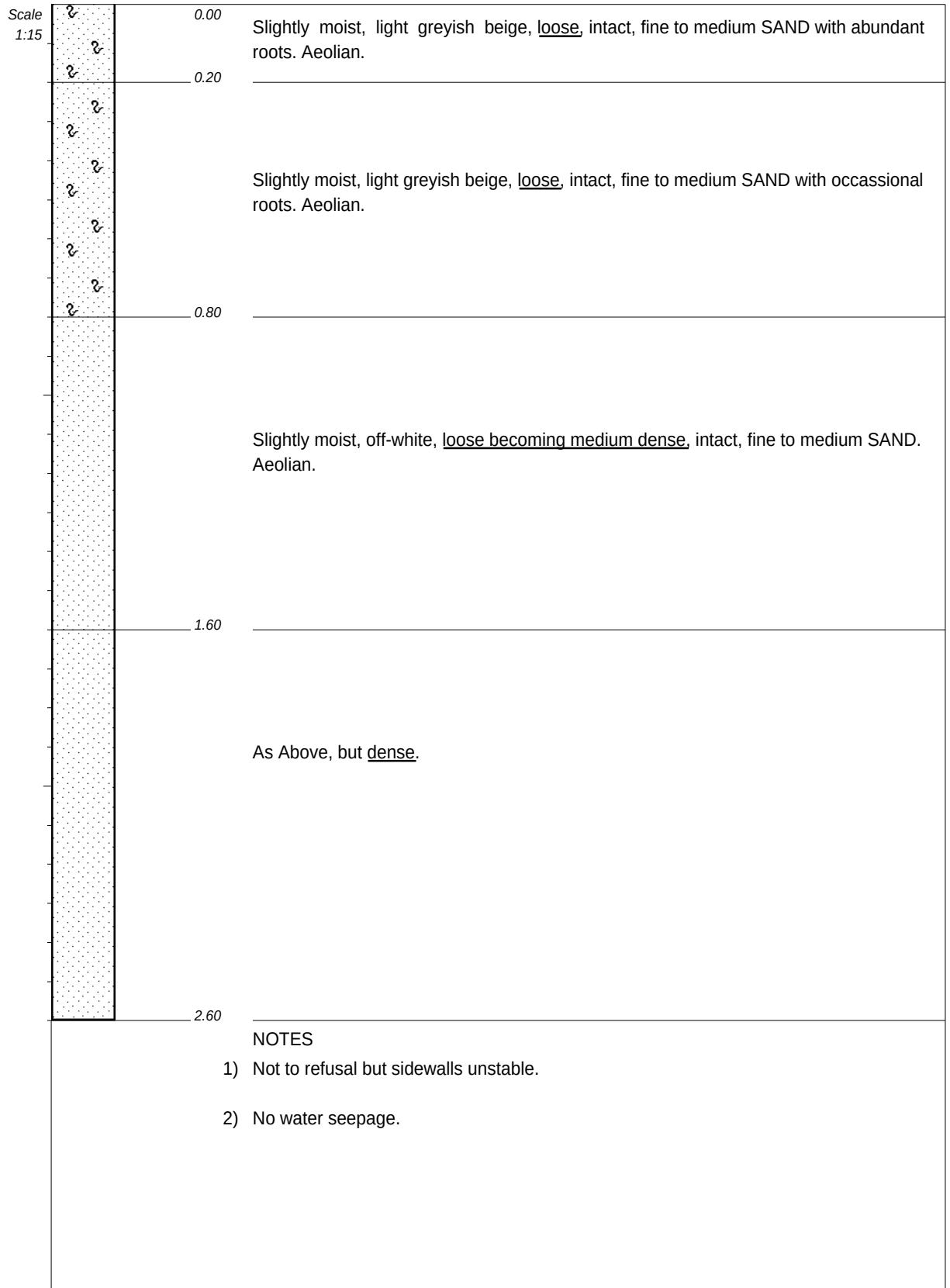
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771247
Y-COORD : 0028731

HOLE No: TP34



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

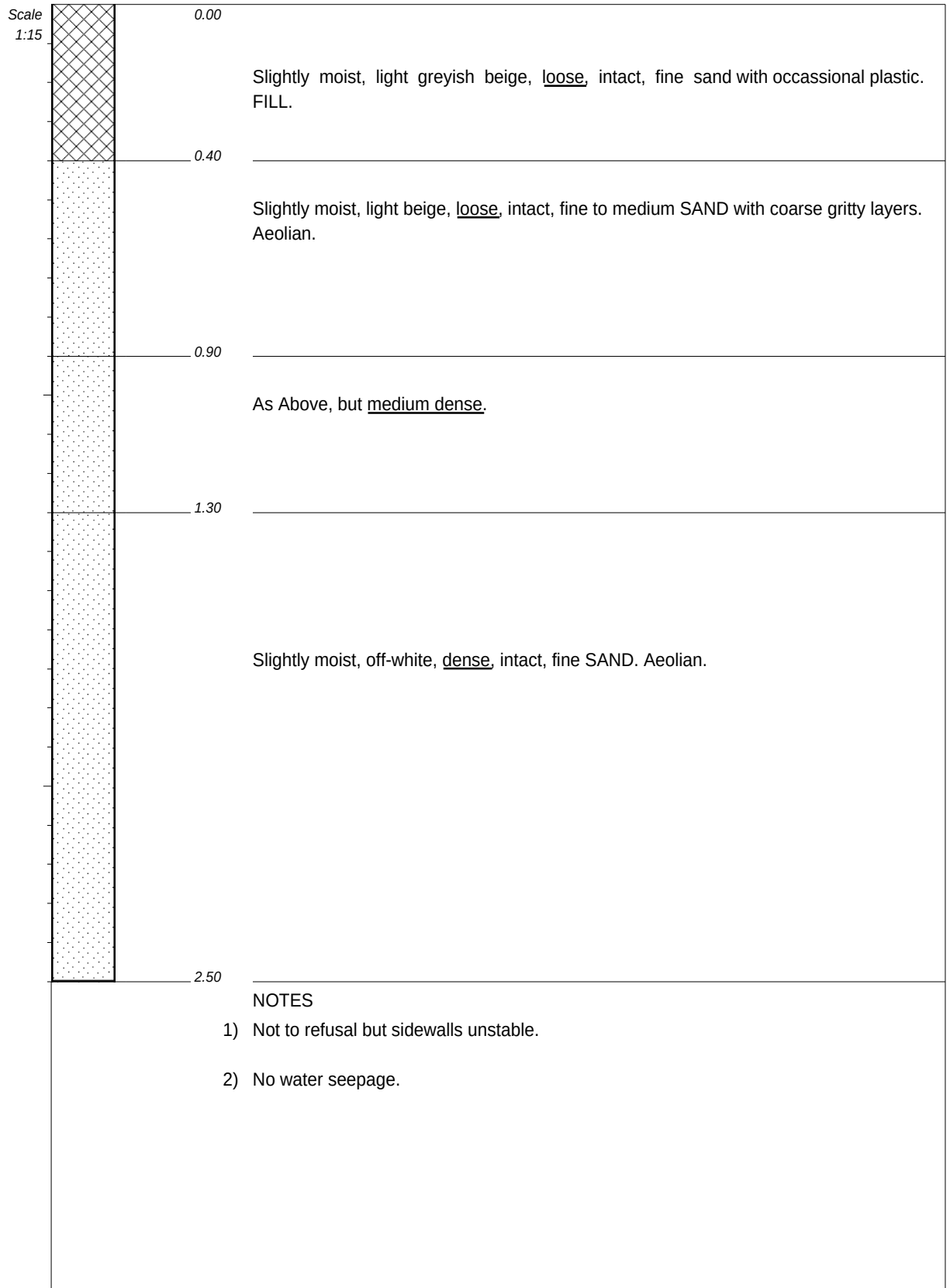
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771383
Y-COORD : 0028710

HOLE No: TP35



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

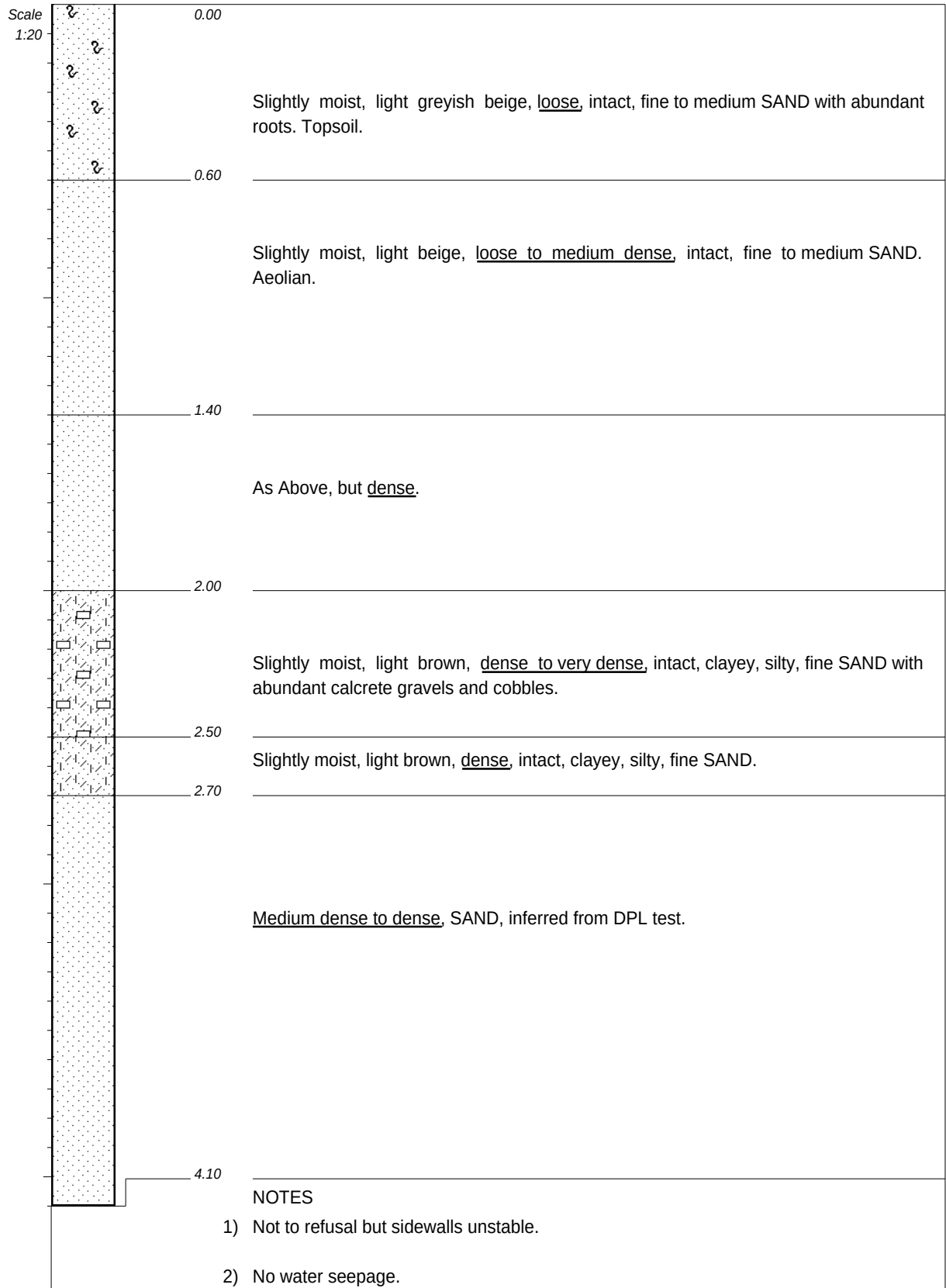
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771306
Y-COORD : 0028595

HOLE No: TP36



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

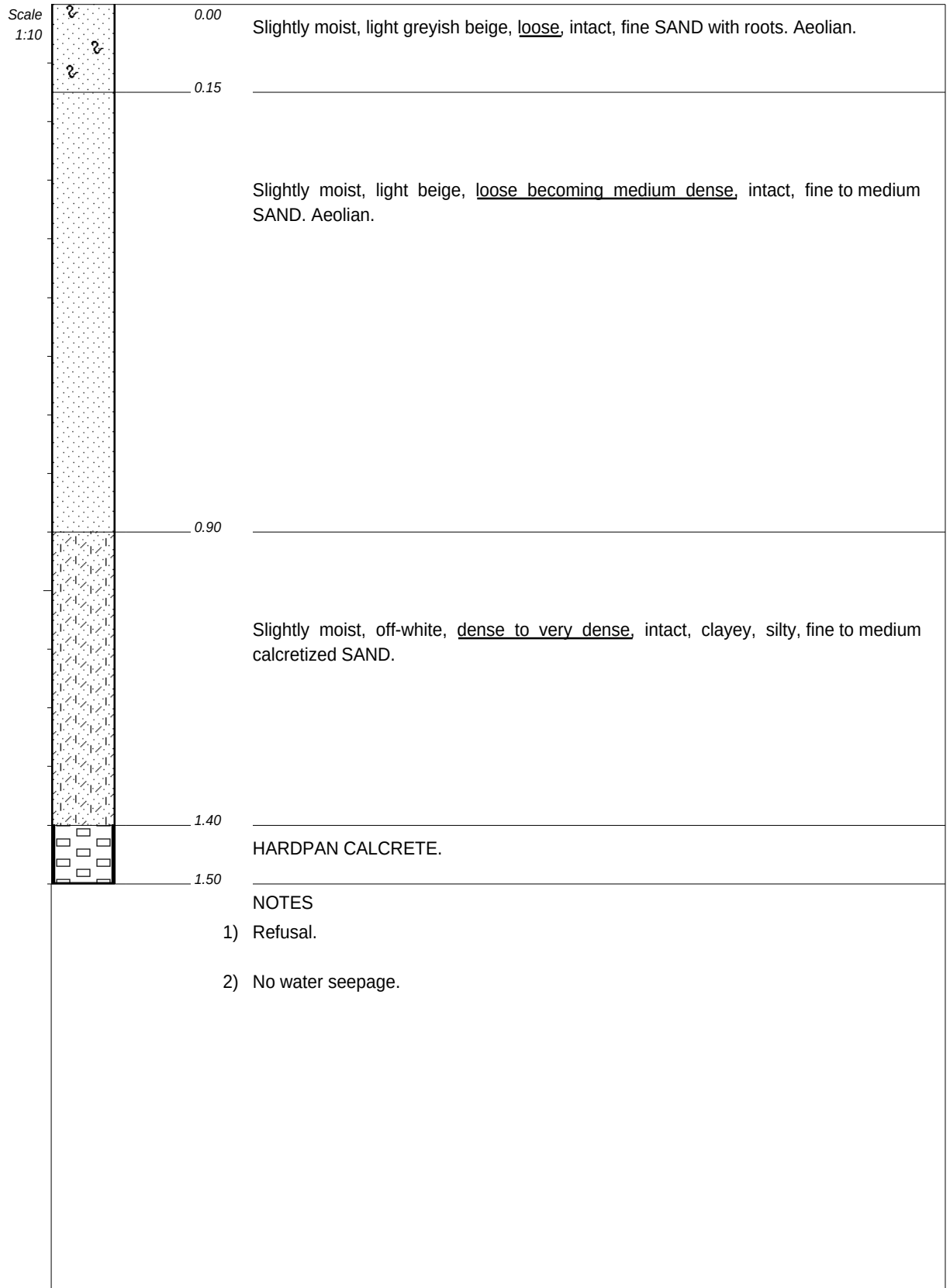
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771164
Y-COORD : 0028621

HOLE No: TP37



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

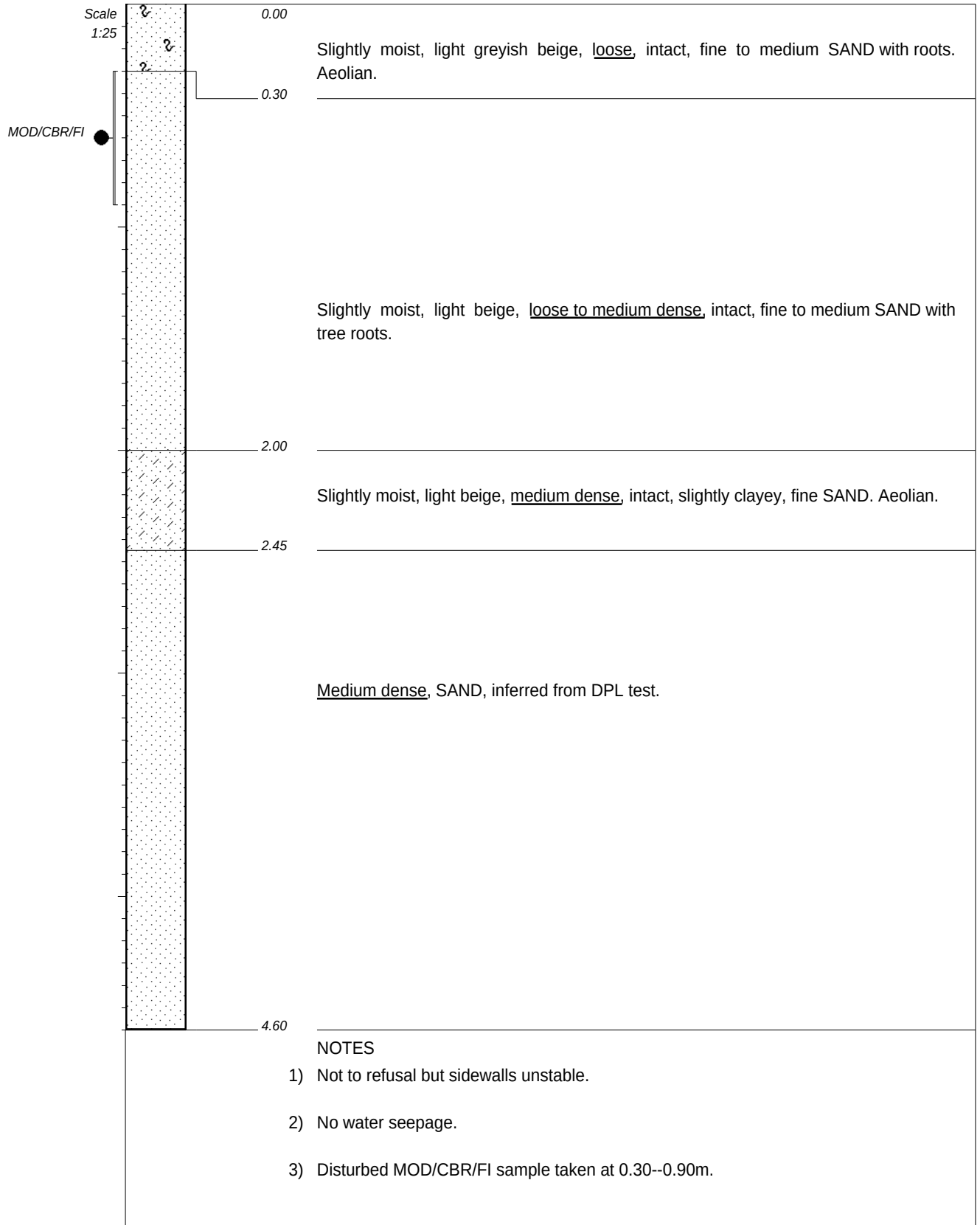
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771037
Y-COORD : 0028594

HOLE No: TP38

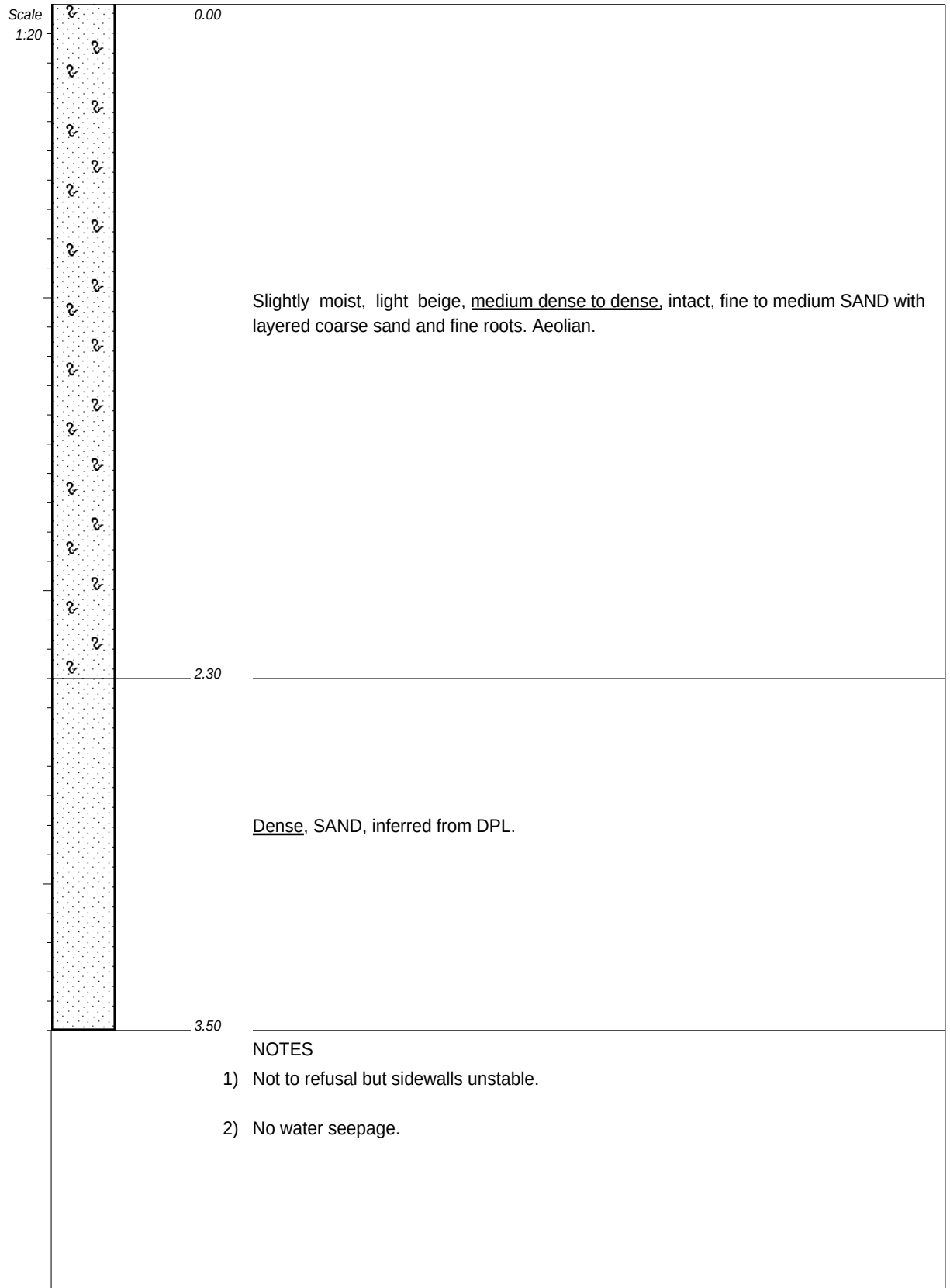


CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

INCLINATION : VERTICAL
DIAM :
DATE :
DATE : 17 May 2021
DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3770988
Y-COORD : 0028442

HOLE No: TP39

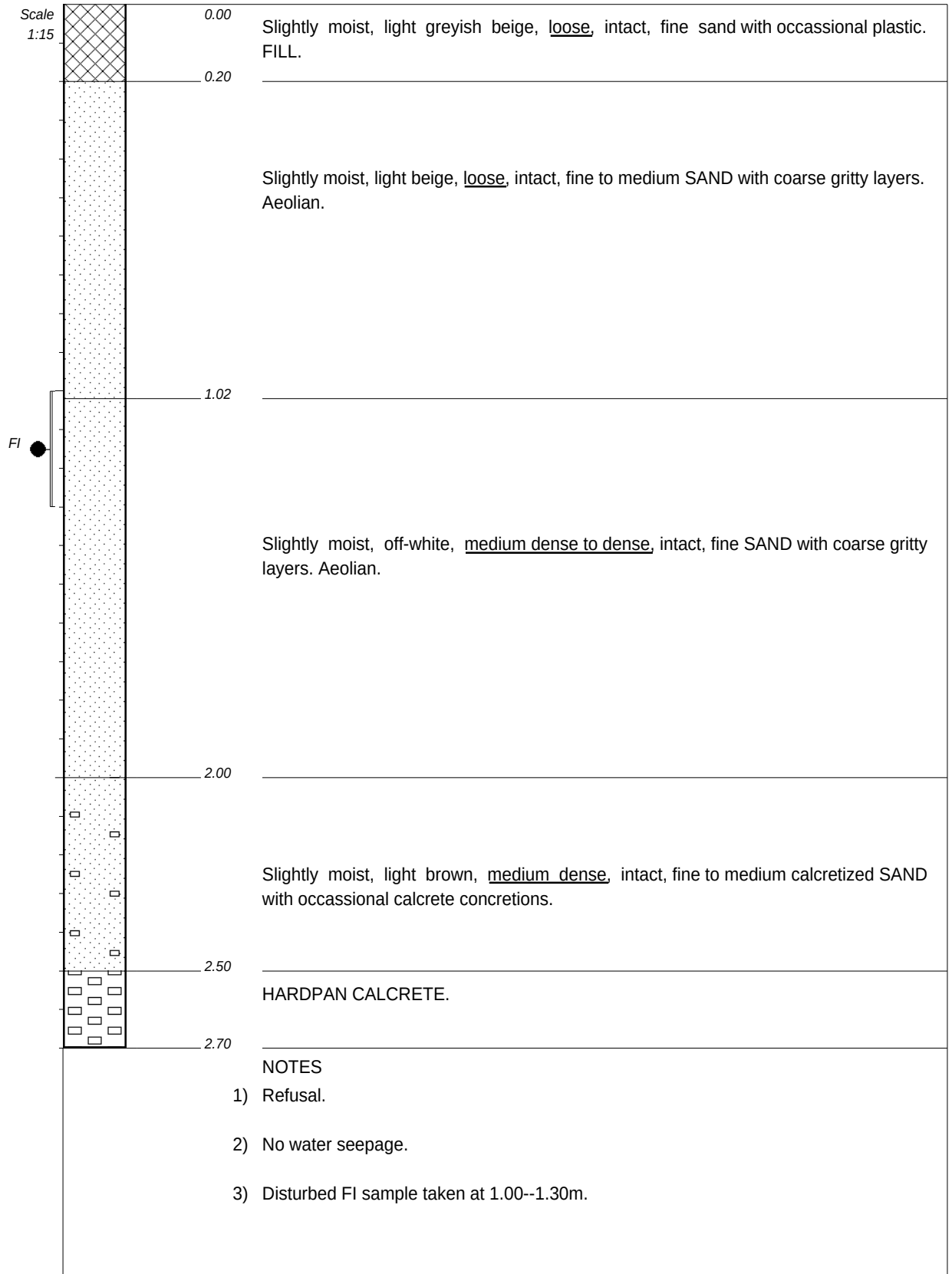


CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFILED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

INCLINATION : VERTICAL
DIAM :
DATE :
DATE : 17 May 2021
DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771160
Y-COORD : 0028492

HOLE No: TP40



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

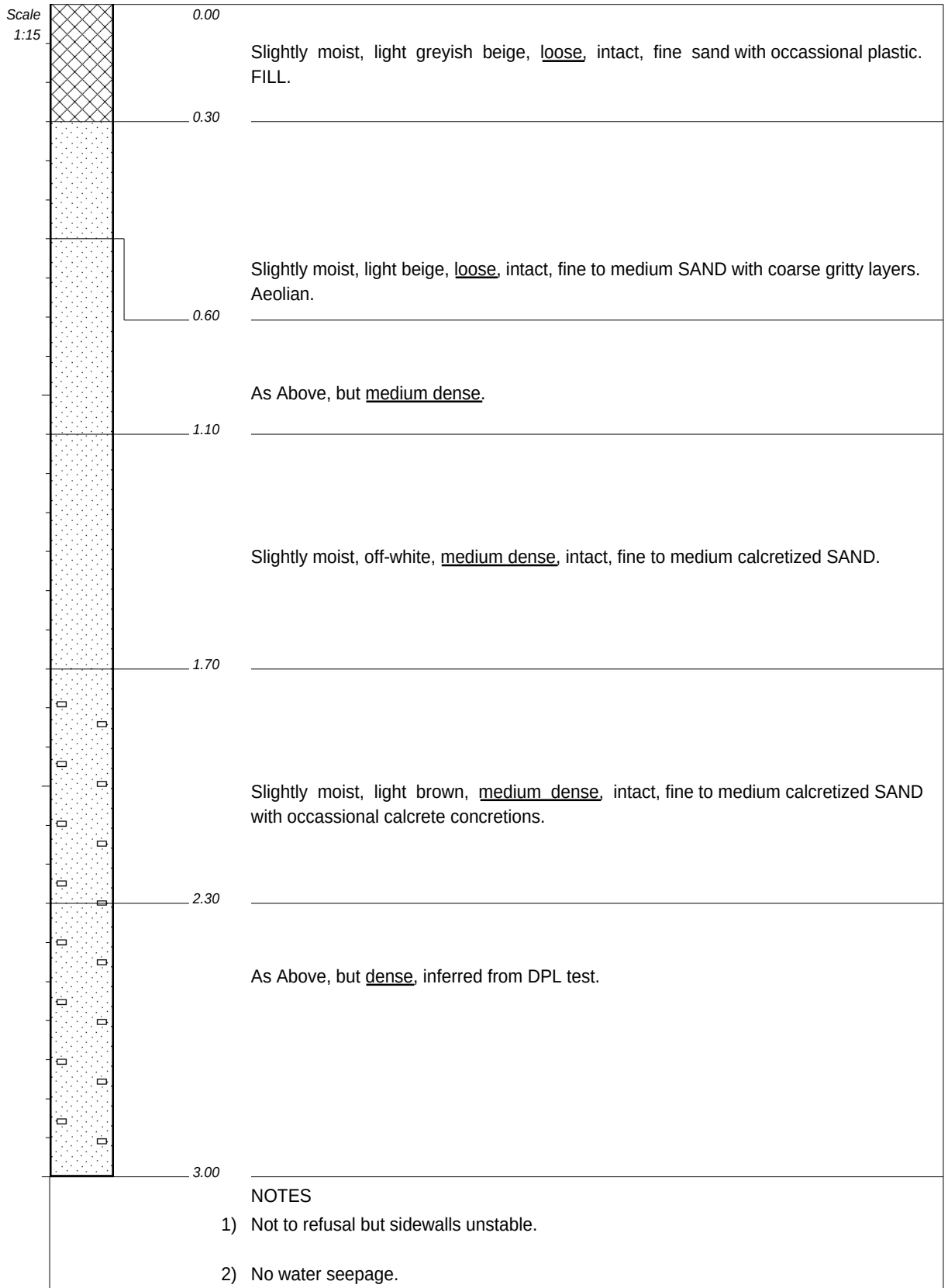
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771240
Y-COORD : 0028490

HOLE No: TP41



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

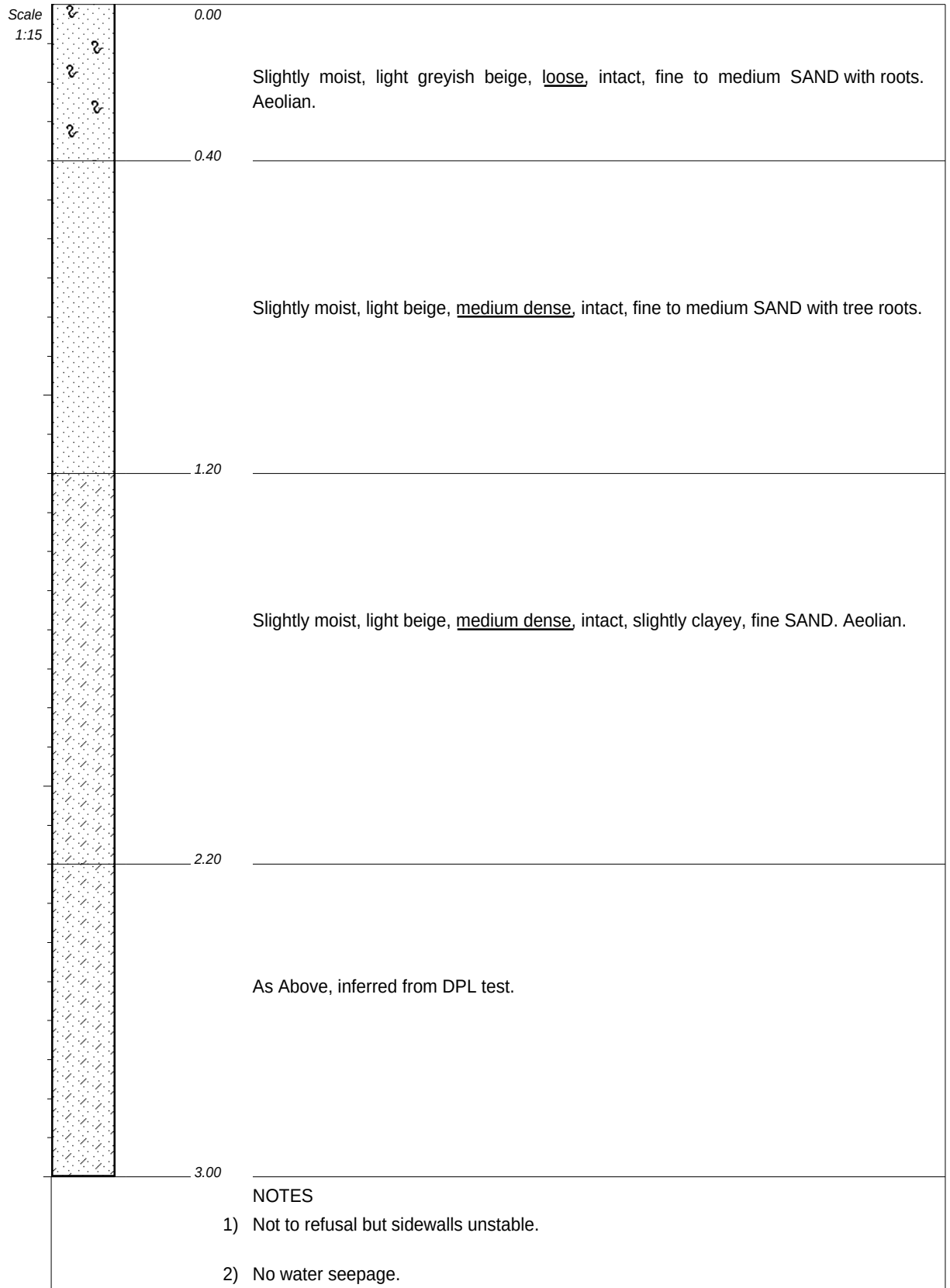
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771327
Y-COORD : 0028400

HOLE No: TP42



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFILED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

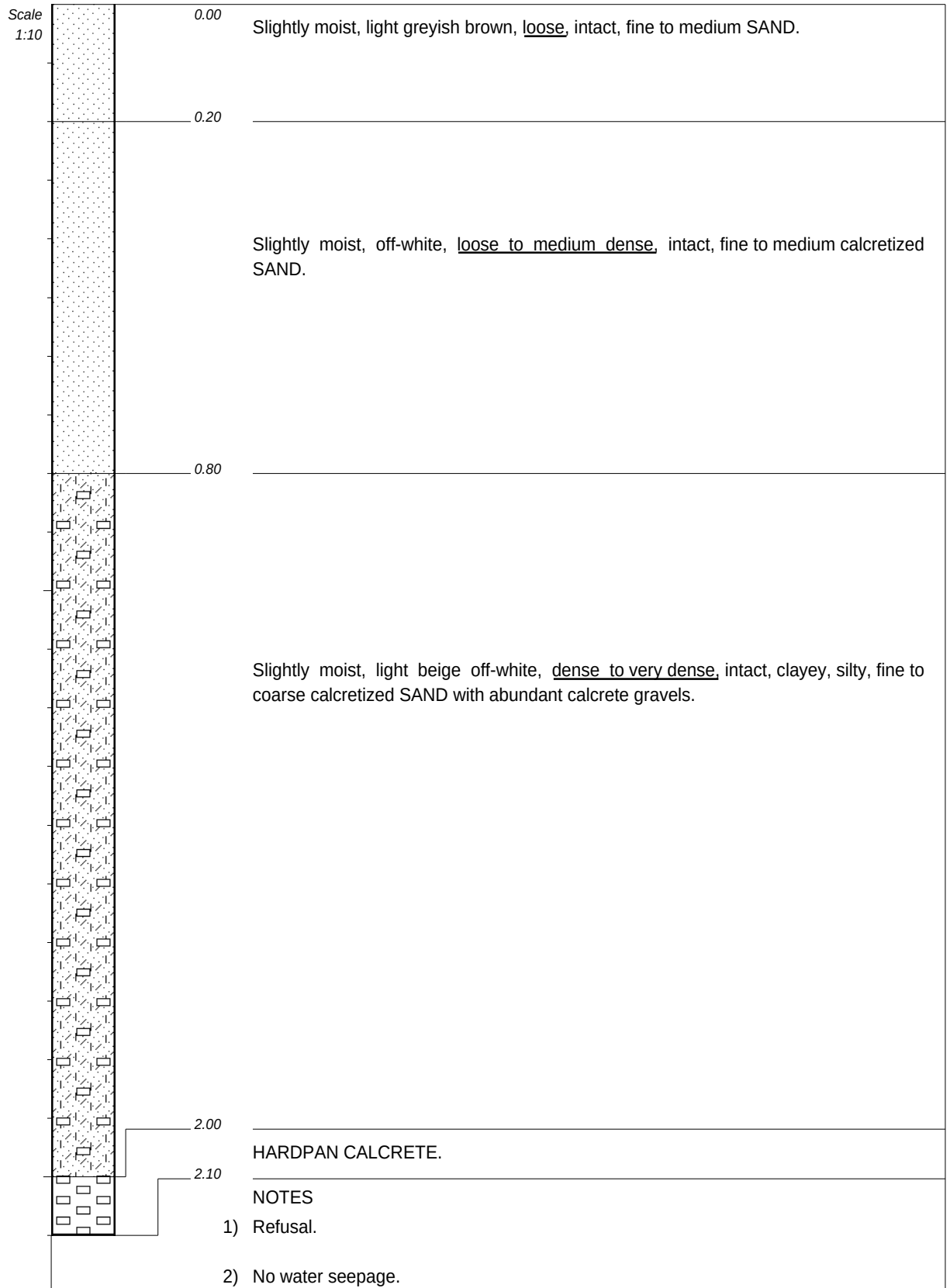
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771341
Y-COORD : 0028252

HOLE No: TP43



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

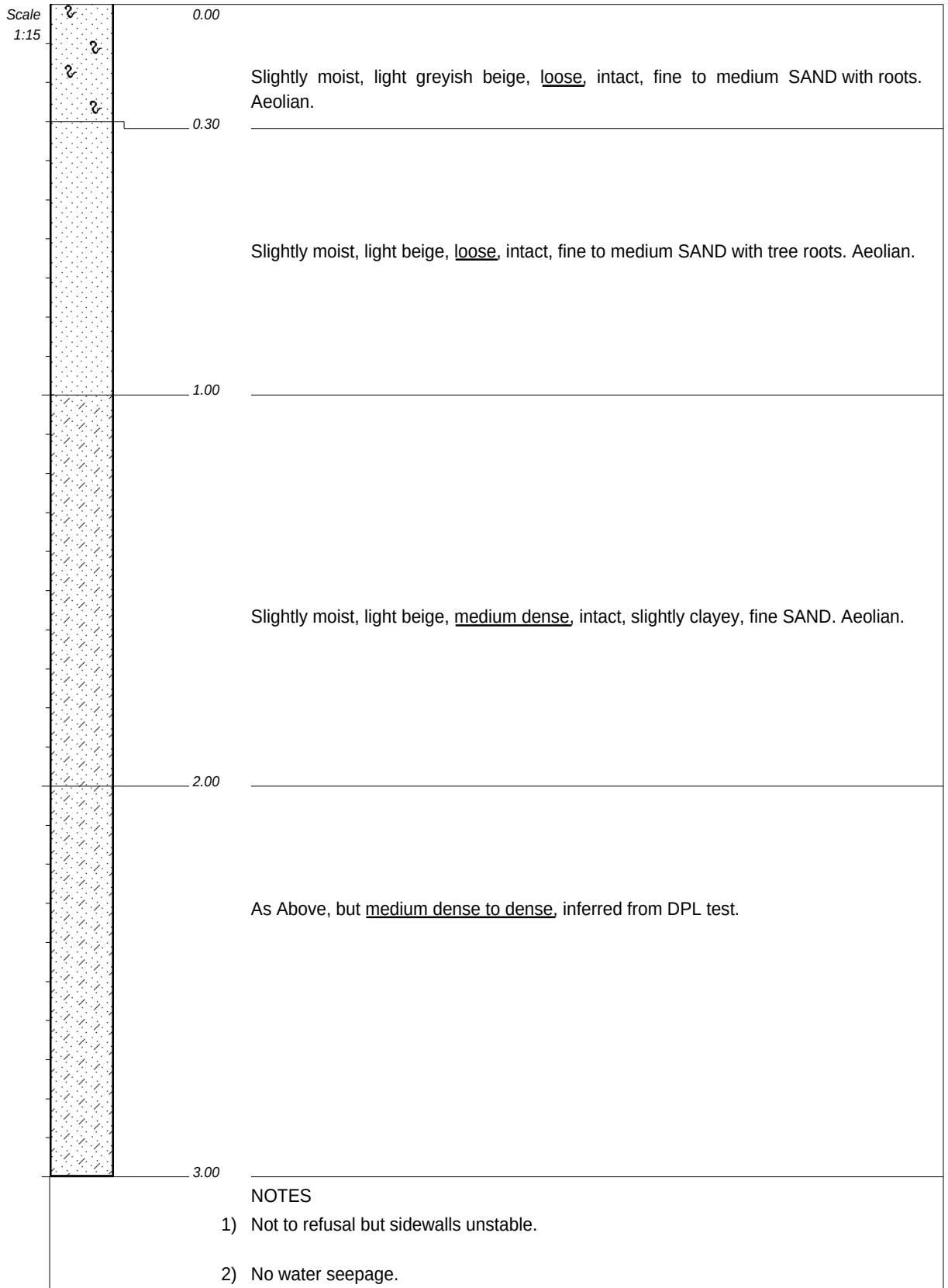
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771249
Y-COORD : 0028303

HOLE No: TP44



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

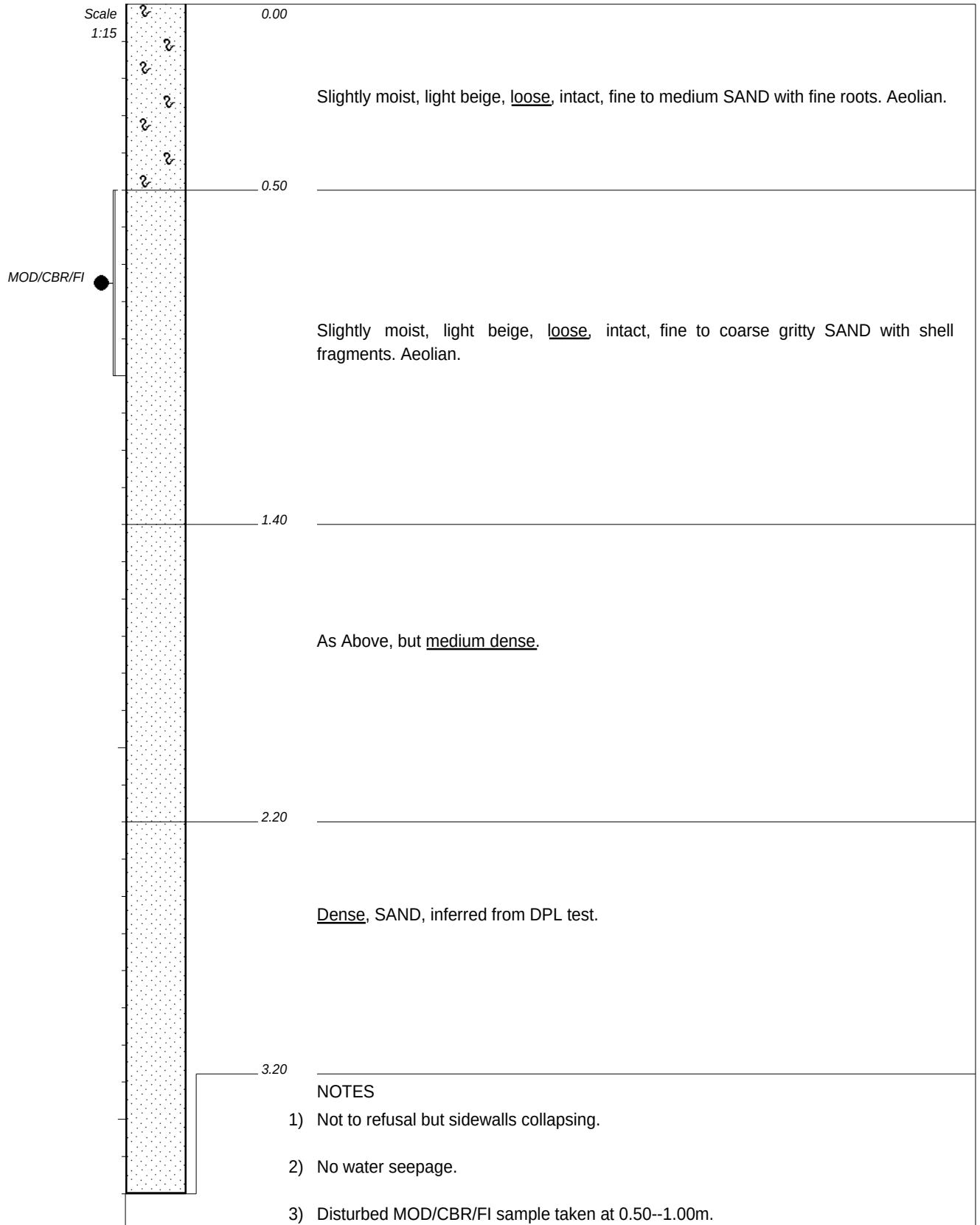
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771097
Y-COORD : 0028303

HOLE No: TP45



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

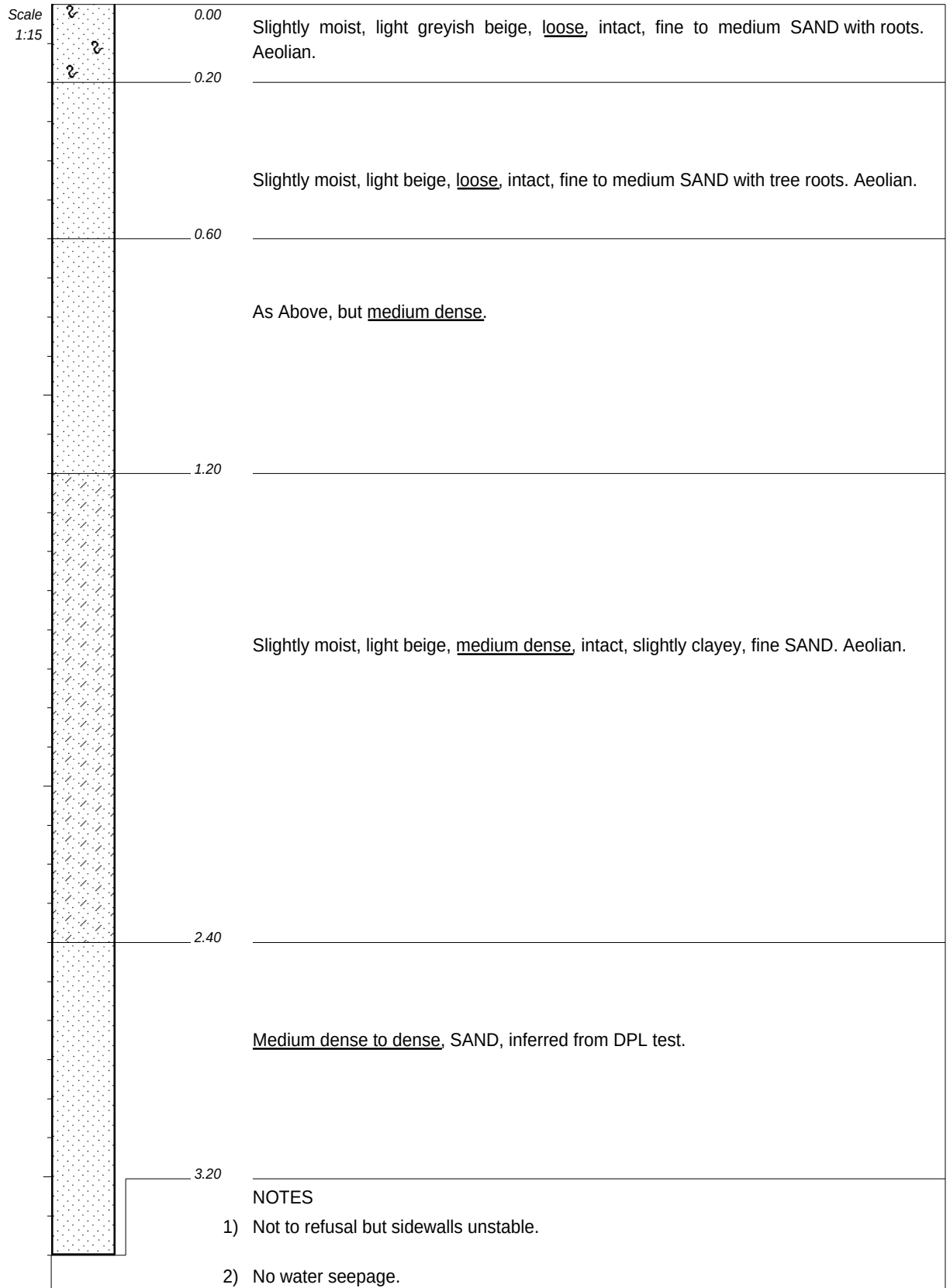
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771199
Y-COORD : 0028162

HOLE No: TP46



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

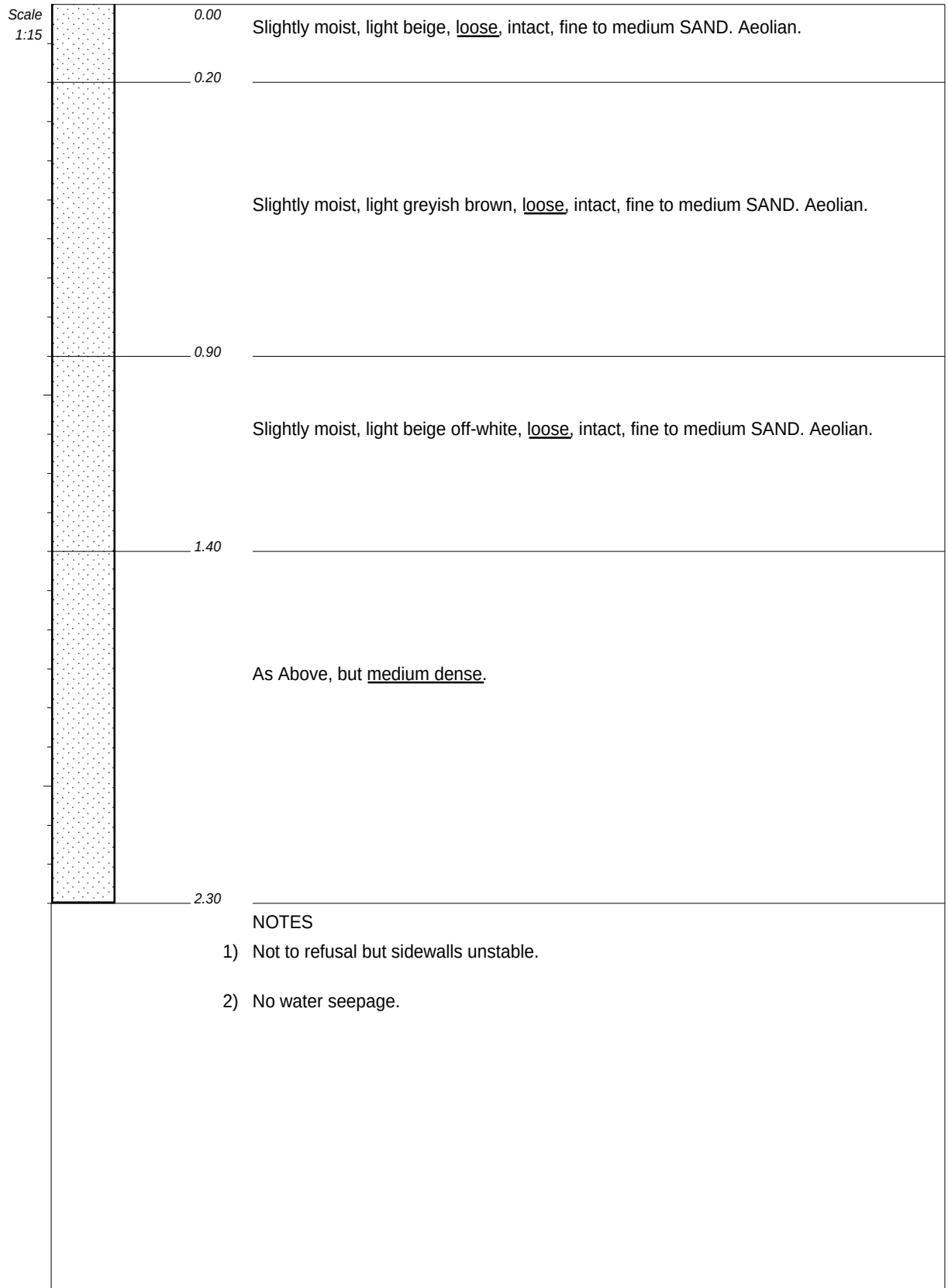
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771310
Y-COORD : 0028095

HOLE No: TP47



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

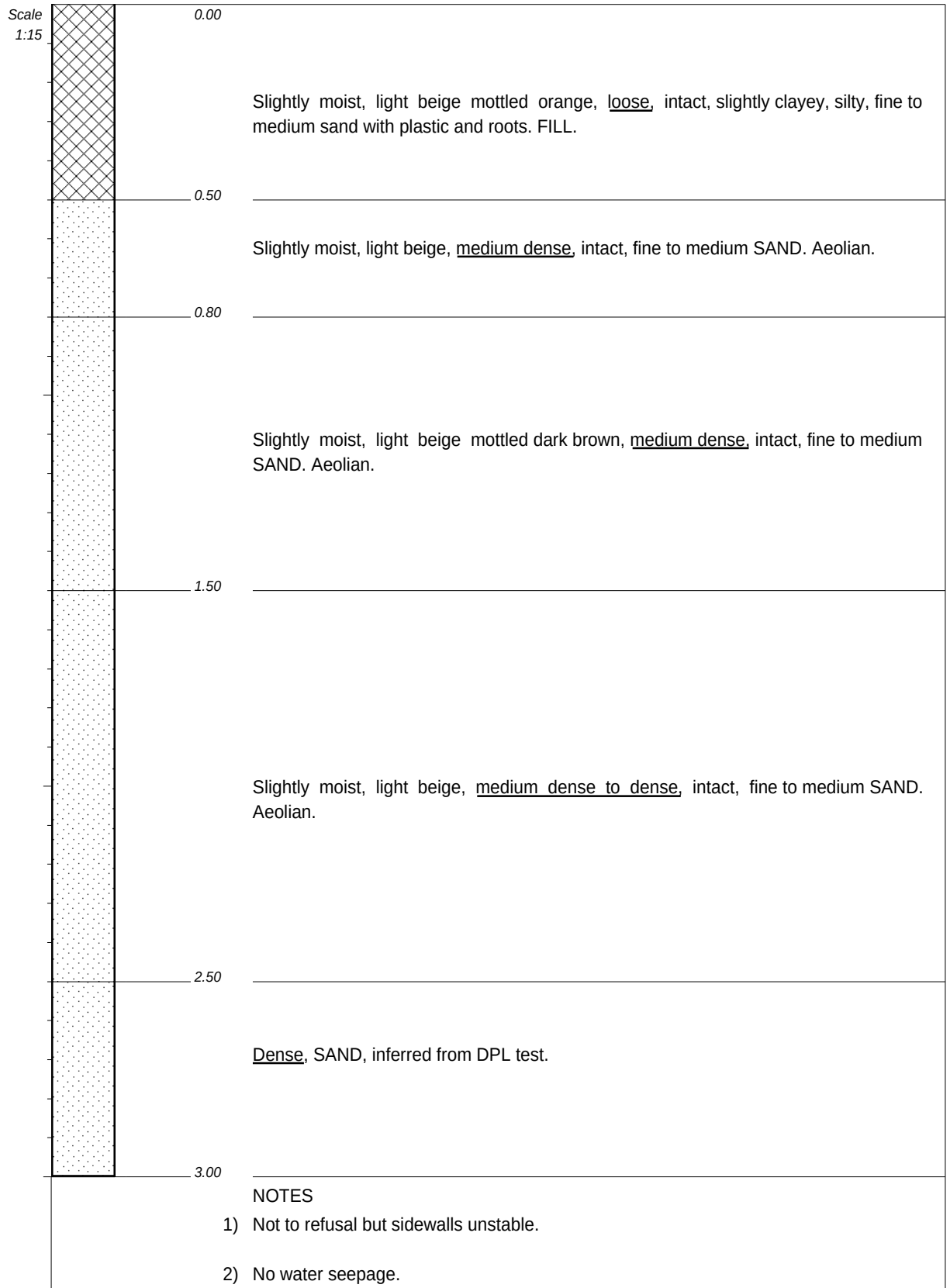
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3770987
Y-COORD : 0028176

HOLE No: TP48



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

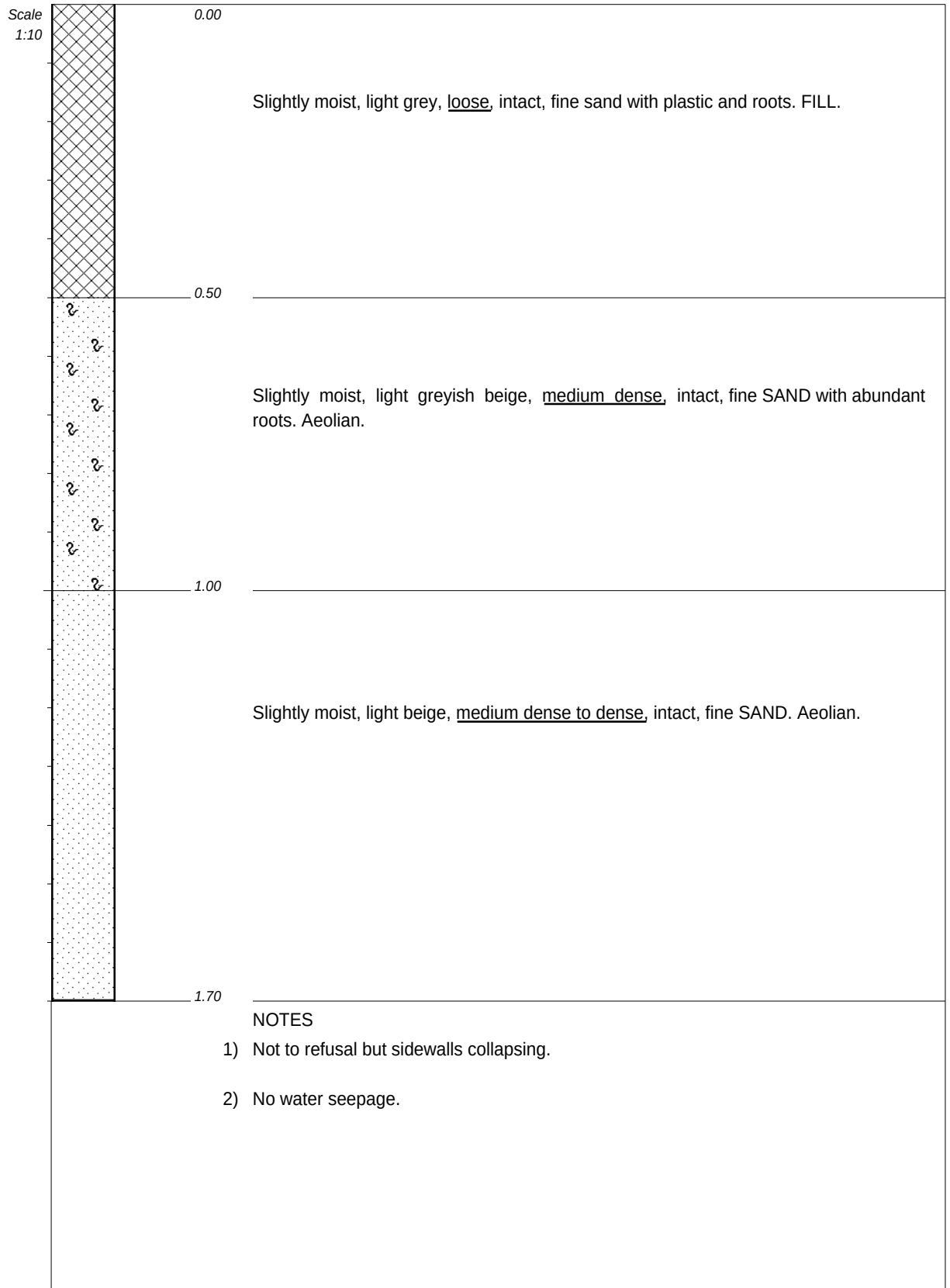
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3770891
Y-COORD : 0028150

HOLE No: TP49



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

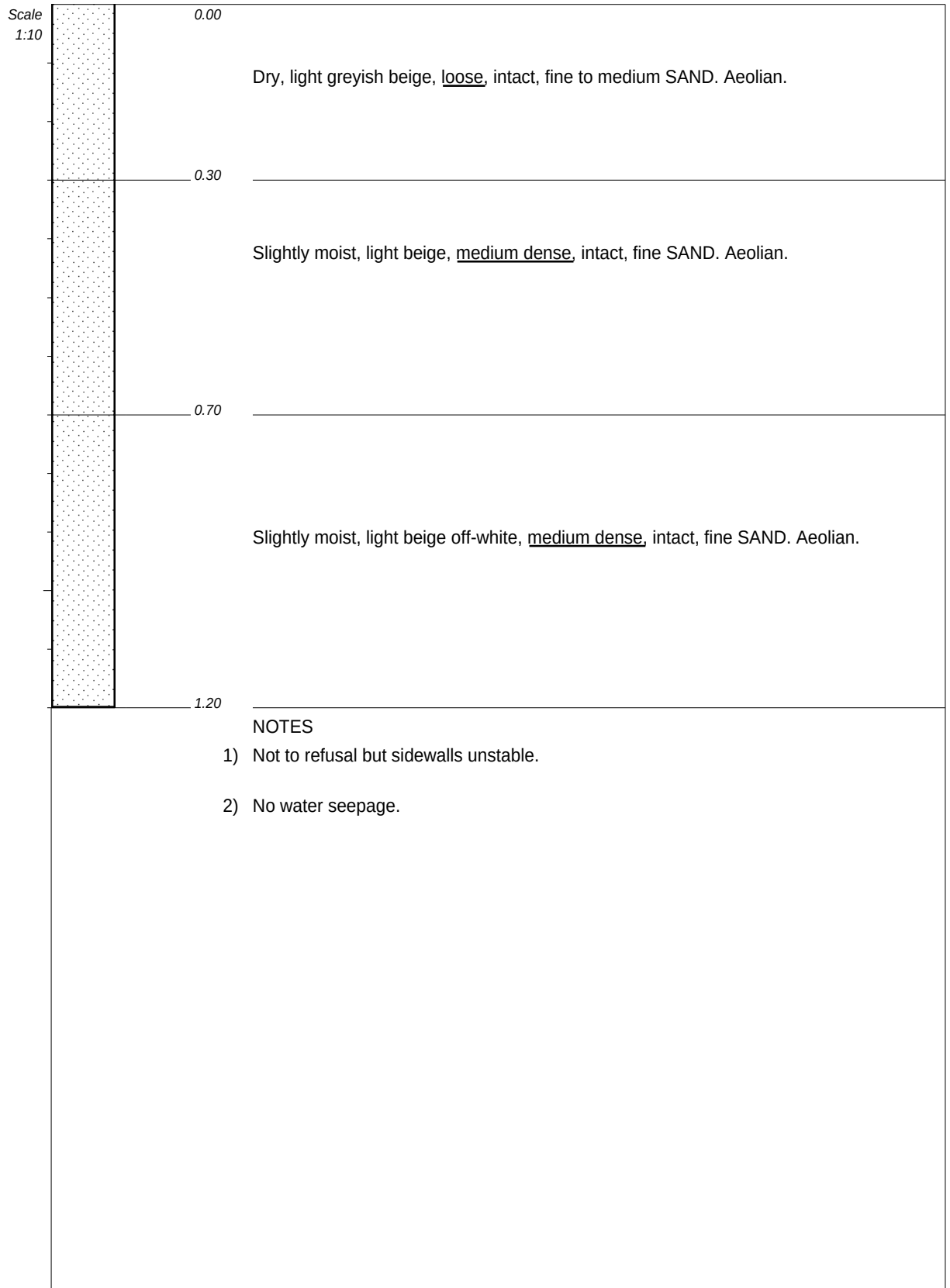
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3770848
Y-COORD : 0028009

HOLE No: TP50



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

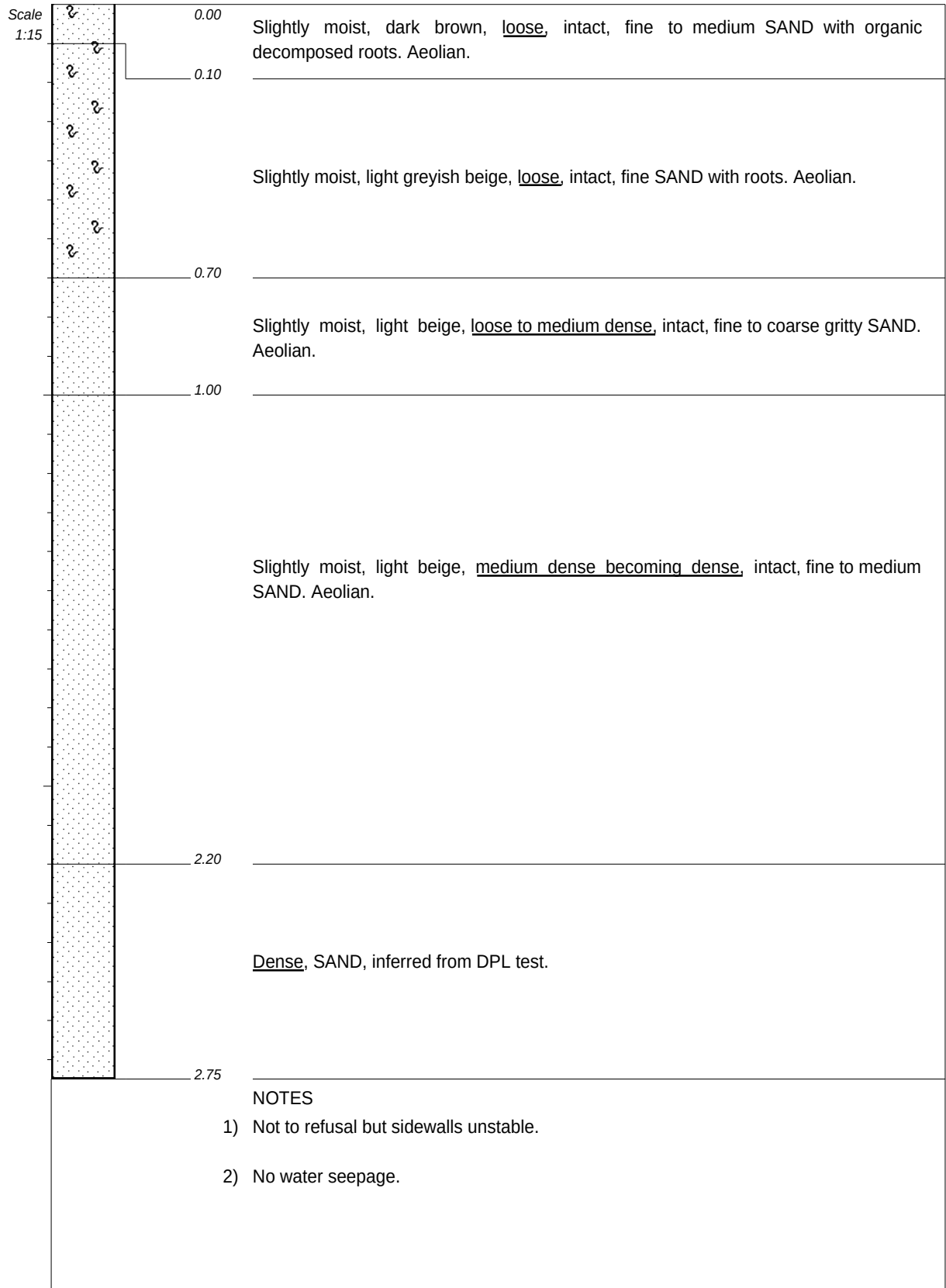
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3770993
Y-COORD : 0028019

HOLE No: TP51

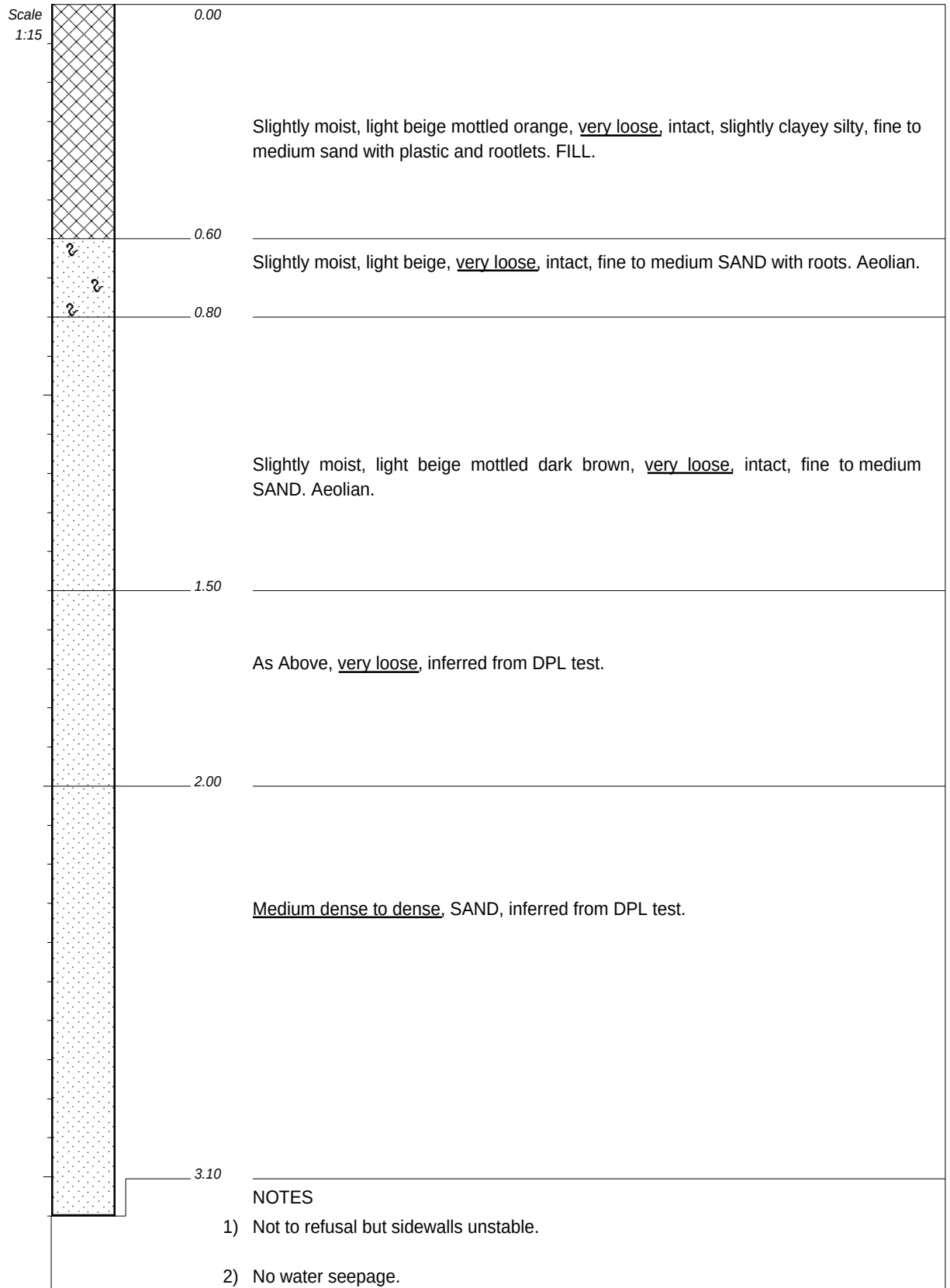


CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

INCLINATION : VERTICAL
DIAM :
DATE :
DATE : 17 May 2021
DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771063
Y-COORD : 0027868

HOLE No: TP52



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

INCLINATION : VERTICAL

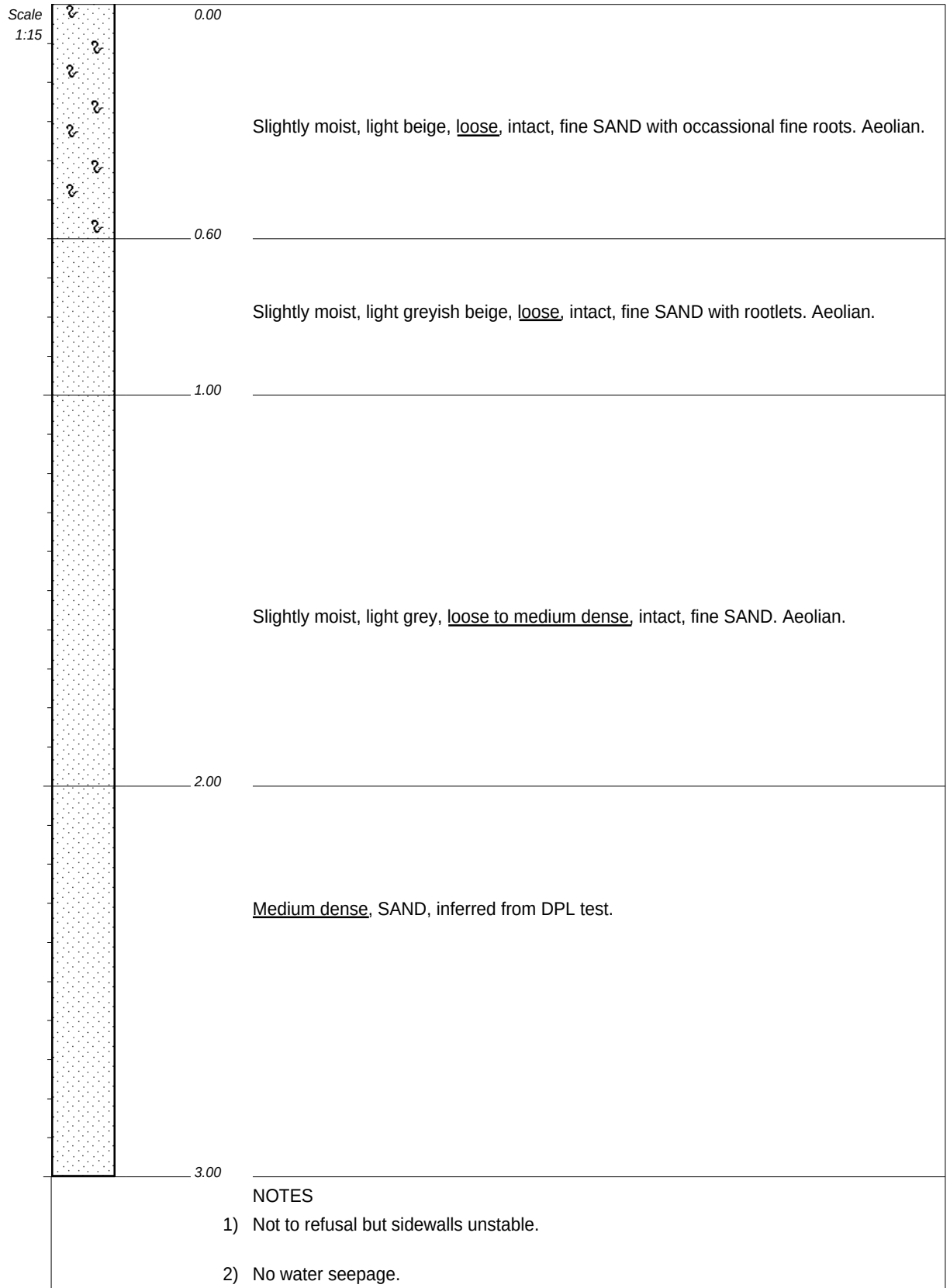
DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771161
Y-COORD : 0027750

HOLE No: TP53



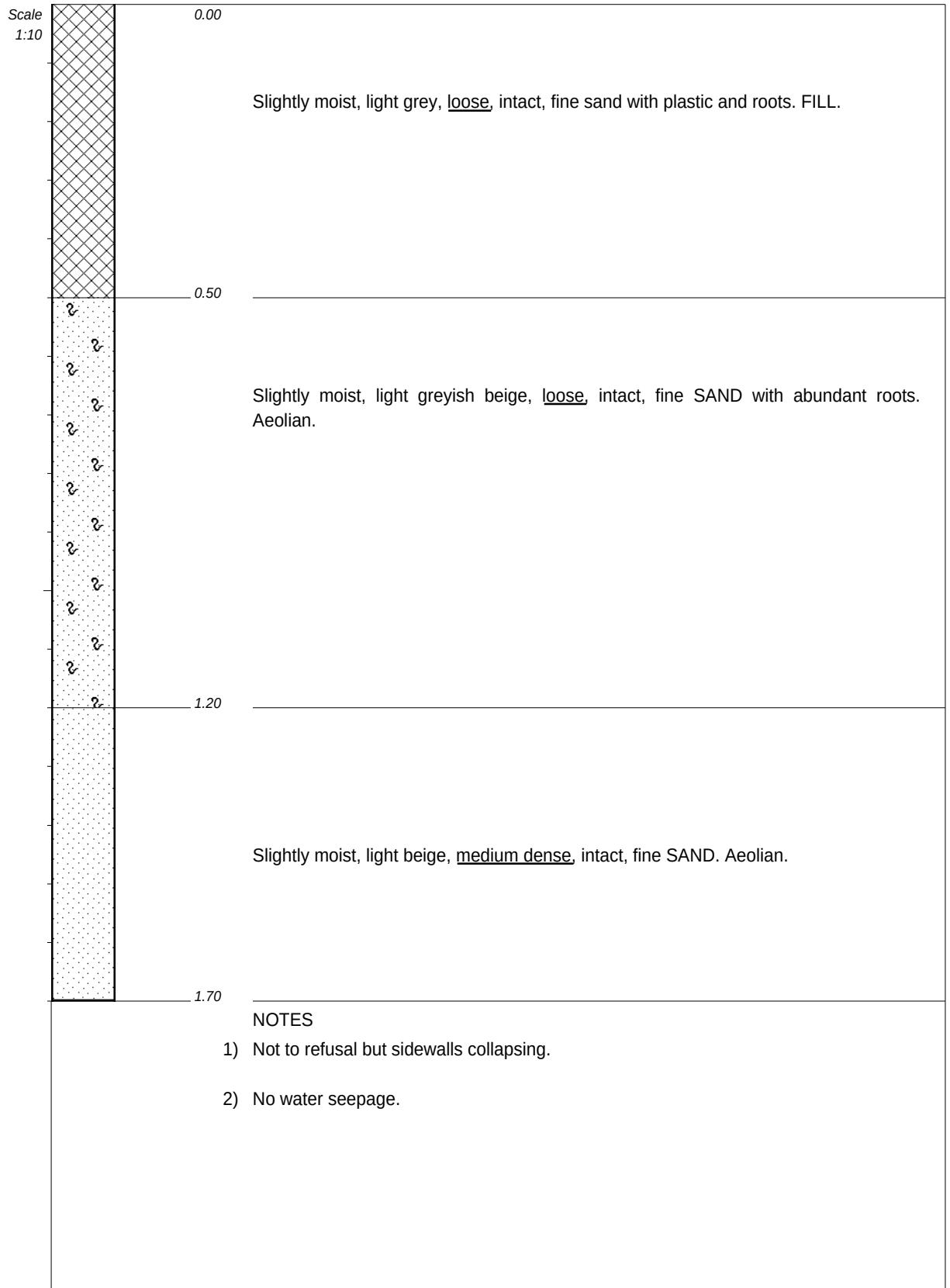


CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

INCLINATION : VERTICAL
DIAM :
DATE :
DATE : 17 May 2021
DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3771010
Y-COORD : 0027568

HOLE No: TP55



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFIED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

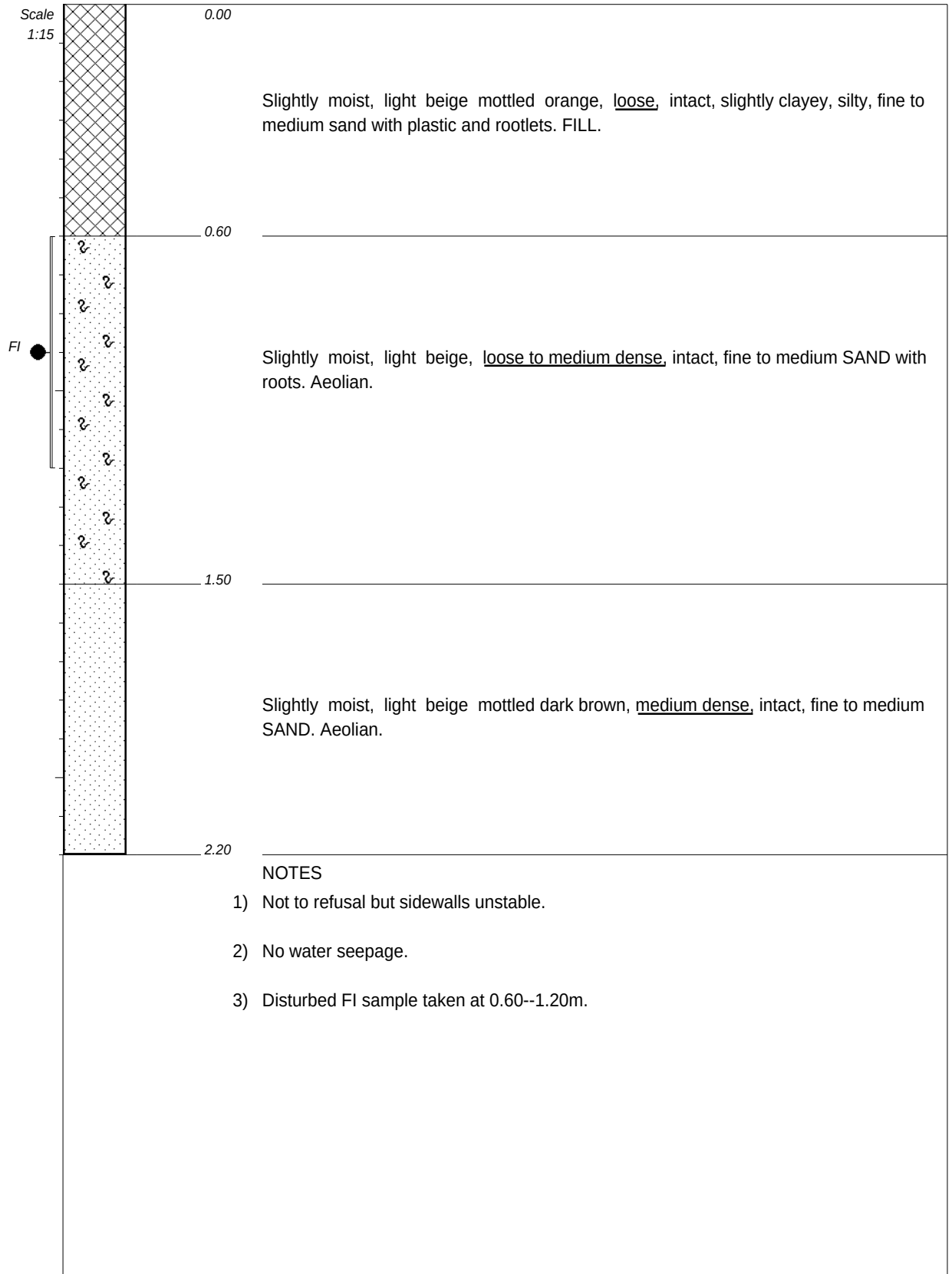
INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3770933
Y-COORD : 0027694

HOLE No: TP56

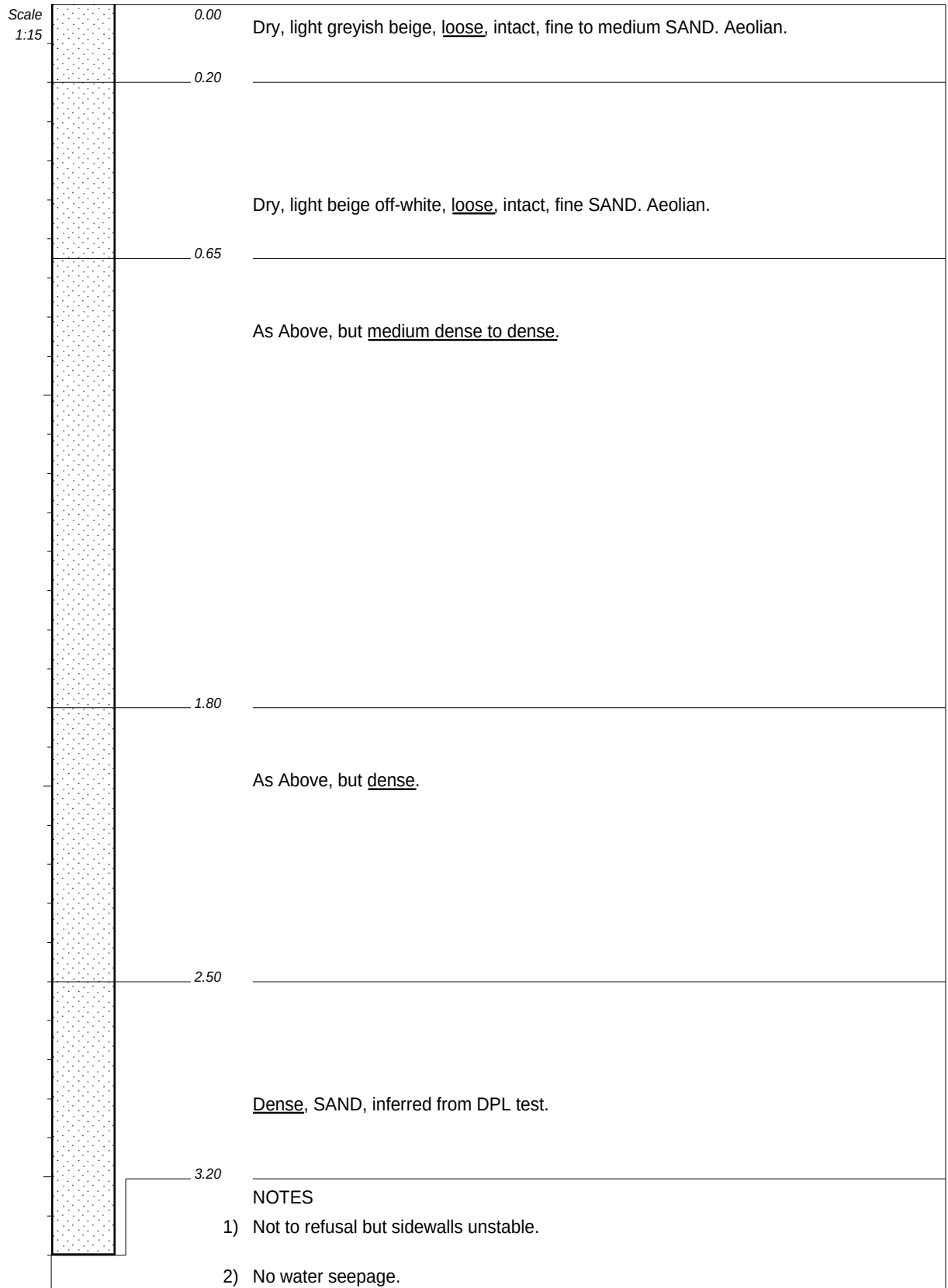


CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFILED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

INCLINATION : VERTICAL
DIAM :
DATE :
DATE : 17 May 2021
DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3770949
Y-COORD : 0027850

HOLE No: TP57



CONTRACTOR : Amanzi Plant Hire
MACHINE : Cat 428E 4X4
DRILLED BY : Madiba
PROFILED BY : AN/JB
TYPE SET BY : Adon
SETUP FILE : STANDARD.SET

INCLINATION : VERTICAL

DIAM :
DATE :
DATE : 17 May 2021

DATE : 25/06/2021 10:31
TEXT : ..000\network\571322-1.TXT

ELEVATION : WGS 84
X-COORD : 3770832
Y-COORD : 0027835

HOLE No: TP58

Appendix B: Photographs

			
	ENKANINI SOUTH HOUSING TESTPIT 1 - GENERAL VIEW AND PROFILE		Project No. 571322

		
	ENKANINI SOUTH HOUSING TESTPIT 2 - GENERAL VIEW AND PROFILE	Project No. 571322









 **srk** consulting

**ENKANINI SOUTH HOUSING
TESTPIT 9 - GENERAL VIEW AND PROFILE**

Project No.
571322



 **srk** consulting

**ENKANINI SOUTH HOUSING
TESTPIT 10 - GENERAL VIEW AND PROFILE**

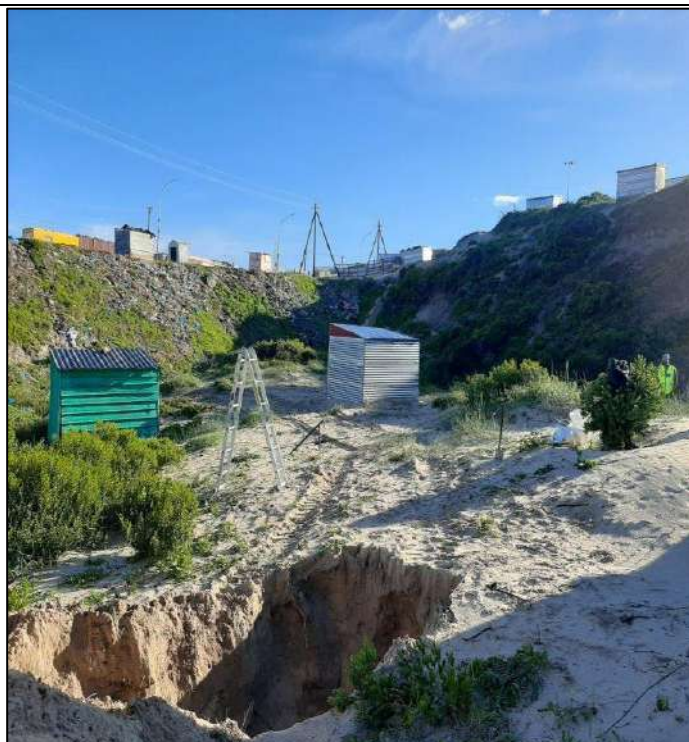
Project No.
571322



 **srk** consulting

**ENKANINI SOUTH HOUSING
TESTPIT 11 - GENERAL VIEW AND PROFILE**

Project No.
571322



 **srk** consulting

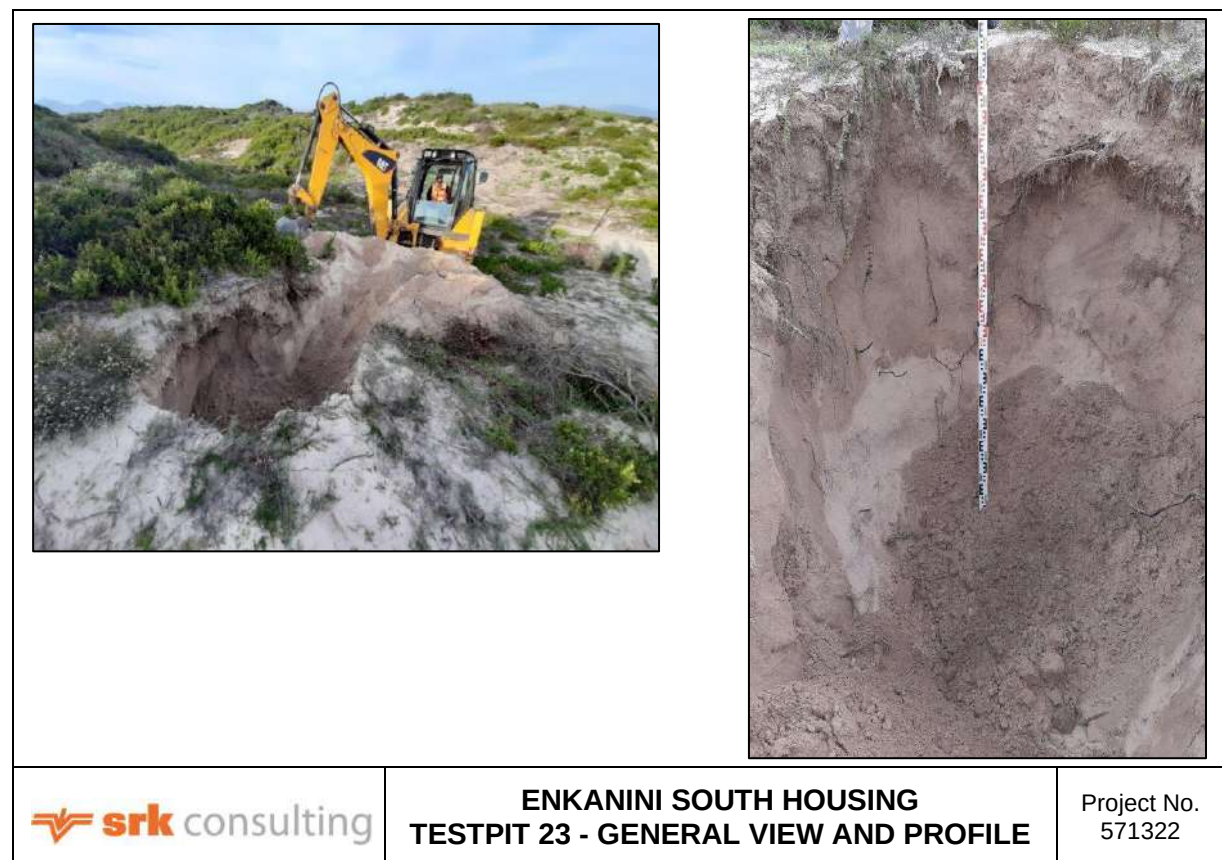
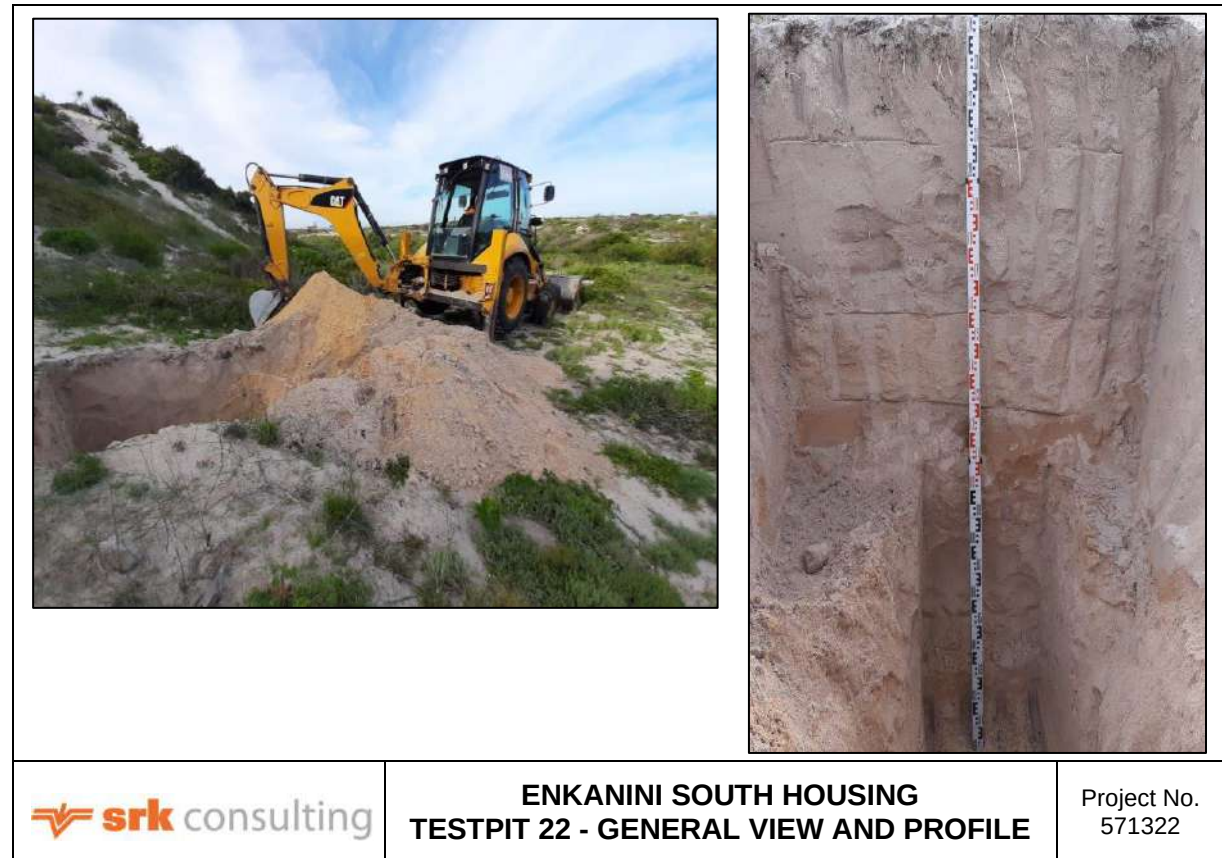
**ENKANINI SOUTH HOUSING
TESTPIT 12 - GENERAL VIEW AND PROFILE**

Project No.
571322











**ENKANINI SOUTH HOUSING
TESTPIT 25 - GENERAL VIEW AND PROFILE**

Project No.
571322



**ENKANINI SOUTH HOUSING
TESTPIT 26 - GENERAL VIEW AND PROFILE**

Project No.
571322





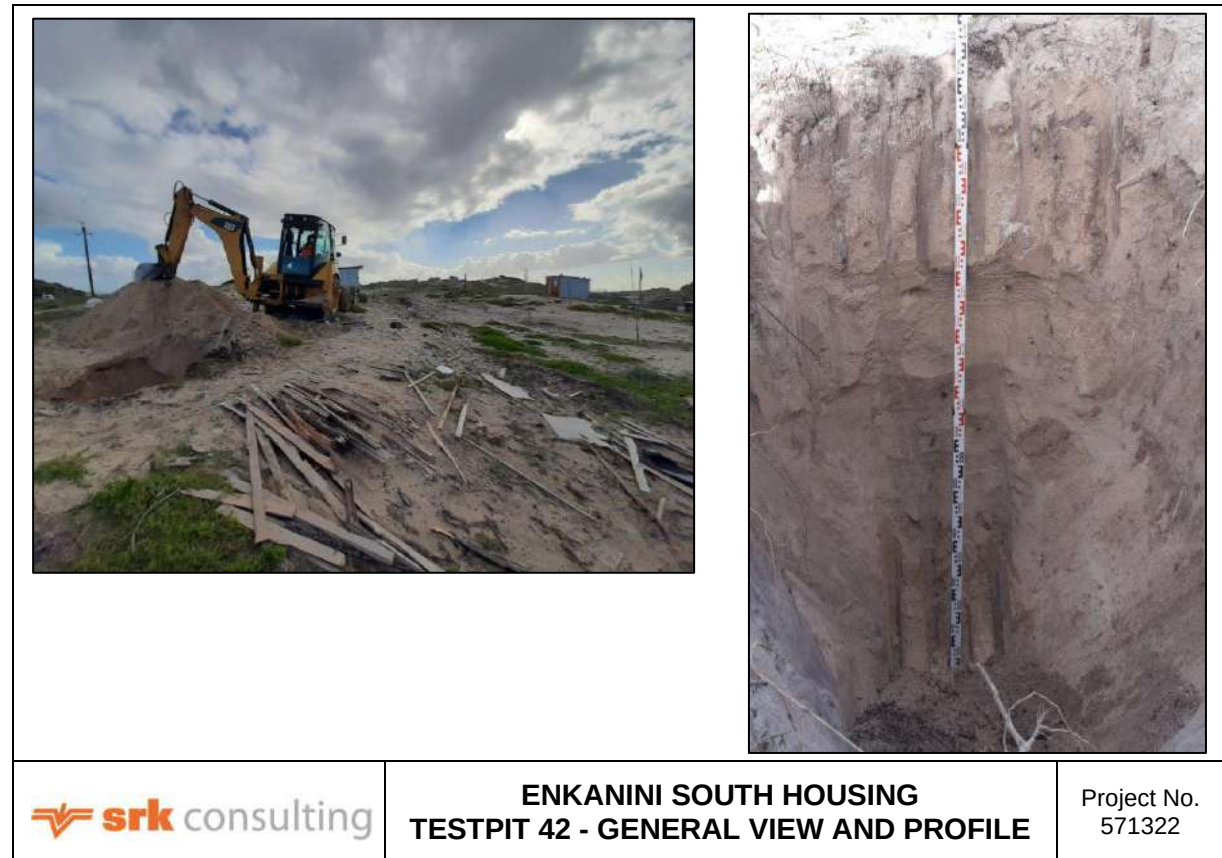


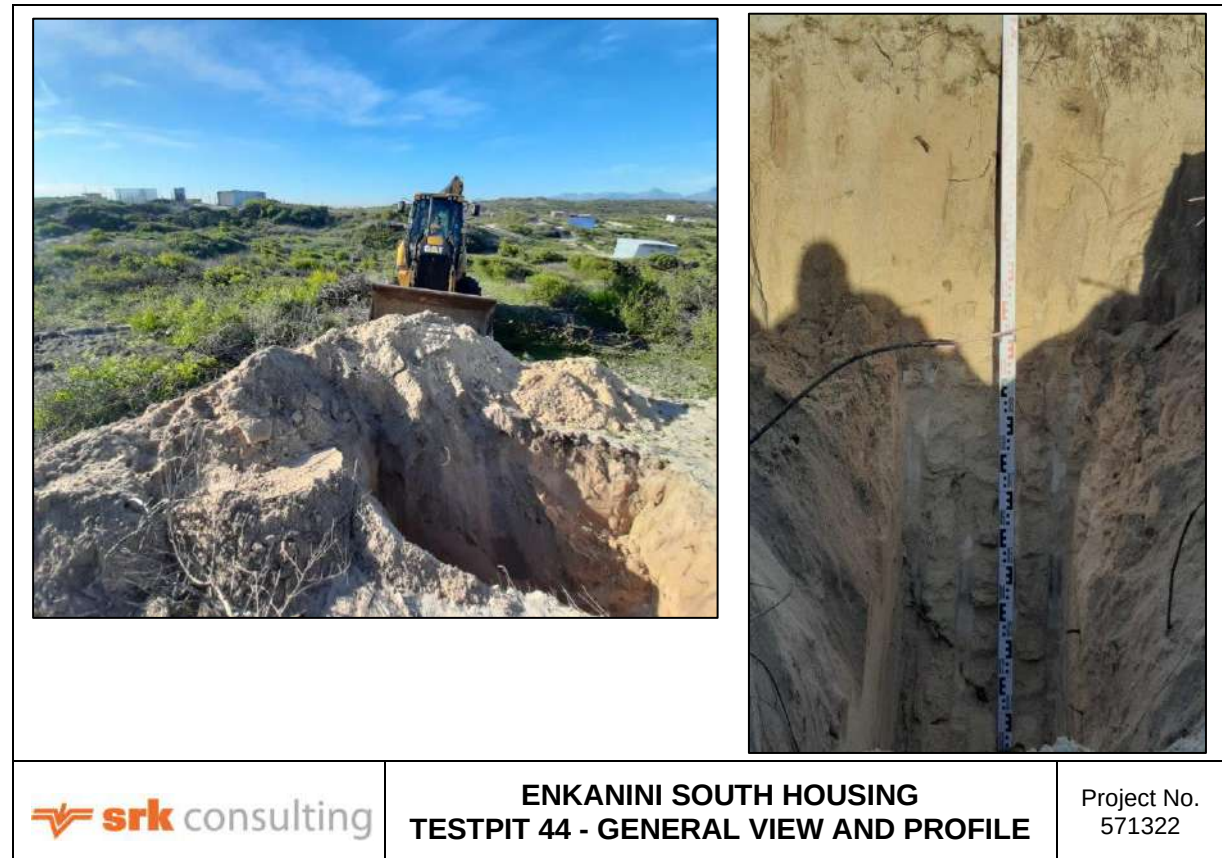


















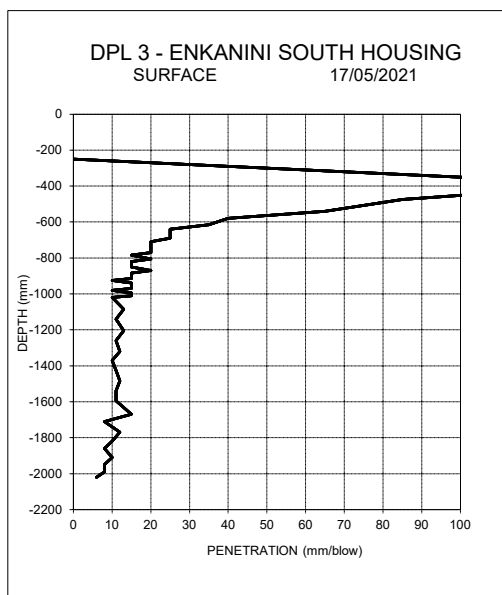
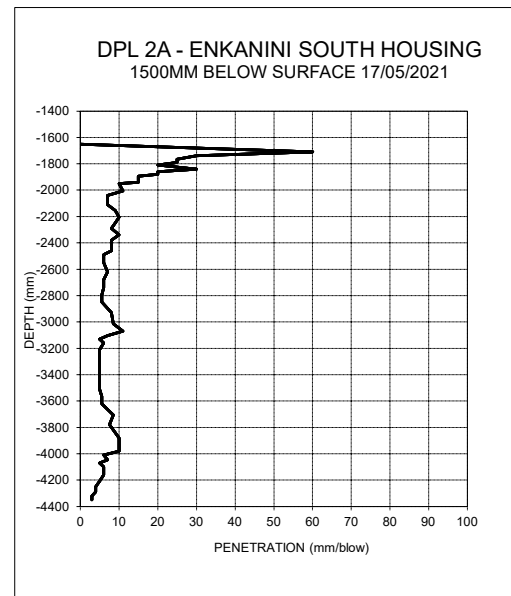
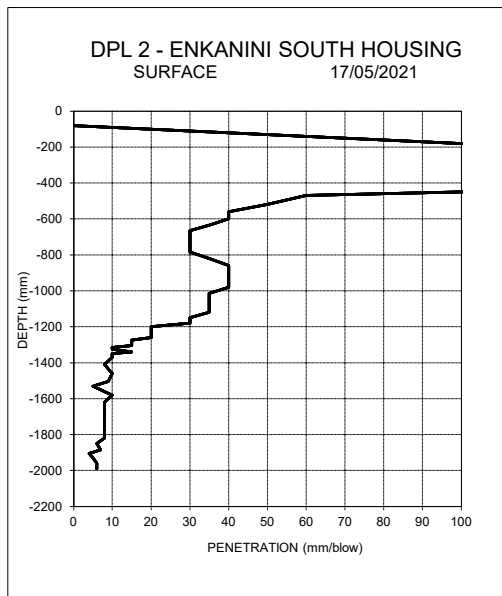
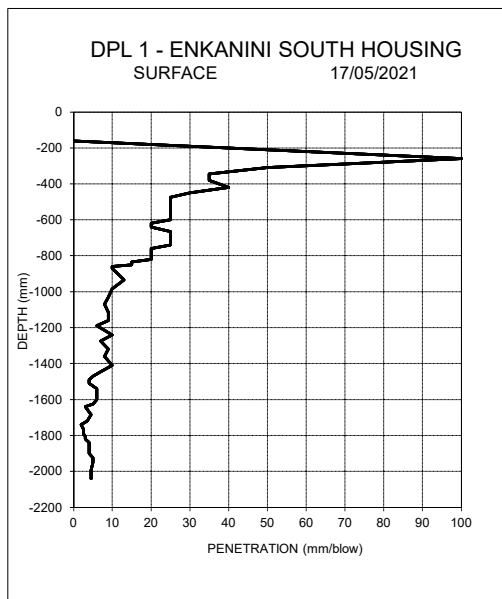






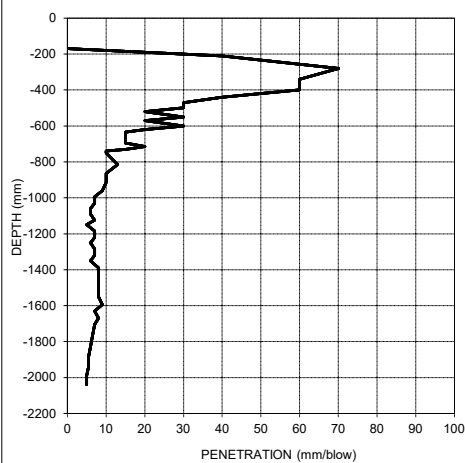


Appendix C: Dynamic Probe Light (DPL) Plots

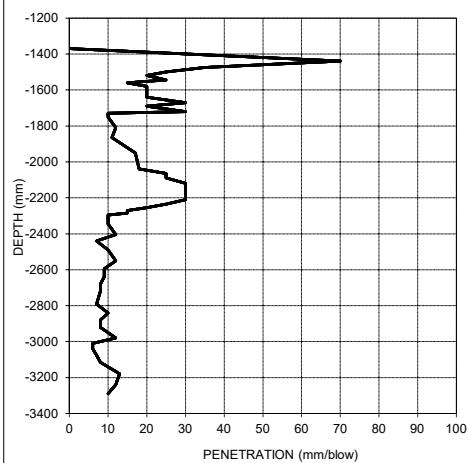
ENKANINI SOUTH 89 HA HOUSING DEVELOPMENT - GEOTECHNICAL INVESTIGATION - DPL PLOTS

ENKANINI SOUTH 89 HA HOUSING DEVELOPMENT - GEOTECHNICAL INVESTIGATION - DPL PLOTS

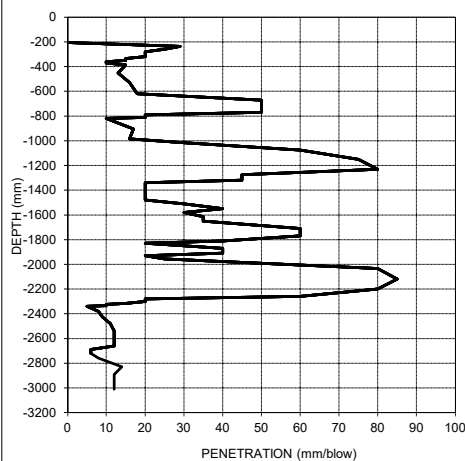
DPL 4 - ENKANINI SOUTH HOUSING
SURFACE 17/05/2021



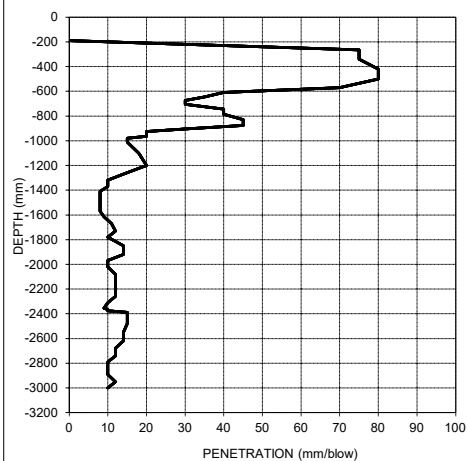
DPL 4A - ENKANINI SOUTH HOUSING
1300MM BELOW SURFACE 17/05/2021



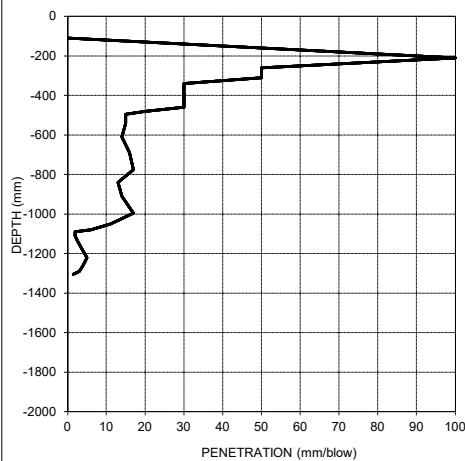
DPL 5 - ENKANINI SOUTH HOUSING
SURFACE 17/05/2021



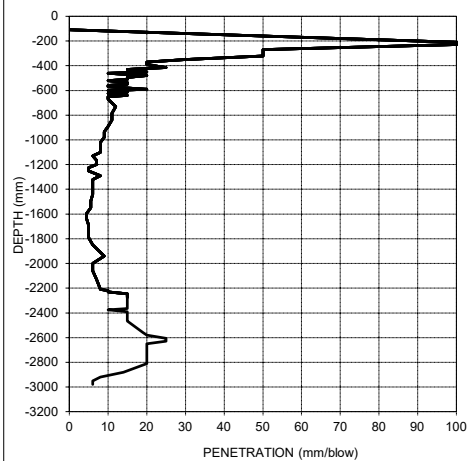
DPL 6 - ENKANINI SOUTH HOUSING
SURFACE 17/05/2021



DPL 7 - ENKANINI SOUTH HOUSING
SURFACE 17/05/2021

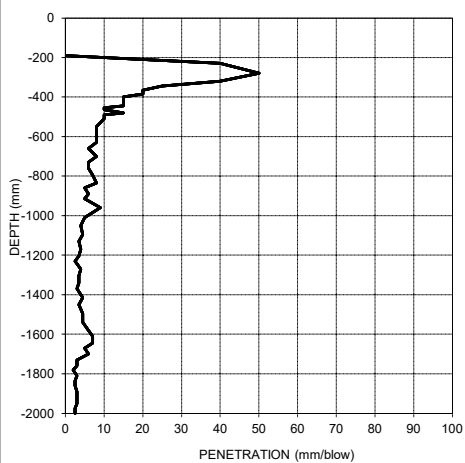


DPL 8 - ENKANINI SOUTH HOUSING
SURFACE 17/05/2021

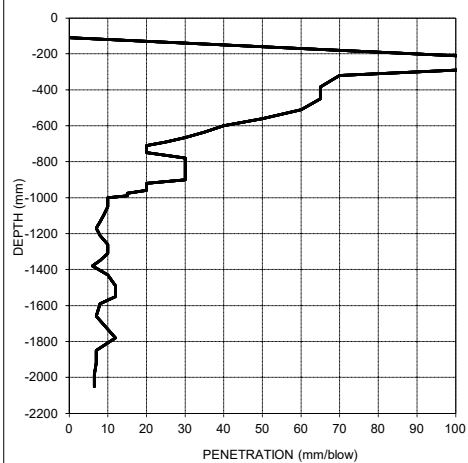


ENKANINI SOUTH 89 HA HOUSING DEVELOPMENT - GEOTECHNICAL INVESTIGATION - DPL PLOTS

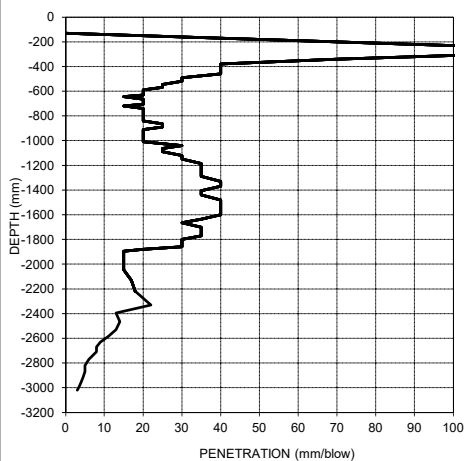
DPL 9 - ENKANINI SOUTH HOUSING
SURFACE 17/05/2021



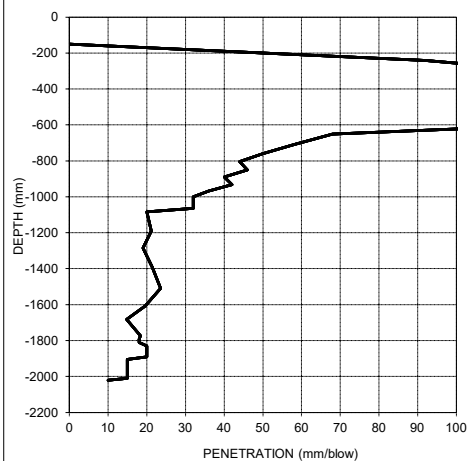
DPL 10 - ENKANINI SOUTH HOUSING
SURFACE 18/05/2021



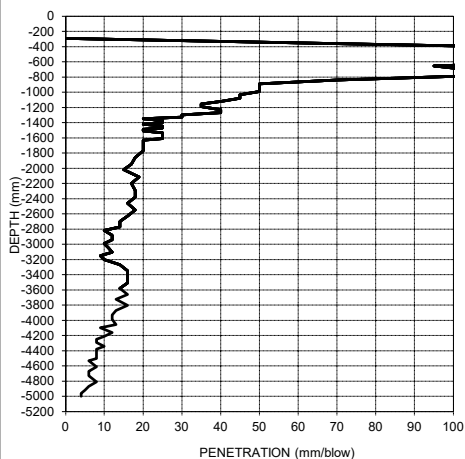
DPL 11 - ENKANINI SOUTH HOUSING
SURFACE 17/05/2021



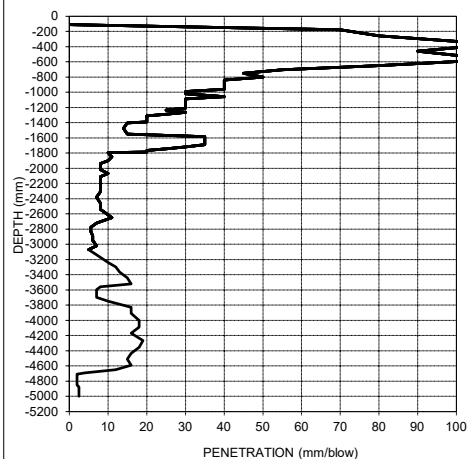
DPL 12 - ENKANINI SOUTH HOUSING
SURFACE 18/05/2021



DPL 13 - ENKANINI SOUTH HOUSING
SURFACE 24/05/2021



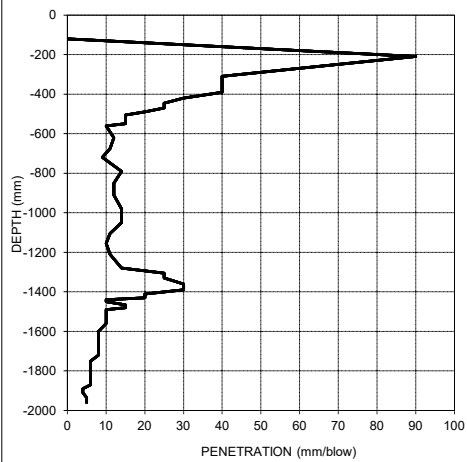
DPL 14 - ENKANINI SOUTH HOUSING
SURFACE 24/05/2021



ENKANINI SOUTH 89 HA HOUSING DEVELOPMENT - GEOTECHNICAL INVESTIGATION - DPL PLOTS

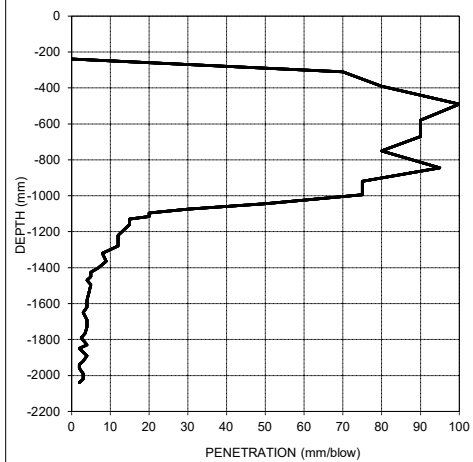
DPL 15 - ENKANINI SOUTH HOUSING
SURFACE

24/05/2021



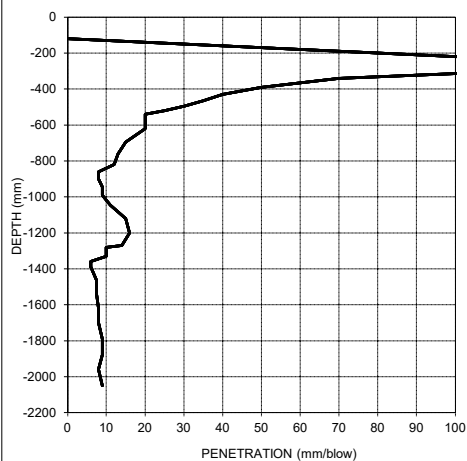
DPL 16 - ENKANINI SOUTH HOUSING
SURFACE

17/05/2021



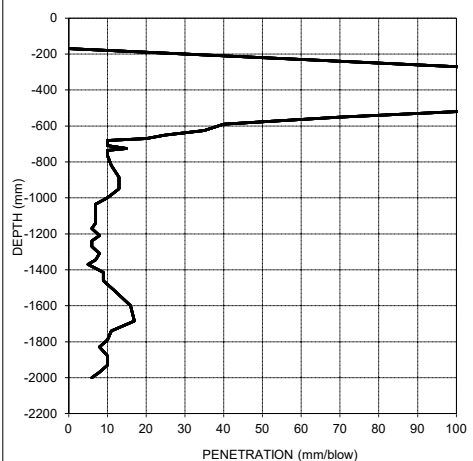
DPL 17 - ENKANINI SOUTH HOUSING
SURFACE

18/05/2021



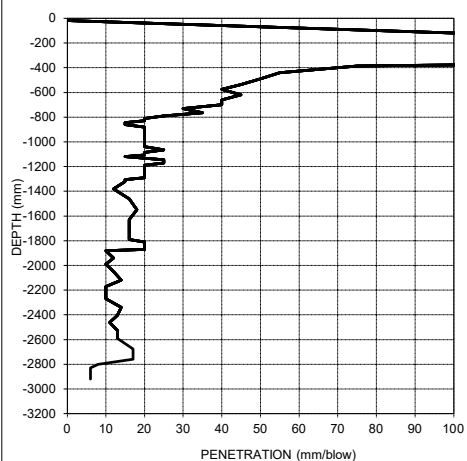
DPL 18 - ENKANINI SOUTH HOUSING
SURFACE

18/05/2021



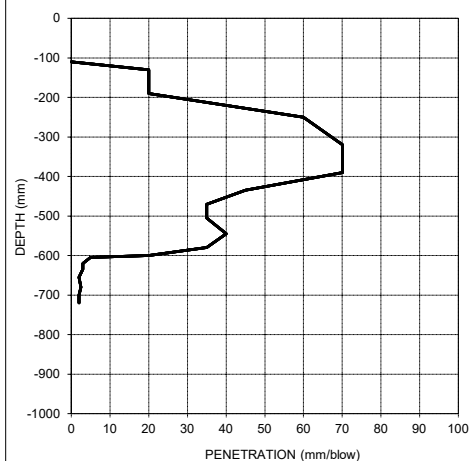
DPL 19 - ENKANINI SOUTH HOUSING
SURFACE

18/05/2021



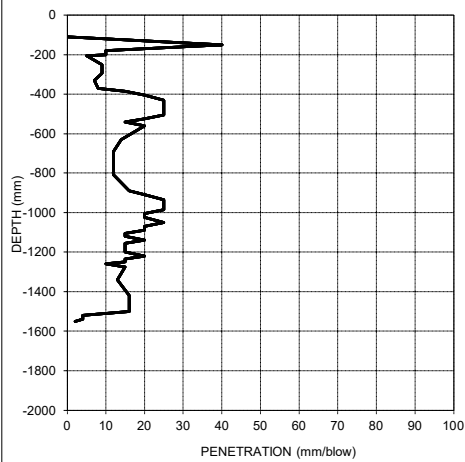
DPL 20 - ENKANINI SOUTH HOUSING
SURFACE

18/05/2021

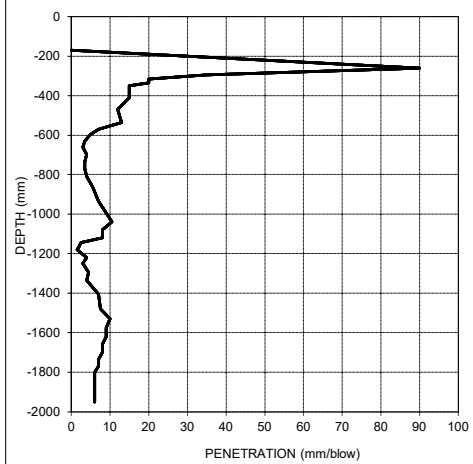


ENKANINI SOUTH 89 HA HOUSING DEVELOPMENT - GEOTECHNICAL INVESTIGATION - DPL PLOTS

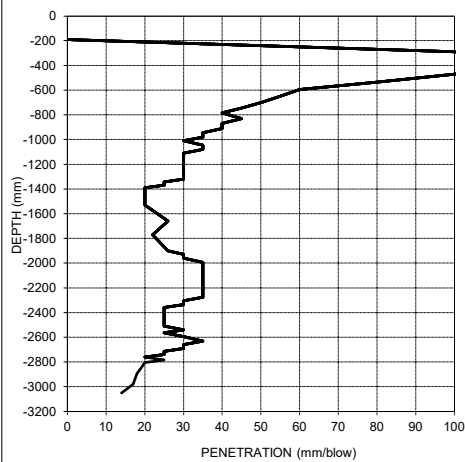
DPL 21 - ENKANINI SOUTH HOUSING
SURFACE 24/05/2021



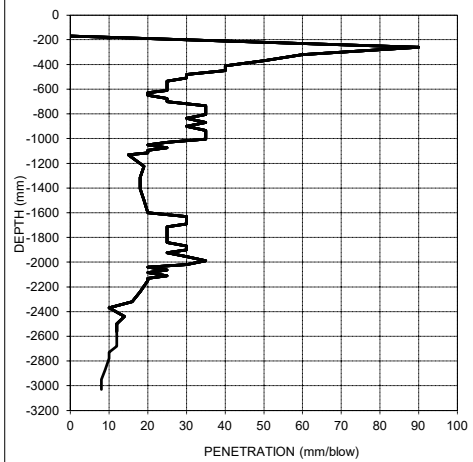
DPL 22 - ENKANINI SOUTH HOUSING
SURFACE 24/05/2021



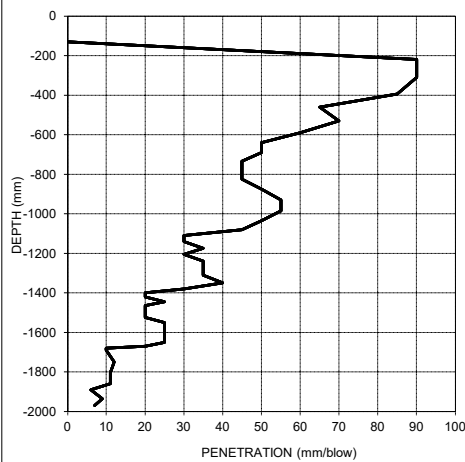
DPL 23 - ENKANINI SOUTH HOUSING
SURFACE 24/05/2021



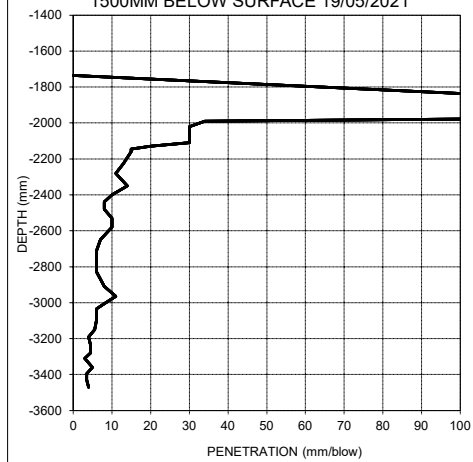
DPL 24 - ENKANINI SOUTH HOUSING
SURFACE 24/05/2021



DPL 25 - ENKANINI SOUTH HOUSING
SURFACE 19/05/2021

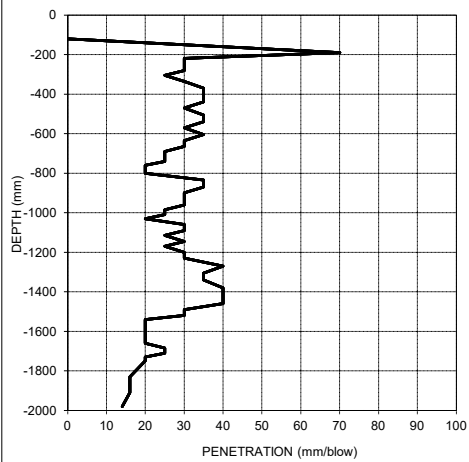


DPL 25A - ENKANINI SOUTH
HOUSING
1500MM BELOW SURFACE 19/05/2021

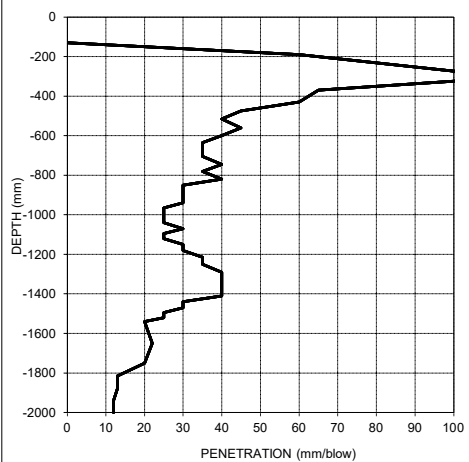


ENKANINI SOUTH 89 HA HOUSING DEVELOPMENT - GEOTECHNICAL INVESTIGATION - DPL PLOTS

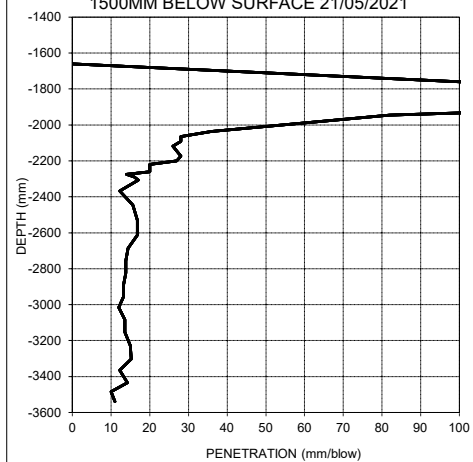
DPL 26 - ENKANINI SOUTH HOUSING
SURFACE 19/05/2021



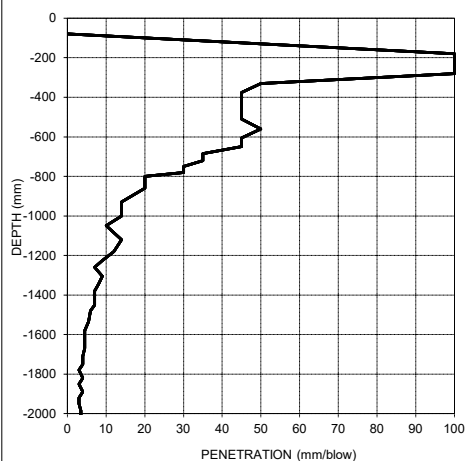
DPL 27 - ENKANINI SOUTH HOUSING
SURFACE 21/05/2021



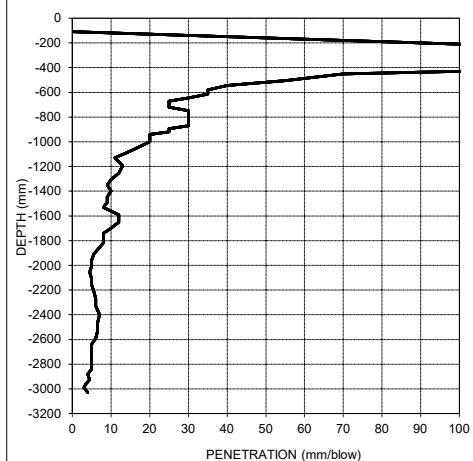
DPL 27A - ENKANINI SOUTH HOUSING
1500MM BELOW SURFACE 21/05/2021



DPL 28 - ENKANINI SOUTH HOUSING
SURFACE 24/05/2021

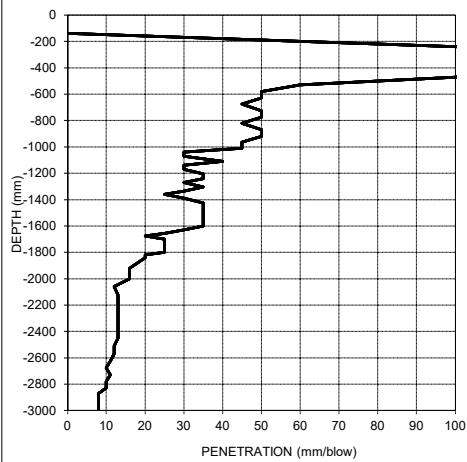


DPL 29 - ENKANINI SOUTH HOUSING
SURFACE 24/05/2021

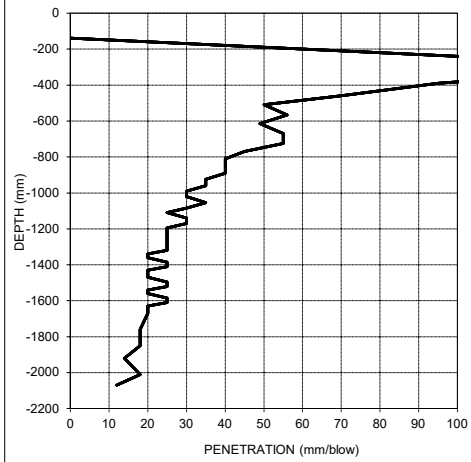


ENKANINI SOUTH 89 HA HOUSING DEVELOPMENT - GEOTECHNICAL INVESTIGATION - DPL PLOTS

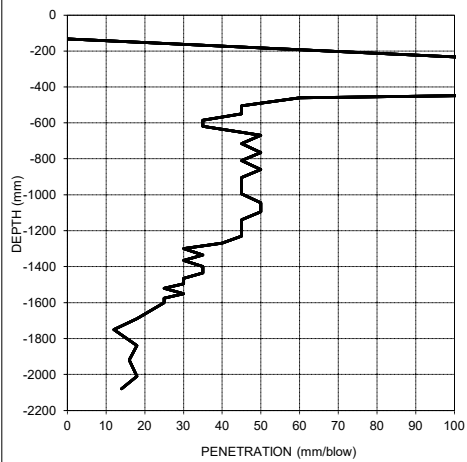
DPL 30 - ENKANINI SOUTH HOUSING
SURFACE 19/05/2021



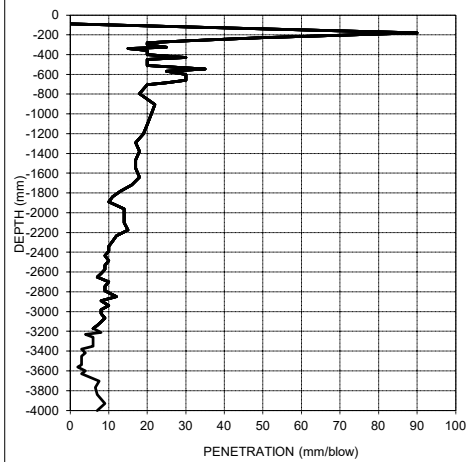
DPL 31 - ENKANINI SOUTH HOUSING
SURFACE 21/05/2021



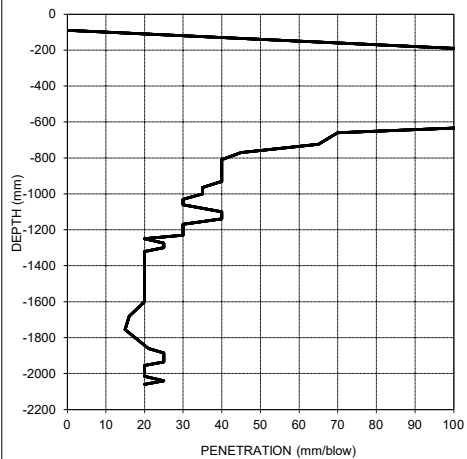
DPL 32 - ENKANINI SOUTH HOUSING
SURFACE 21/05/2021



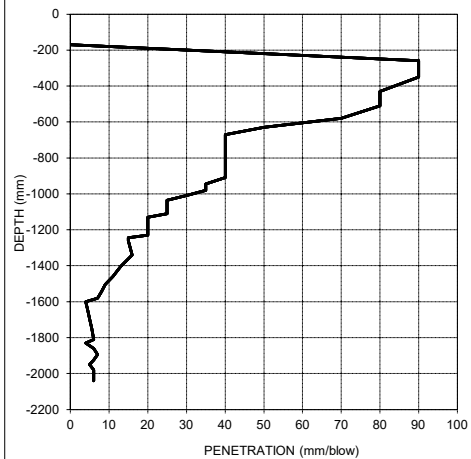
DPL 33 - ENKANINI SOUTH HOUSING
SURFACE 24/05/2021



DPL 34 - ENKANINI SOUTH HOUSING
SURFACE 21/05/2021

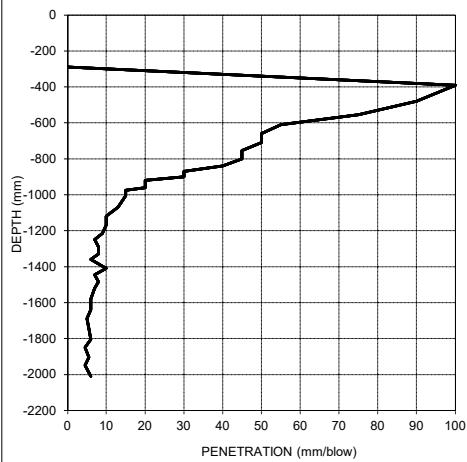


DPL 35 - ENKANINI SOUTH HOUSING
SURFACE 21/05/2021

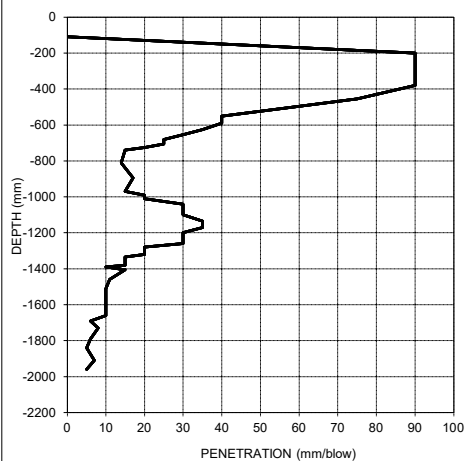


ENKANINI SOUTH 89 HA HOUSING DEVELOPMENT - GEOTECHNICAL INVESTIGATION - DPL PLOTS

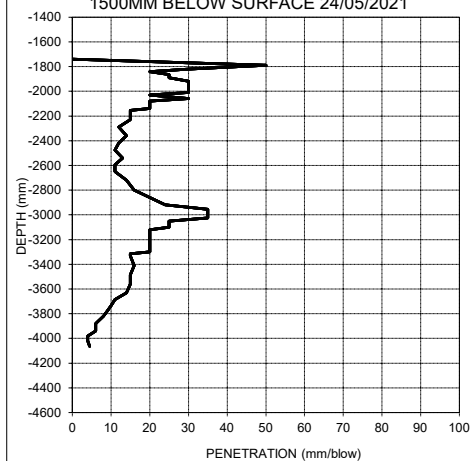
DPL 36 - ENKANINI SOUTH HOUSING
SURFACE 21/05/2021



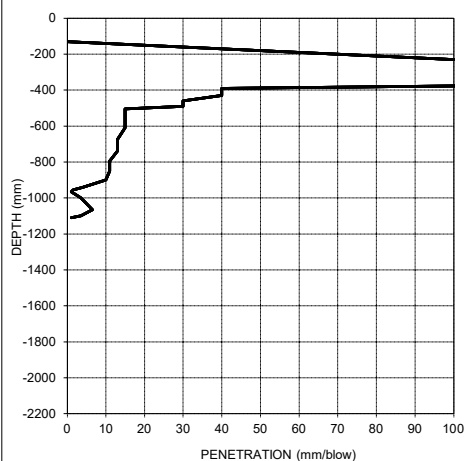
DPL 37 - ENKANINI SOUTH HOUSING
SURFACE 24/05/2021



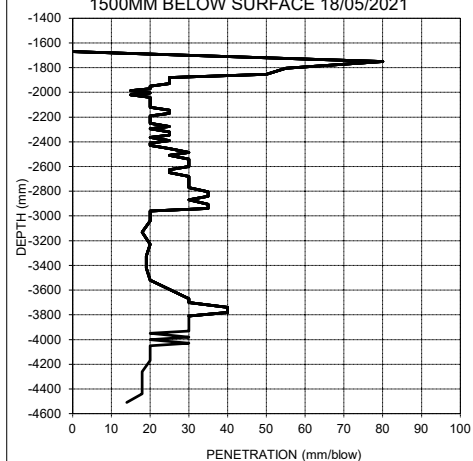
DPL 37A - ENKANINI SOUTH HOUSING
1500MM BELOW SURFACE 24/05/2021



DPL 38 - ENKANINI SOUTH HOUSING
SURFACE 24/05/2021

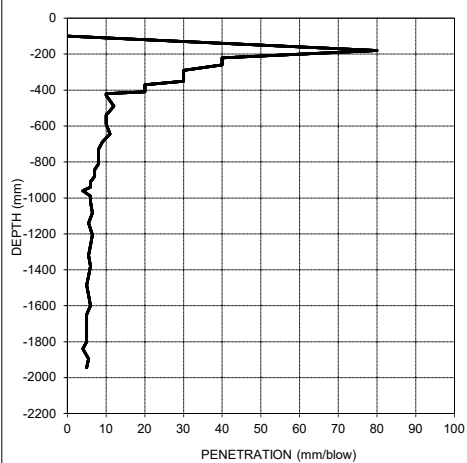


DPL 39A - ENKANINI SOUTH HOUSING
1500MM BELOW SURFACE 18/05/2021

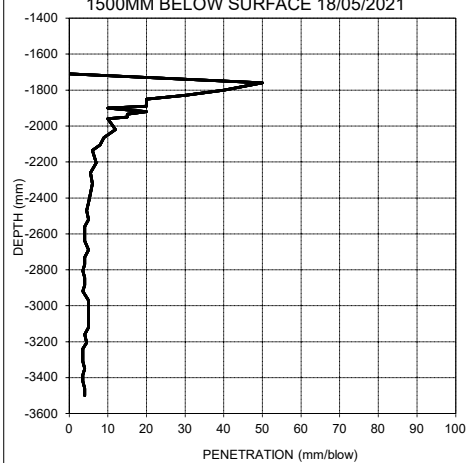


ENKANINI SOUTH 89 HA HOUSING DEVELOPMENT - GEOTECHNICAL INVESTIGATION - DPL PLOTS

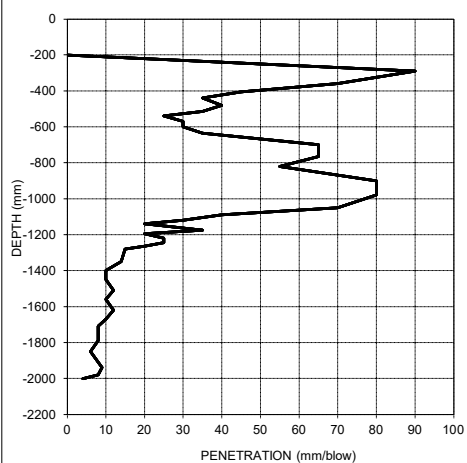
DPL 40 - ENKANINI SOUTH HOUSING
SURFACE 18/05/2021



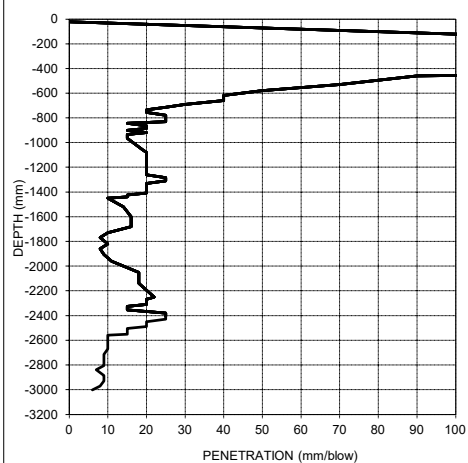
DPL 40A - ENKANINI SOUTH HOUSING
1500MM BELOW SURFACE 18/05/2021



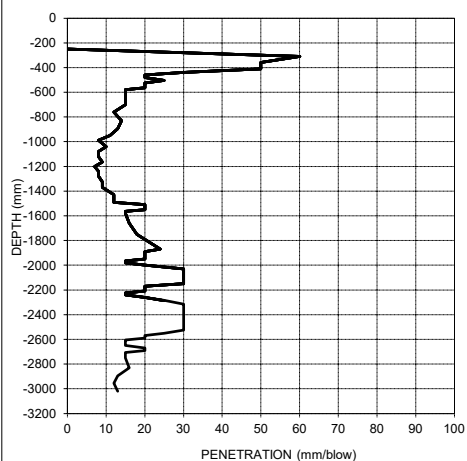
DPL 41 - ENKANINI SOUTH HOUSING
SURFACE 21/05/2021



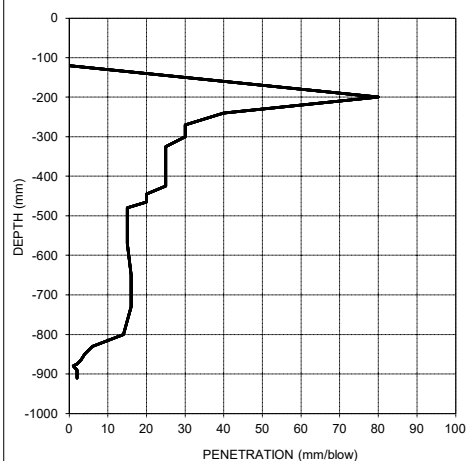
DPL 42 - ENKANINI SOUTH HOUSING
SURFACE 21/05/2021



DPL 43 - ENKANINI SOUTH HOUSING
SURFACE 18/05/2021

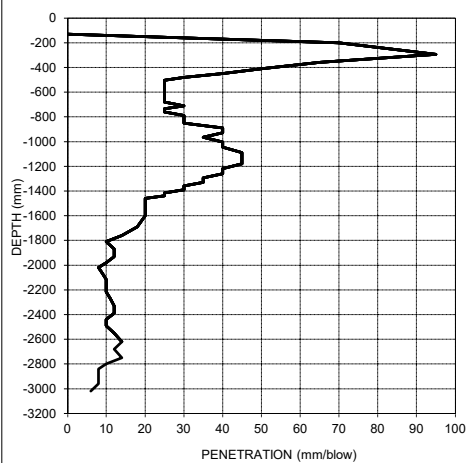


DPL 44 - ENKANINI SOUTH HOUSING
SURFACE 18/05/2021

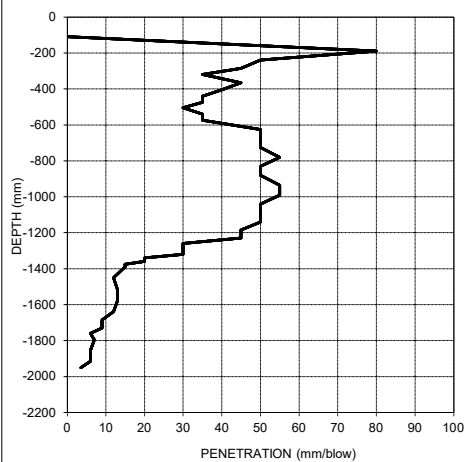


ENKANINI SOUTH 89 HA HOUSING DEVELOPMENT - GEOTECHNICAL INVESTIGATION - DPL PLOTS

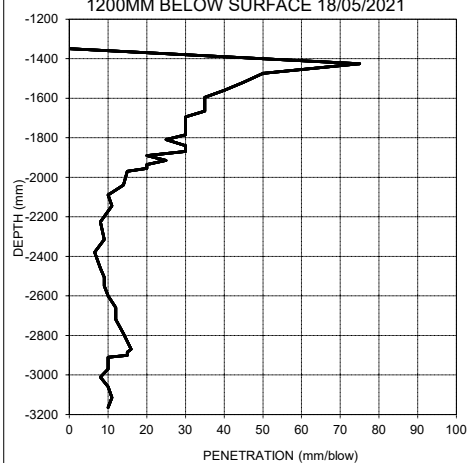
DPL 45 - ENKANINI SOUTH HOUSING
SURFACE 18/05/2021



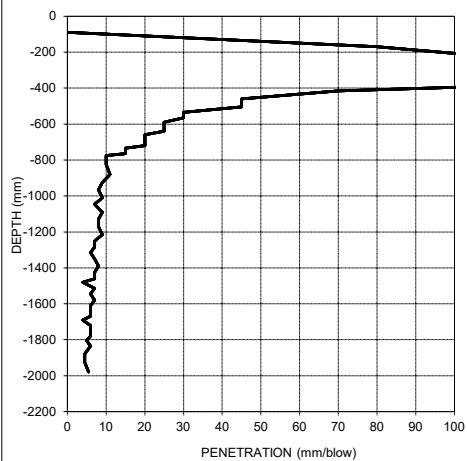
DPL 46 - ENKANINI SOUTH HOUSING
SURFACE 18/05/2021



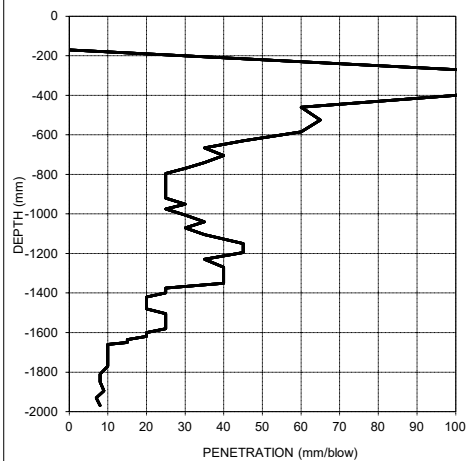
DPL 46A - ENKANINI SOUTH
HOUSING
1200MM BELOW SURFACE 18/05/2021



DPL 47 - ENKANINI SOUTH HOUSING
SURFACE 18/05/2021



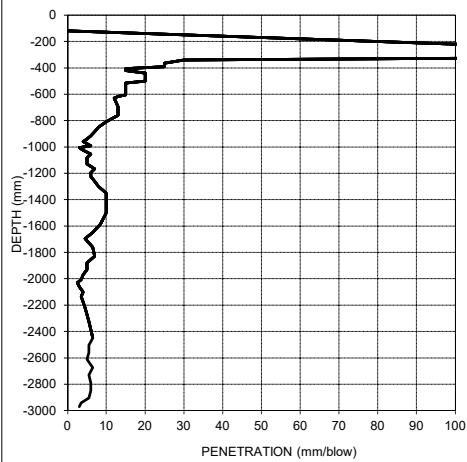
DPL 48 - ENKANINI SOUTH HOUSING
SURFACE 19/05/2021



ENKANINI SOUTH 89 HA HOUSING DEVELOPMENT - GEOTECHNICAL INVESTIGATION - DPL PLOTS

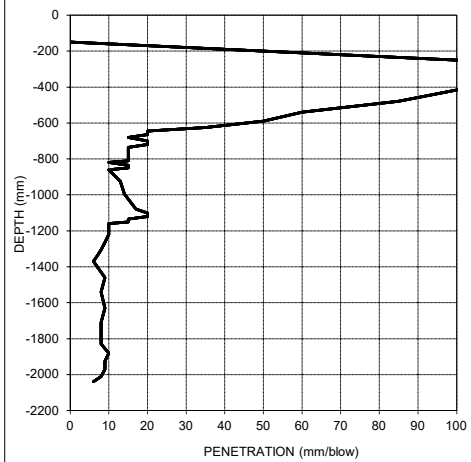
DPL 49 - ENKANINI SOUTH HOUSING
SURFACE

19/05/2021



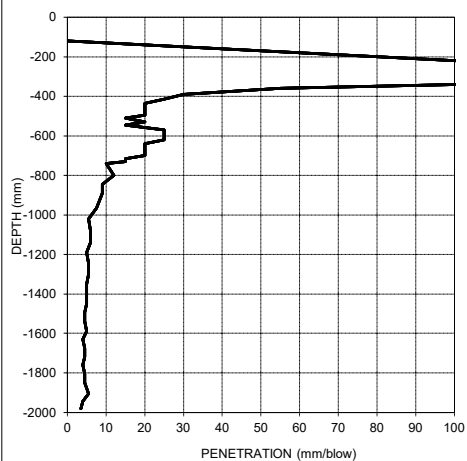
DPL 50 - ENKANINI SOUTH HOUSING
SURFACE

19/05/2021



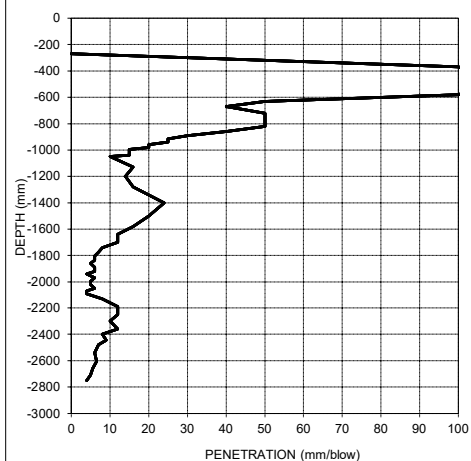
DPL 51 - ENKANINI SOUTH HOUSING
SURFACE

19/05/2021



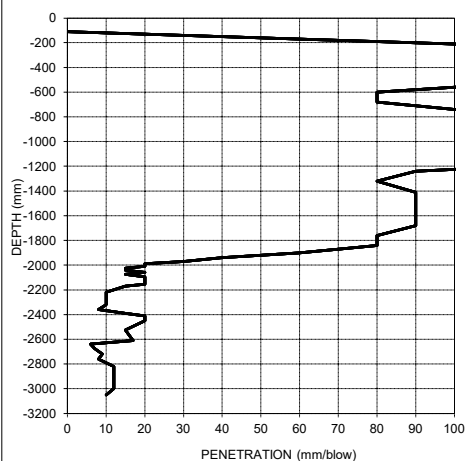
DPL 52 - ENKANINI SOUTH HOUSING
SURFACE

19/05/2021



DPL 53 - ENKANINI SOUTH HOUSING
SURFACE

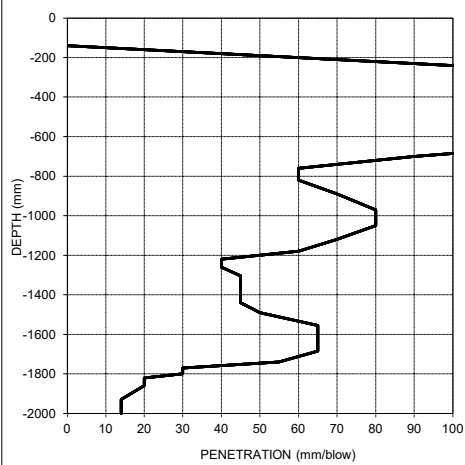
19/05/2021



ENKANINI SOUTH 89 HA HOUSING DEVELOPMENT - GEOTECHNICAL INVESTIGATION - DPL PLOTS

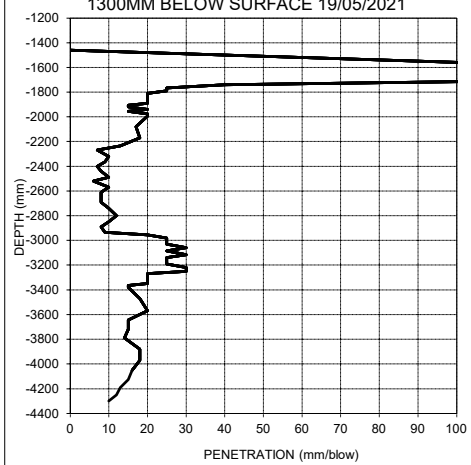
DPL 54 - ENKANINI SOUTH HOUSING
SURFACE

19/05/2021



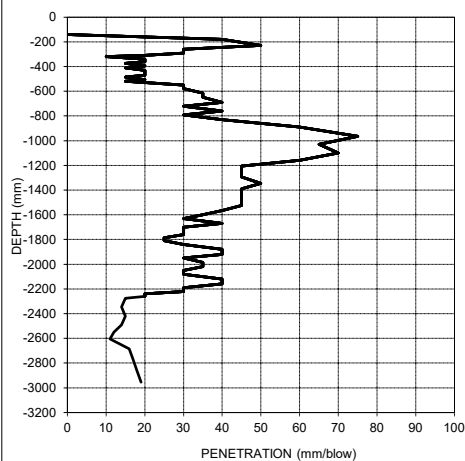
DPL 54A - ENKANINI SOUTH HOUSING
1300MM BELOW SURFACE

19/05/2021



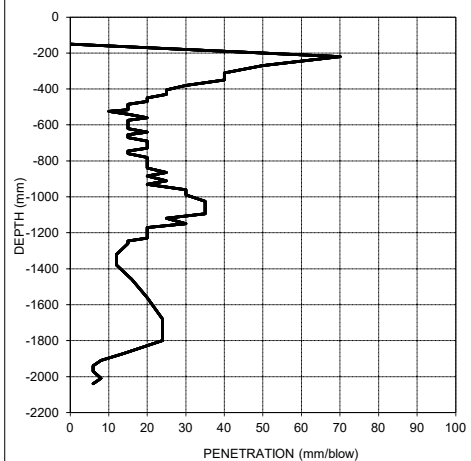
DPL 55 - ENKANINI SOUTH HOUSING
SURFACE

19/05/2021



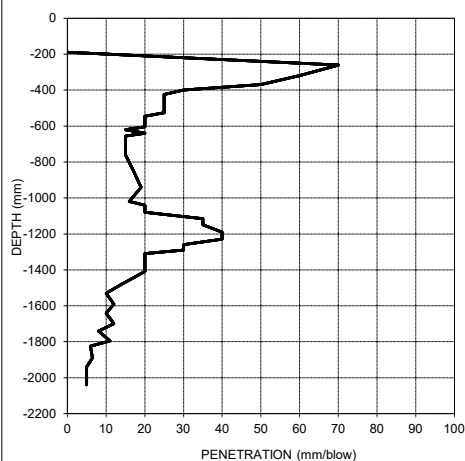
DPL 56 - ENKANINI SOUTH HOUSING
SURFACE

19/05/2021

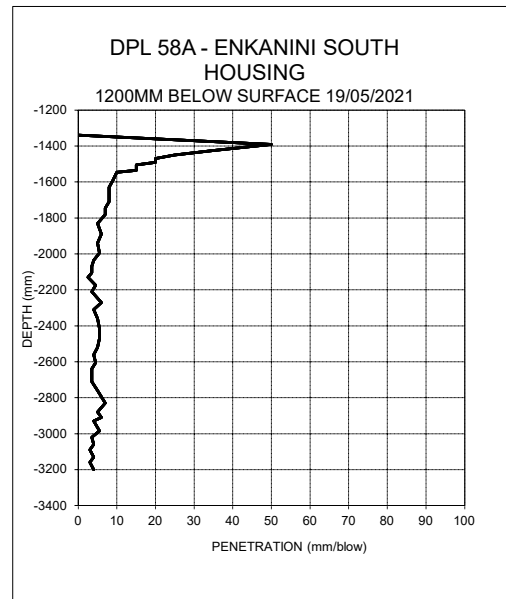
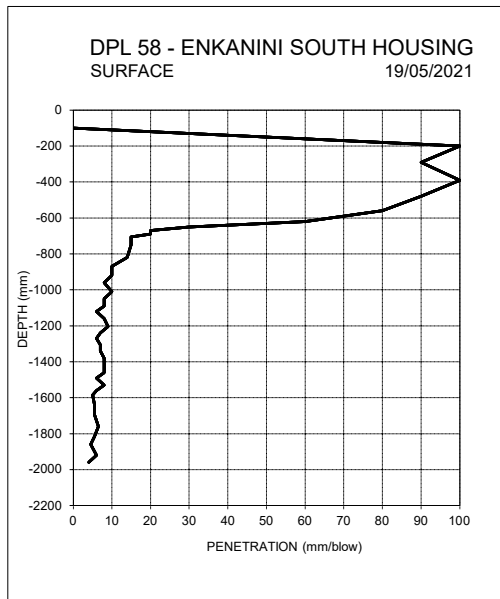


DPL 57 - ENKANINI SOUTH HOUSING
SURFACE

19/05/2021



ENKANINI SOUTH 89 HA HOUSING DEVELOPMENT - GEOTECHNICAL INVESTIGATION - DPL PLOTS



Appendix D: Laboratory Test Results

Customer : **SRK Consulting (South Africa) (Pty) Ltd**

P.O Box 55291, Northlands

South Africa

2116

Attention : Mr D Du Preez

Project : Enkanini Housing

Date Received : 25/05/2021

Date Reported : 03/05/2021

Req. Number : 14787

Date Sampled: 25/05/2021

FOUNDATION INDICATOR ASTM D422

Material Description:	Light Brown Sand	Sample Number:	15940		
Position:	TP1	Liquid Limit	N.P	Linear Shrinkage	0,0
Depth:	0,40-0,9m	Plasticity Index	N.P	Insitu M/C%	6,9

PH (TMH1 A20)

-

(TMH1 A21T)
Conductivity
s.m⁻¹

-

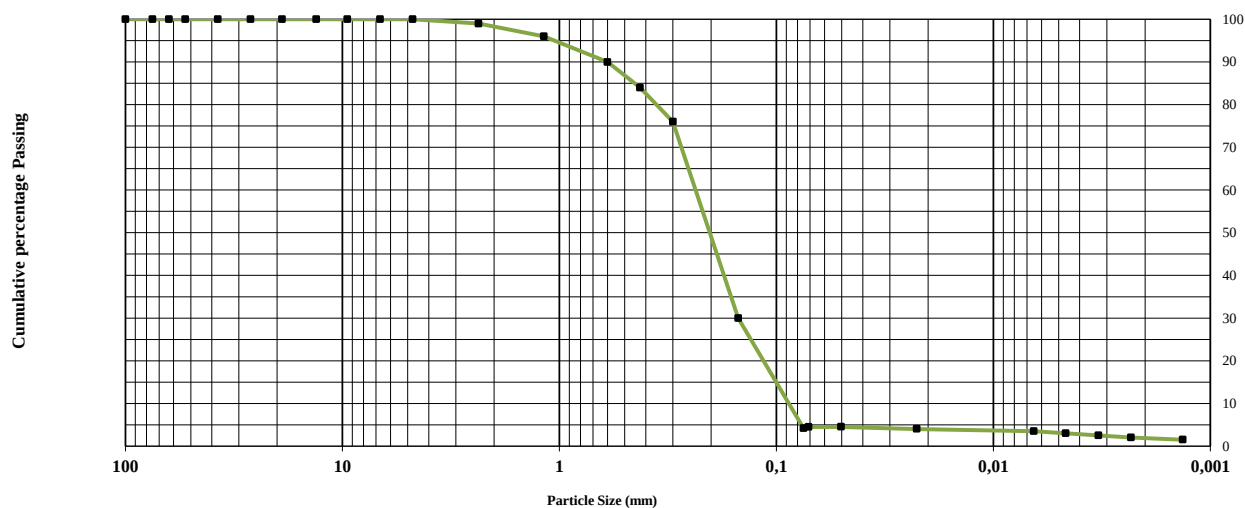
SG (TMH1 A12T)*

2,577

SIEVE ANALYSIS (TMH 1 A1a)***HYDROMETER ASTM D422**

100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,071	0,050	0,023	0,007	0,005	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	100	100	99	96	90	84	76	30	4,2	5	5	4	4	3	3	2	2

% Passing

Particle Size Distribution

% Gravel

2

% Sand

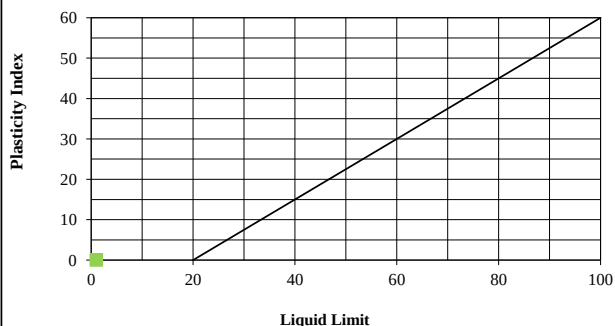
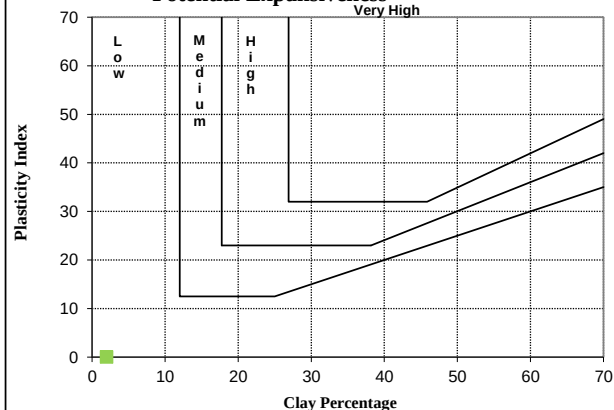
93

% Silt

3

% Clay

2

Plasticity Chart
A Line**Potential Expansiveness**

NOTE: All tests marked with (*) means that those test methods are not accredited.

Customer : **SRK Consulting (South Africa) (Pty) Ltd**

P.O Box 55291, Northlands

South Africa

2116

Attention : Mr D Du Preez

Project : Enkanini Housing

Date Received : 25/05/2021

Date Reported : 03/05/2021

Req. Number : 14787

FOUNDATION INDICATOR ASTM D422

Material Description:	Light Brown Sand	Sample Number:	15941		
Position:	TP8	Liquid Limit	N/A	Linear Shrinkage	0,0
Depth:	0,60-1,00m	Plasticity Index	N/A	Insitu M/C%	5,9

PH (TMH1 A20)*

-

(TMH1 A21T)*
Conductivity
s.m⁻¹

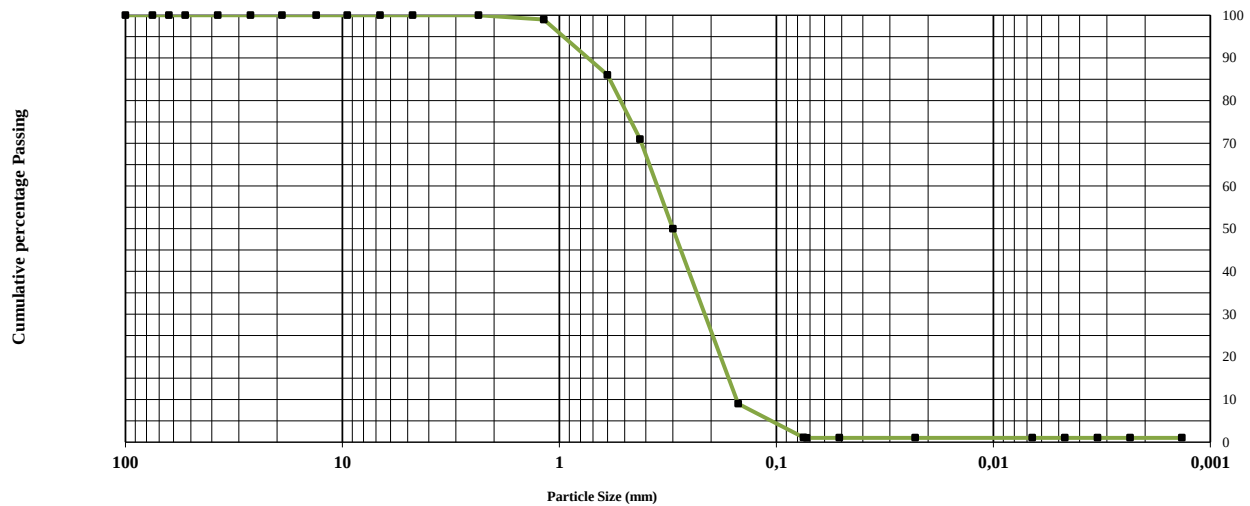
-

SG (TMH1 A12T)*

2,551

SIEVE ANALYSIS (TMH 1 A1a)***HYDROMETER ASTM D422**

100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,072	0,051	0,023	0,007	0,005	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	100	100	100	99	86	71	50	9	1,1	1	1	1	1	1	1	1	1
% Passing																									

Particle Size Distribution

% Gravel

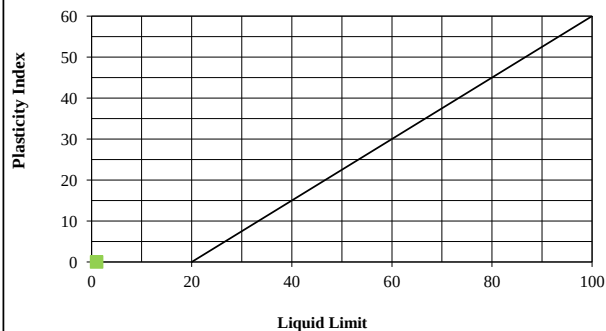
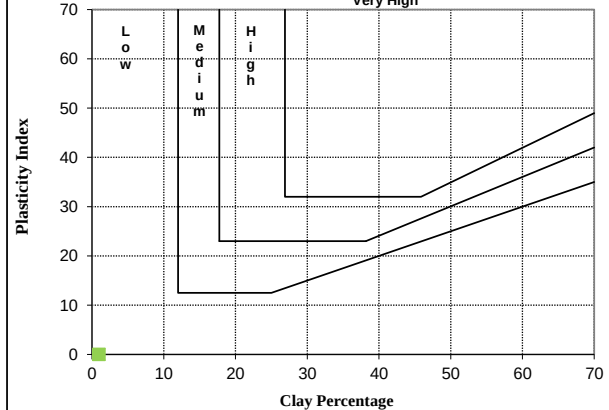
% Sand

99

% Silt

% Clay

1

Plasticity Chart
A Line**Potential Expansiveness**
Very High

NOTE: All tests marked with (*) means that those test methods are not accredited.

Customer : **SRK Consulting (South Africa) (Pty) Ltd**

P.O Box 55291, Northlands

South Africa

2116

Attention : Mr D Du Preez

Project : Enkanini Housing

Date Received : 25/05/2021

Date Reported : 03/06/2021

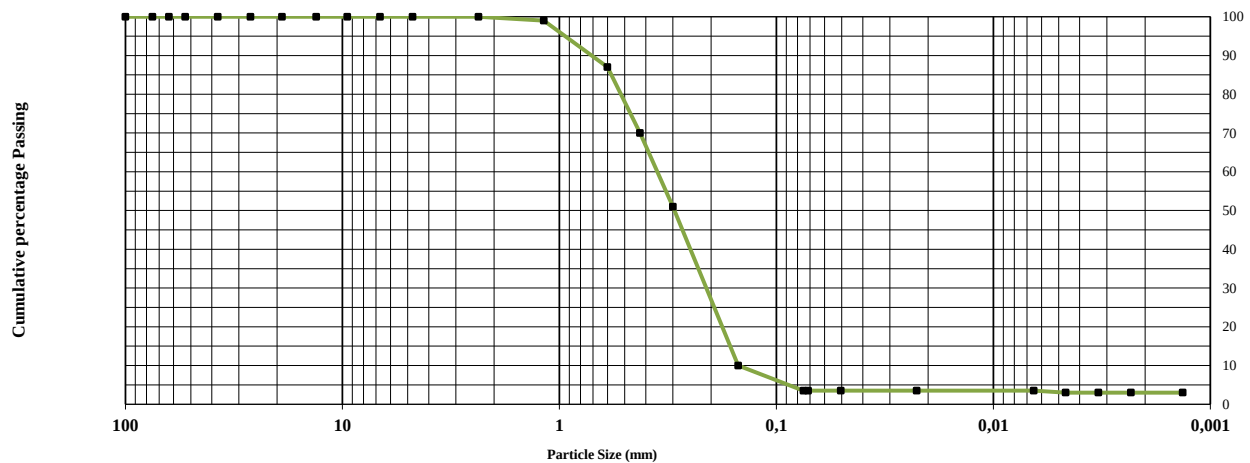
Req. Number : 14787

MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

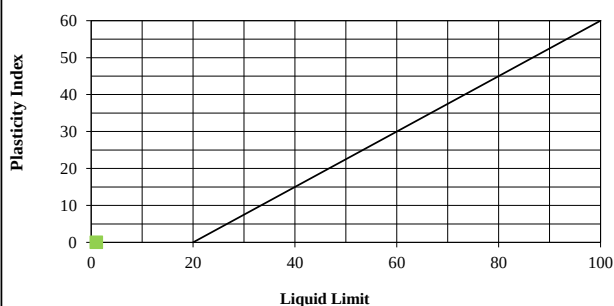
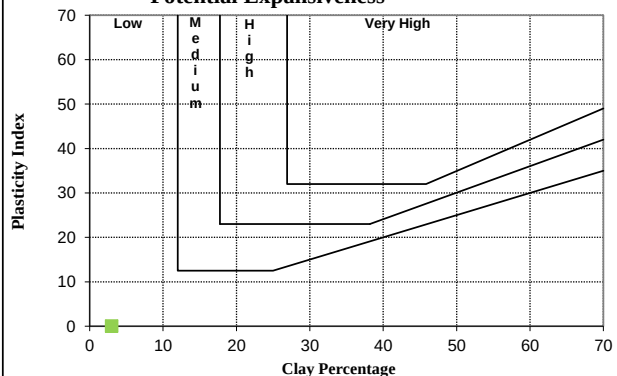
Material Description:	Light Brown Sand	Sample Number:	15942		
Position:	TP9	Liquid Limit	N.P	Linear Shrinkage	0,0
Depth:	0,3-0,8m	Plasticity Index	N.P	Insitu M/C%	6,5

pH (TMH1 A20)*	-	Conductivity s.m ⁻¹ (TMH1 A21T)*	-	SG (TMH1 A12T)*	2,604
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SIEVE ANALYSIS (TMH 1 A1a)*																		HYDROMETER ASTM D422									
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,071	0,050	0,023	0,007	0,005	0,003	0,002	0,001		
100	100	100	100	100	100	100	100	100	100	100	100	99	87	70	51	10	3,5	4	4	4	4	3	3	3	3		
% Passing																											
MOD AASHTO SANS 3001 GR30											CBR SANS 3001 GR40																
OMC%		12,4									COMP MC		% SWELL		100%		98%		97%		95%		93%		90%		
MDD(KG/M³)		1611									12,2		0		13		11		10		9		8		7		

Particle Size Distribution

% Gravel		% Sand	96	% Silt	1	% Clay	3
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Plasticity Chart
A Line**Potential Expansiveness**

NOTE: All tests marked with (*) means that those test methods are not accredited.

Customer : **SRK Consulting (South Africa) (Pty) Ltd**
P.O Box 55291, Northlands
South Africa
2116
Attention : Mr D Du Preez

Project : Enkanini Housing
Date Received : 25/05/2021
Date Reported : 03/06/2021
Req. Number : 14787

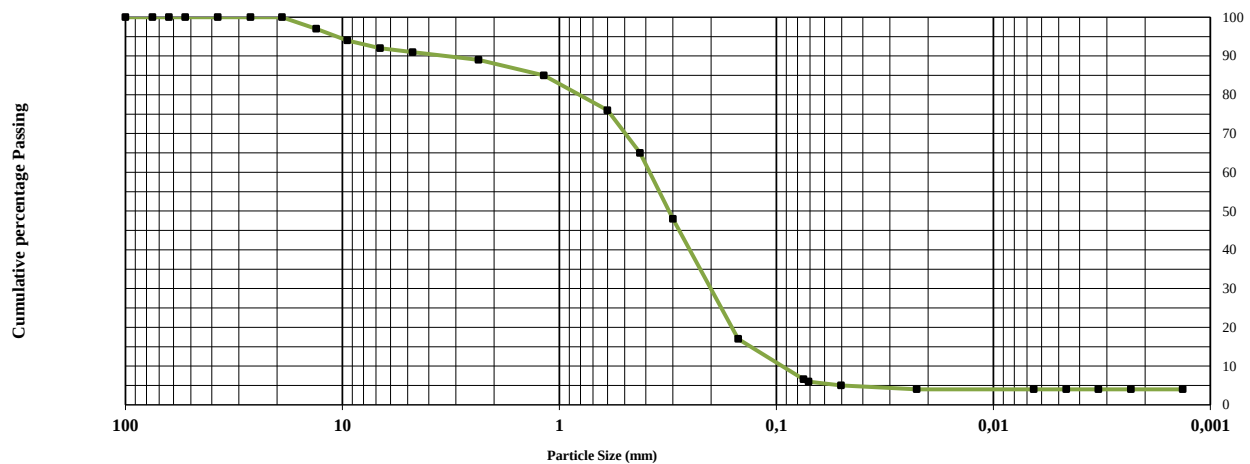
MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

Material Description:	Light Brown Sand	Sample Number:	15943		
Position:	TP20	Liquid Limit	N.P	Linear Shrinkage	0,0
Depth:	0,8-1,20m	Plasticity Index	N.P	Insitu M/C%	6,6

PH (TMH1 A20)*	-	(TMH1 A21T)* Conductivity s.m ⁻¹	-	SG (TMH1 A12T)*	2,632
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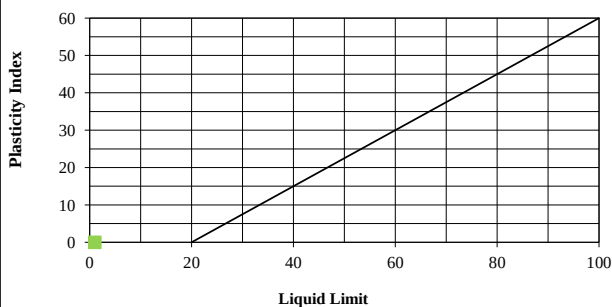
SIEVE ANALYSIS (TMH 1 A1a)*																	HYDROMETER ASTM D422									
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,071	0,050	0,023	0,007	0,005	0,003	0,002	0,001	
100	100	100	100	100	100	100	97	94	92	91	89	85	76	65	48	17	6,6	6	5	4	4	4	4	4	4	
% Passing																										
MOD AASHTO SANS 3001 GR30										CBR SANS 3001 GR40																
OMC%		12,4									COMP MC		% SWELL		100%		98%		97%		95%		93%		90%	
MDD(KG/M³)		1725									12		0		30		23		19		14		11		7	

Particle Size Distribution

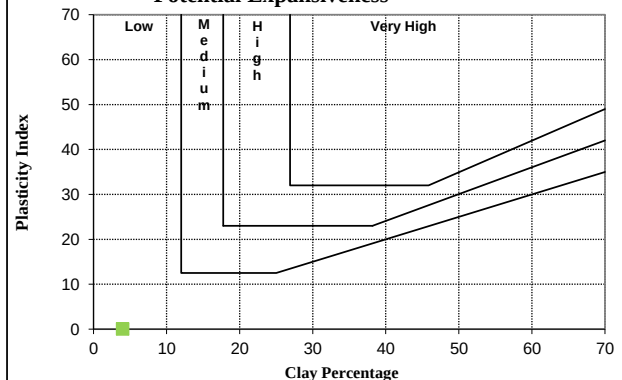


% Gravel	12	% Sand	83	% Silt	1	% Clay	4
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Plasticity Chart
A Line



Potential Expansiveness



NOTE: All tests marked with (*) means that those test methods are not accredited.

Customer : **SRK Consulting (South Africa) (Pty) Ltd**

P.O Box 55291, Northlands

South Africa

2116

Attention : Mr D Du Preez

Project : Enkanini Housing

Date Received : 25/05/2021

Date Reported : 03/05/2021

Req. Number : 14787

FOUNDATION INDICATOR ASTM D422

Material Description:	Light Brown Sand	Sample Number:	15944		
Position:	TP22	Liquid Limit	N/A	Linear Shrinkage	0,0
Depth:	0,40-0,90m	Plasticity Index	N/A	Insitu M/C%	6,2

PH (TMH1 A20)*

-

(TMH1 A21T)*
Conductivity
s.m⁻¹

-

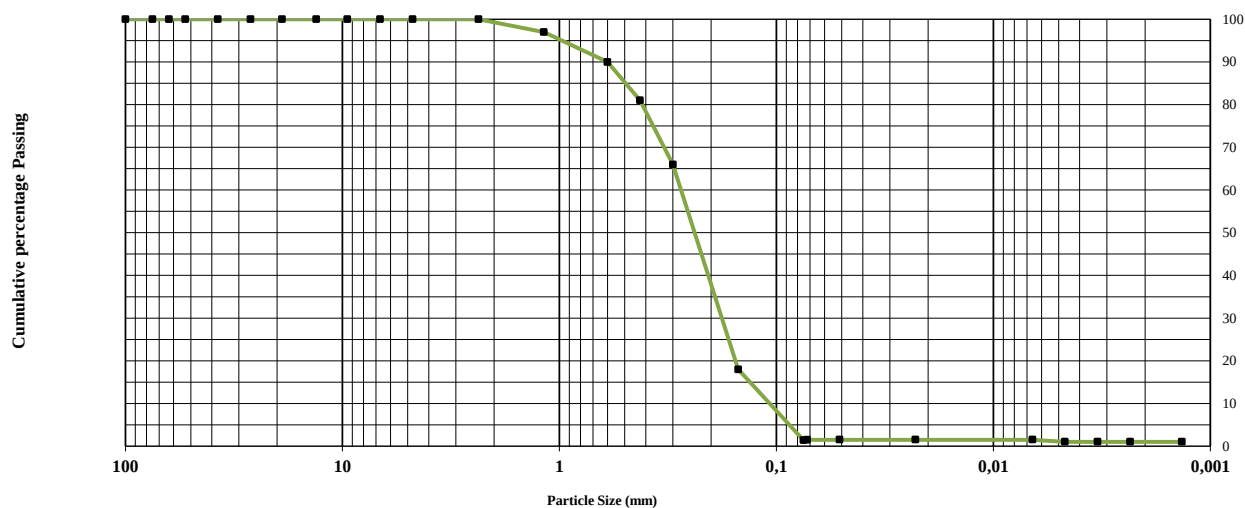
SG (TMH1 A12T)*

2,577

SIEVE ANALYSIS (TMH 1 A1a)***HYDROMETER ASTM D422**

100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,072	0,051	0,023	0,007	0,005	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	100	100	100	97	90	81	66	18	1,4	2	2	2	2	1	1	1	1

% Passing

Particle Size Distribution

% Gravel

1

% Sand

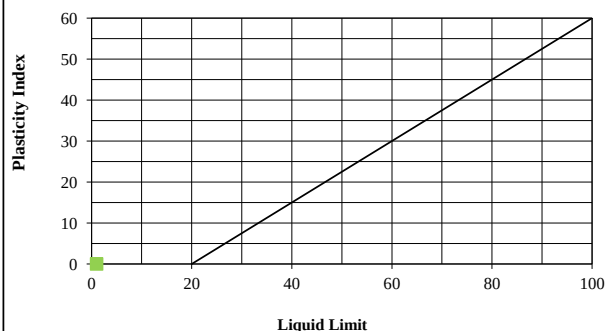
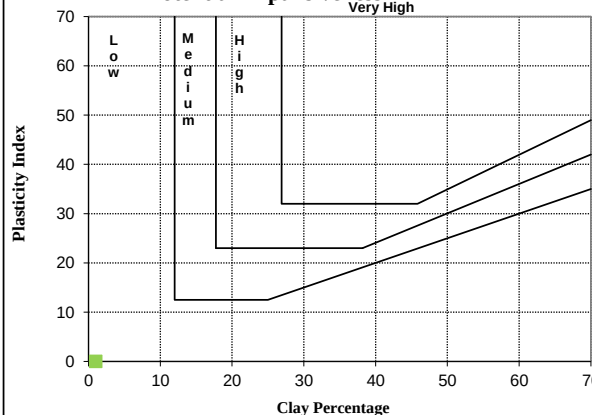
97

% Silt

1

% Clay

1

Plasticity Chart
A Line**Potential Expansiveness**
Very High

NOTE: All tests marked with (*) means that those test methods are not accredited.

Customer : **SRK Consulting (South Africa) (Pty) Ltd**
P.O Box 55291, Northlands
South Africa
2116
Attention : Mr D Du Preez

Project : Enkanini Housing
Date Received : 25/05/2021
Date Reported : 03/06/2021
Req. Number : 14787

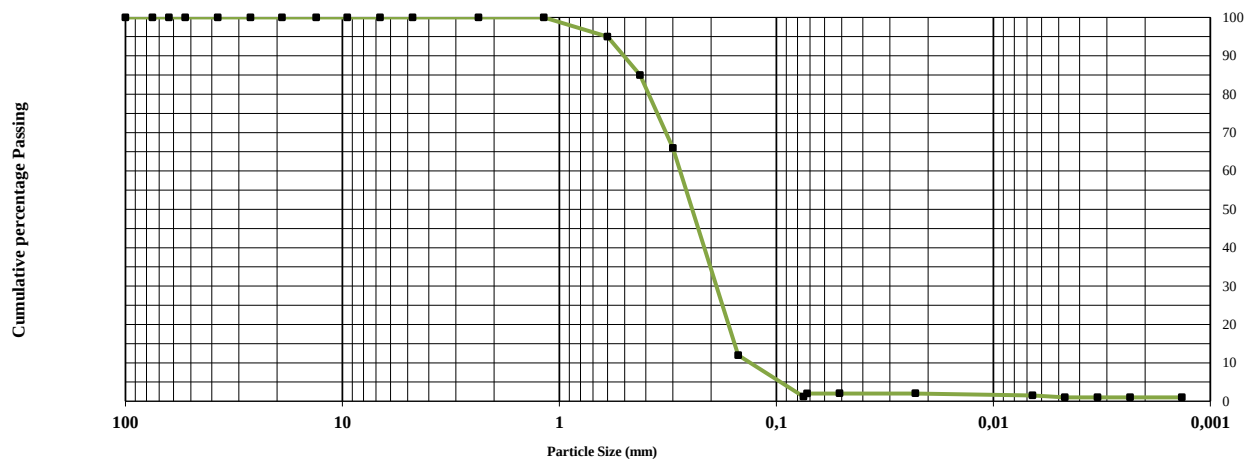
MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

Material Description:	Light Brown Sand	Sample Number:	15945		
Position:	TP25	Liquid Limit	N.P	Linear Shrinkage	0,0
Depth:	0,4-1,0m	Plasticity Index	N.P	Insitu M/C%	5,9

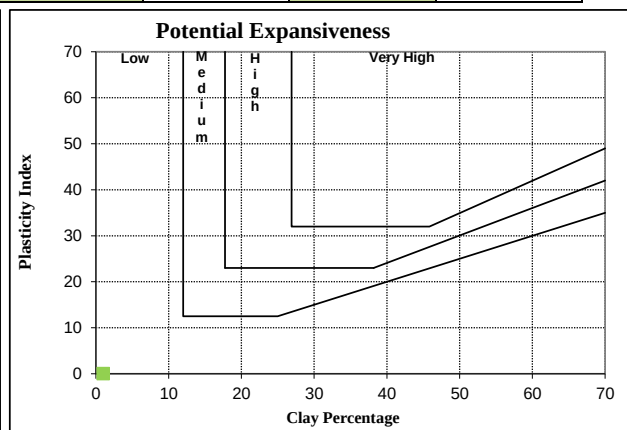
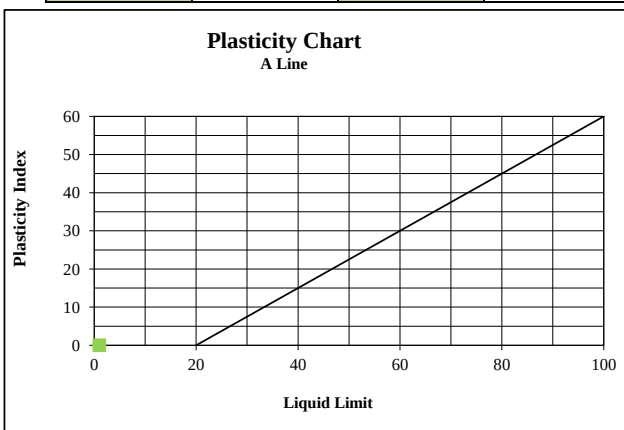
PH (TMH1 A20)*	-	(TMH1 A21T)* Conductivity s.m ⁻¹	-	SG (TMH1 A12T)*	2,604
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SIEVE ANALYSIS (TMH 1 A1a)*																		HYDROMETER ASTM D422									
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,072	0,051	0,023	0,007	0,005	0,003	0,002	0,001		
100	100	100	100	100	100	100	100	100	100	100	100	100	95	85	66	12	1,2	2	2	2	2	1	1	1	1		
% Passing																											
MOD AASHTO SANS 3001 GR30										CBR SANS 3001 GR40																	
OMC%		12,1									COMP MC		% SWELL		100%		98%		97%		95%		93%		90%		
MDD(KG/M³)		1591									13		0		12		11		10		9		8		7		

Particle Size Distribution



% Gravel		% Sand	98	% Silt	1	% Clay	1
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NOTE: All tests marked with (*) means that those test methods are not accredited.

Customer : **SRK Consulting (South Africa) (Pty) Ltd**

P.O Box 55291, Northlands

South Africa

2116

Attention : Mr D Du Preez

Project : Enkanini Housing

Date Received : 25/05/2021

Date Reported : 03/05/2021

Req. Number : 14787

FOUNDATION INDICATOR ASTM D422

Material Description:	Light Brown Sand	Sample Number:	15946		
Position:	TP27	Liquid Limit	N,P	Linear Shrinkage	0,0
Depth:	1,40-1,60m	Plasticity Index	N,P	Insitu M/C%	8,5

PH (TMH1 A20)*

-

(TMH1 A21T)*
Conductivity
s.m⁻¹

-

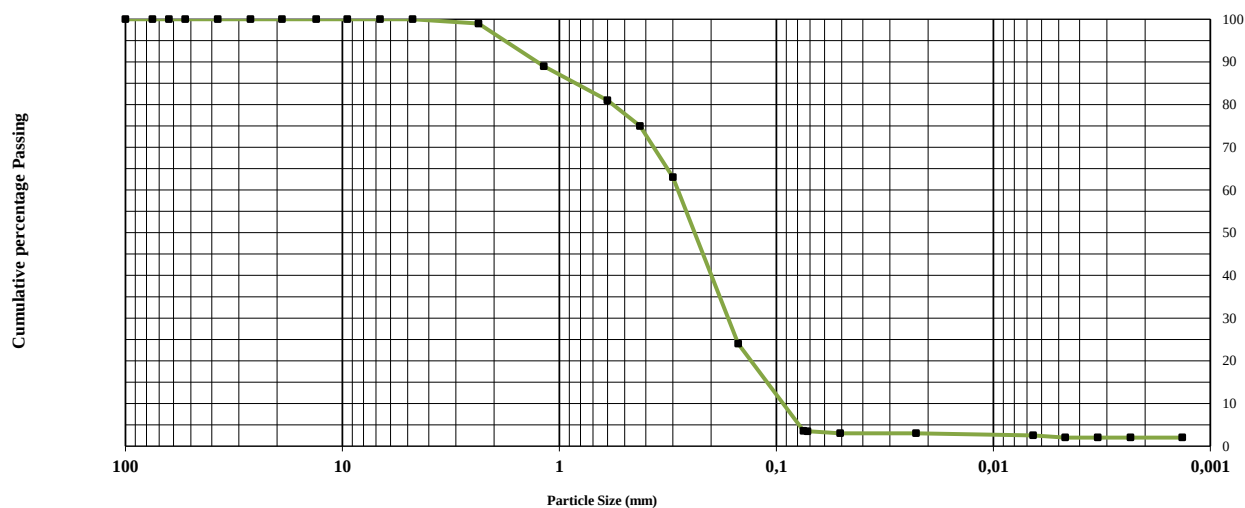
SG (TMH1 A12T)*

2,604

SIEVE ANALYSIS (TMH 1 A1a)***HYDROMETER ASTM D422**

100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,072	0,051	0,023	0,007	0,005	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	100	100	99	89	81	75	63	24	3,6	4	3	3	3	2	2	2	2

% Passing

Particle Size Distribution

% Gravel

4

% Sand

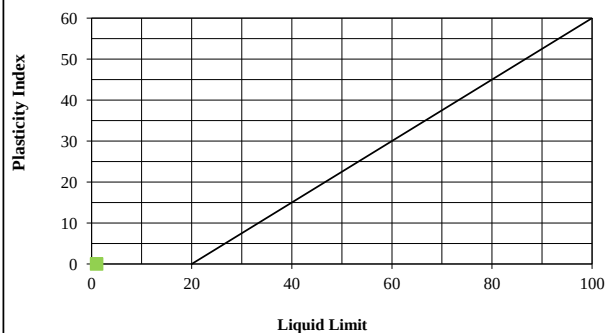
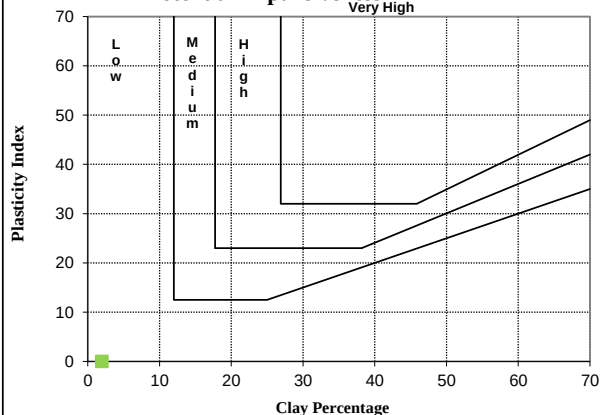
93

% Silt

1

% Clay

2

Plasticity Chart
A Line**Potential Expansiveness**
Very High

NOTE: All tests marked with (*) means that those test methods are not accredited.

Customer : **SRK Consulting (South Africa) (Pty) Ltd**

P.O Box 55291, Northlands

South Africa

2116

Attention : Mr D Du Preez

Project : Enkanini Housing

Date Received : 25/05/2021

Date Reported : 03/05/2021

Req. Number : 14787

Date Sampled: 25/05/2021

FOUNDATION INDICATOR ASTM D422

Material Description:	Light Brown Sand	Sample Number:	15947		
Position:	TP34	Liquid Limit	N.P	Linear Shrinkage	0,0
Depth:	0,50-0,80m	Plasticity Index	N.P	Insitu M/C%	6,1

PH (TMH1 A20)

-

(TMH1 A21T)
Conductivity
s.m⁻¹

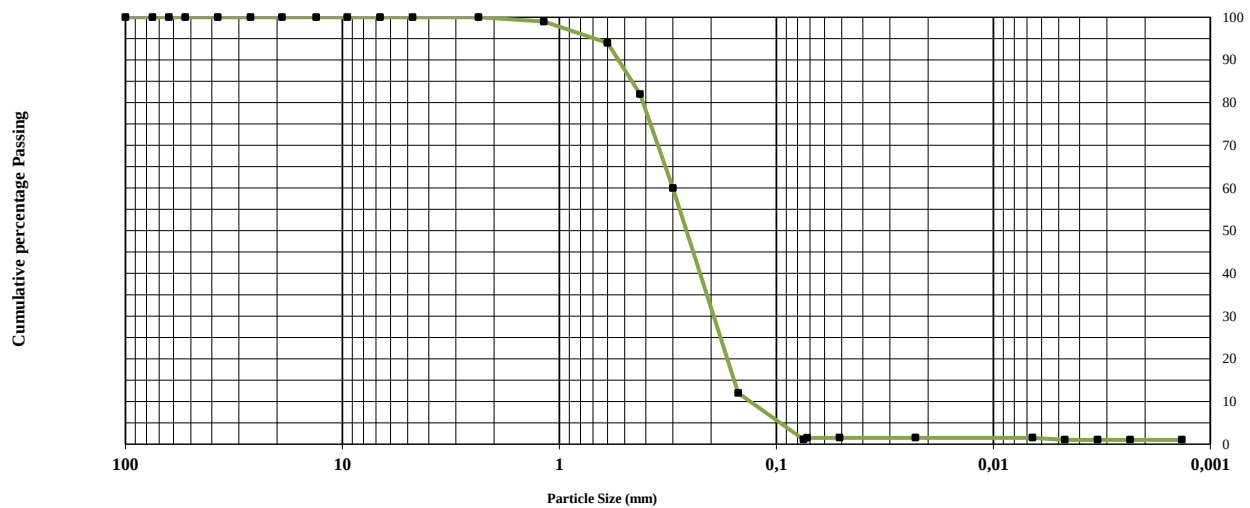
-

SG (TMH1 A12T)*

2,577

SIEVE ANALYSIS (TMH 1 A1a)***HYDROMETER ASTM D422**

100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,072	0,051	0,023	0,007	0,005	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	100	100	100	99	94	82	60	12	1,1	2	2	2	2	1	1	1	1
% Passing																									

Particle Size Distribution

% Gravel

% Sand

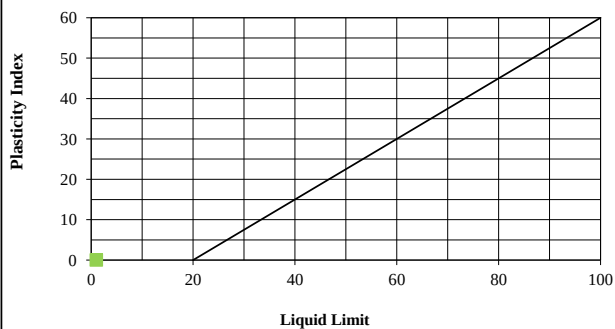
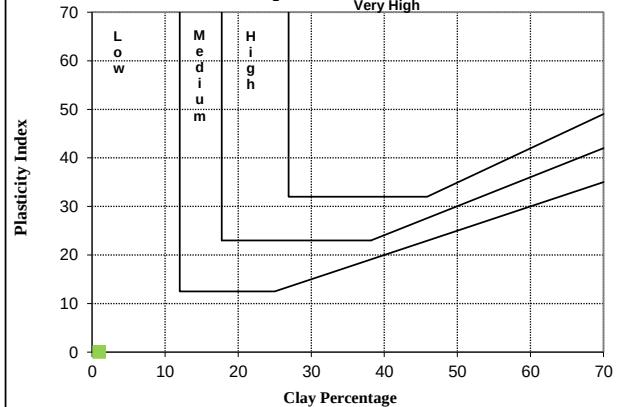
98

% Silt

1

% Clay

1

Plasticity Chart
A Line**Potential Expansiveness**
Very High

NOTE: All tests marked with (*) means that those test methods are not accredited.

Customer : **SRK Consulting (South Africa) (Pty) Ltd**
P.O Box 55291, Northlands
South Africa
2116
Attention : Mr D Du Preez

Project : Enkanini Housing
Date Received : 25/05/2021
Date Reported : 03/06/2021
Req. Number : 14787

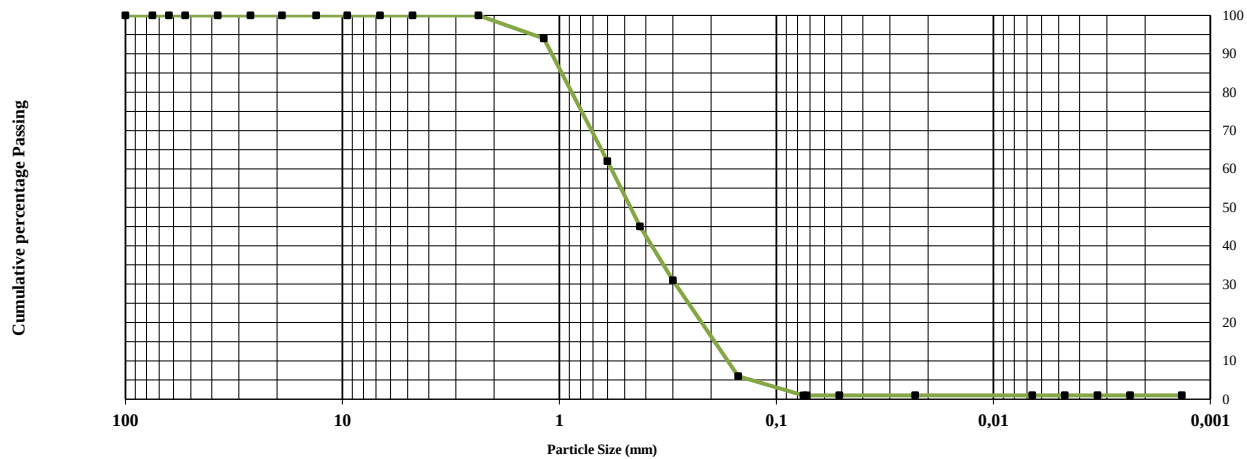
MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

Material Description:	Light Brown Sand	Sample Number:	15948		
Position:	TP39	Liquid Limit	N.P	Linear Shrinkage	0,0
Depth:	0,3-0,9m	Plasticity Index	N.P	Insitu M/C%	5,9

PH (TMH1 A20)*	-	(TMH1 A21T)* Conductivity s.m ⁻¹	-	SG (TMH1 A12T)*	2,604
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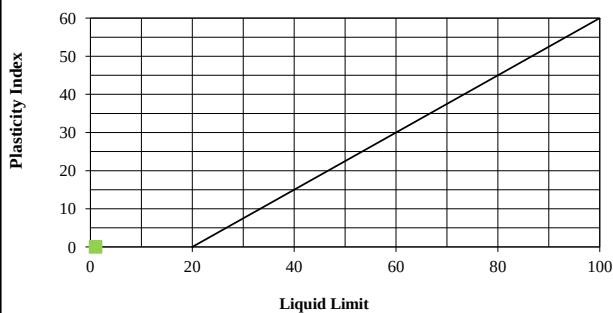
SIEVE ANALYSIS (TMH 1 A1a)*																		HYDROMETER ASTM D422								
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,072	0,051	0,023	0,007	0,005	0,003	0,002	0,001	
100	100	100	100	100	100	100	100	100	100	100	100	94	62	45	31	6	1	1	1	1	1	1	1	1	1	
% Passing																										
MOD AASHTO SANS 3001 GR30										CBR SANS 3001 GR40																
OMC%		12,3									COMP MC		% SWELL		100%		98%		97%		95%		93%		90%	
MDD(KG/M³)		1665									12		0		15		14		12		10		8		6	

Particle Size Distribution

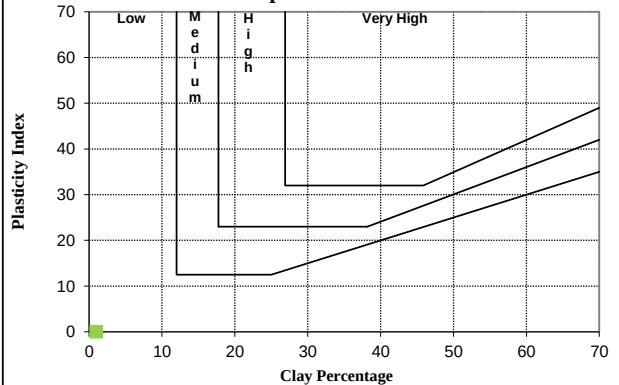


% Gravel	2	% Sand	97	% Silt		% Clay	1
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Plasticity Chart
A Line



Potential Expansiveness



NOTE: All tests marked with (*) means that those test methods are not accredited.

Customer : **SRK Consulting (South Africa) (Pty) Ltd**

P.O Box 55291, Northlands

South Africa

2116

Attention : Mr D Du Preez

Project : Enkanini Housing

Date Received : 25/05/2021

Date Reported : 03/05/2021

Req. Number : 14787

FOUNDATION INDICATOR ASTM D422

Material Description:	Light Brown Sand	Sample Number:	15949		
Position:	TP41	Liquid Limit	N/A	Linear Shrinkage	0,0
Depth:	1,0-1,3	Plasticity Index	N/A	Insitu M/C%	6,1

PH (TMH1 A20)*

-

(TMH1 A21T)*
Conductivity
s.m⁻¹

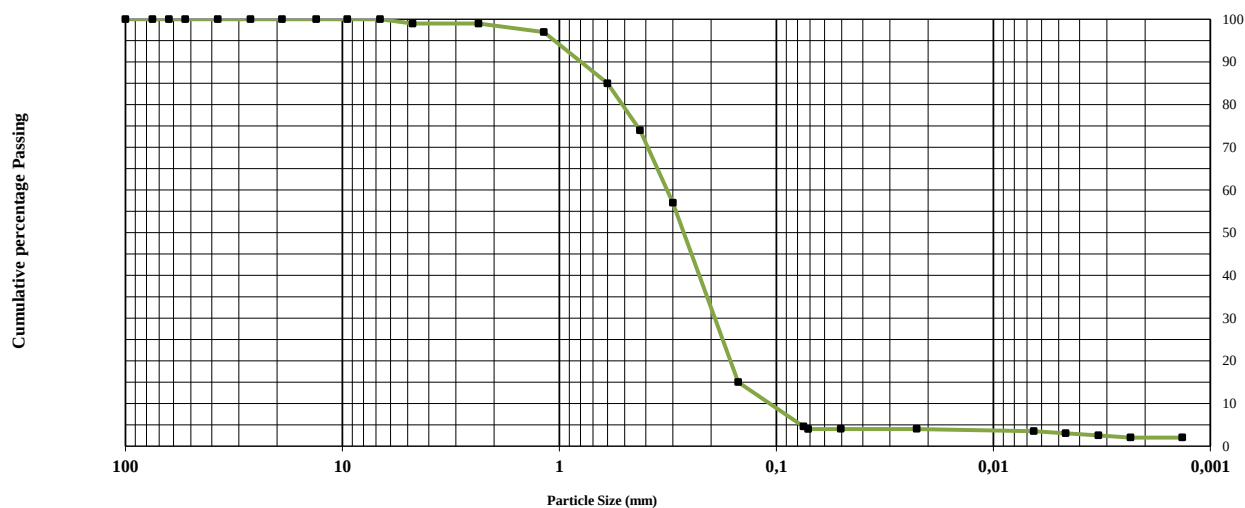
-

SG (TMH1 A12T)*

2,604

SIEVE ANALYSIS (TMH 1 A1a)***HYDROMETER ASTM D422**

100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,071	0,050	0,023	0,007	0,005	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	100	99	99	97	85	74	57	15	4,6	4	4	4	4	3	3	2	2
% Passing																									

Particle Size Distribution

% Gravel

2

% Sand

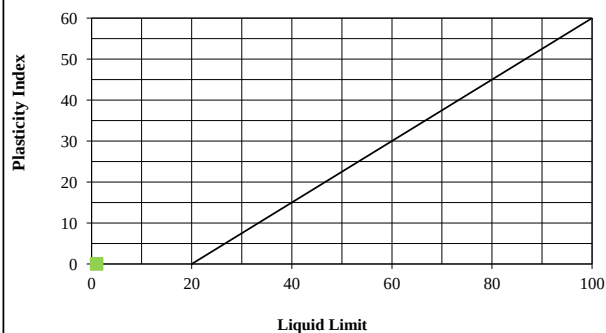
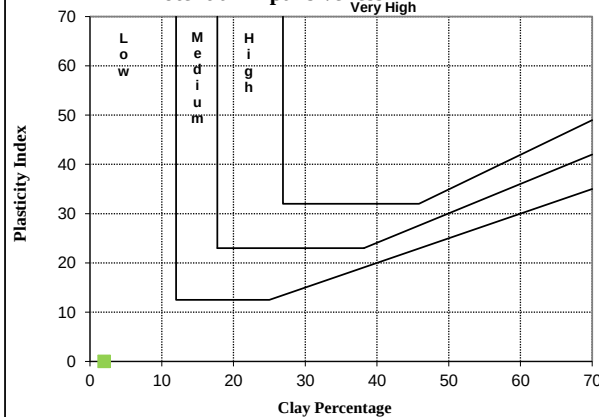
94

% Silt

2

% Clay

2

Plasticity Chart
A Line**Potential Expansiveness**
Very High

NOTE: All tests marked with (*) means that those test methods are not accredited.

Customer : **SRK Consulting (South Africa) (Pty) Ltd**
P.O Box 55291, Northlands
South Africa
2116
Attention : Mr D Du Preez

Project : Enkanini Housing
Date Received : 25/05/2021
Date Reported : 03/06/2021
Req. Number : 14787

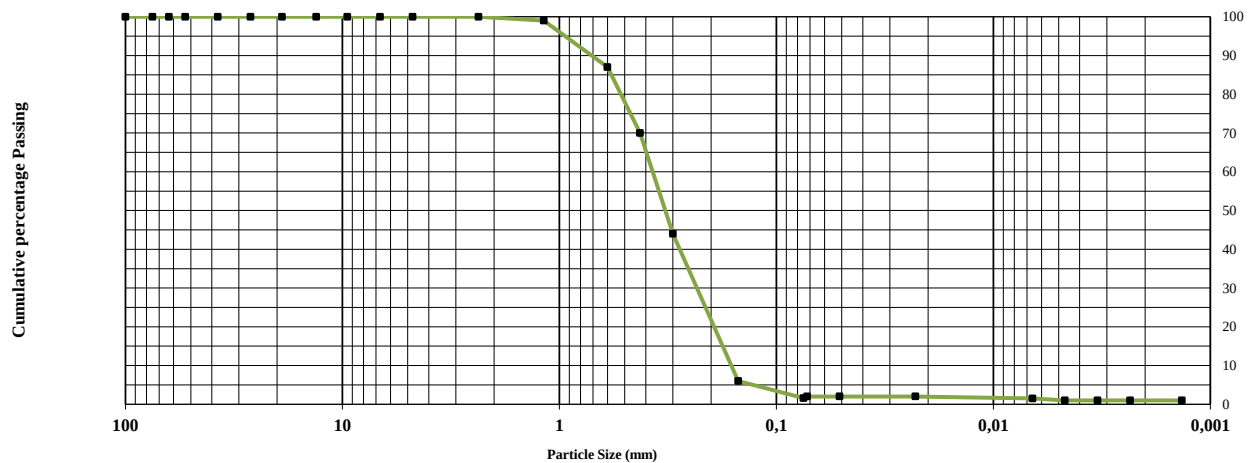
MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

Material Description:	Light Brown Sand	Sample Number:	15950		
Position:	TP46	Liquid Limit	N.P	Linear Shrinkage	0,0
Depth:	0,5-1,00m	Plasticity Index	N.P	Insitu M/C%	5,2

pH (TMH1 A20)*	-	Conductivity s.m ⁻¹ (TMH1 A21T)*	-	SG (TMH1 A12T)*	2,577
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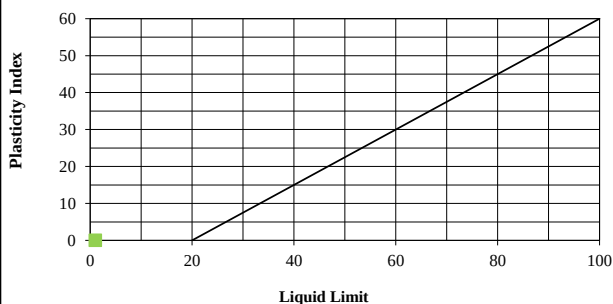
SIEVE ANALYSIS (TMH 1 A1a)*																	HYDROMETER ASTM D422										
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,072	0,051	0,023	0,007	0,005	0,003	0,002	0,001		
100	100	100	100	100	100	100	100	100	100	100	100	99	87	70	44	6	1,6	2	2	2	2	1	1	1	1		
% Passing																											
MOD AASHTO SANS 3001 GR30											CBR SANS 3001 GR40																
OMC%		12,1										COMP MC		% SWELL		100%		98%		97%		95%		93%		90%	
MDD(KG/M ³)		1648										12,3		0		15		14		13		12		10		8	

Particle Size Distribution

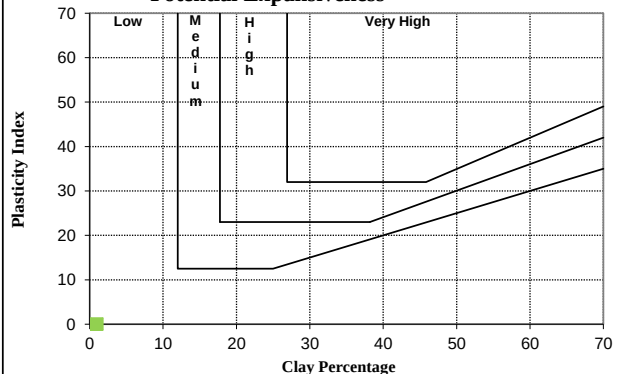


% Gravel		% Sand	98	% Silt	1	% Clay	1
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Plasticity Chart
A Line



Potential Expansiveness



NOTE: All tests marked with (*) means that those test methods are not accredited.

Customer : **SRK Consulting (South Africa) (Pty) Ltd**
P.O Box 55291, Northlands
South Africa
2116
Attention : Mr D Du Preez

Project : Enkanini Housing
Date Received : 25/05/2021
Date Reported : 03/06/2021
Req. Number : 14787

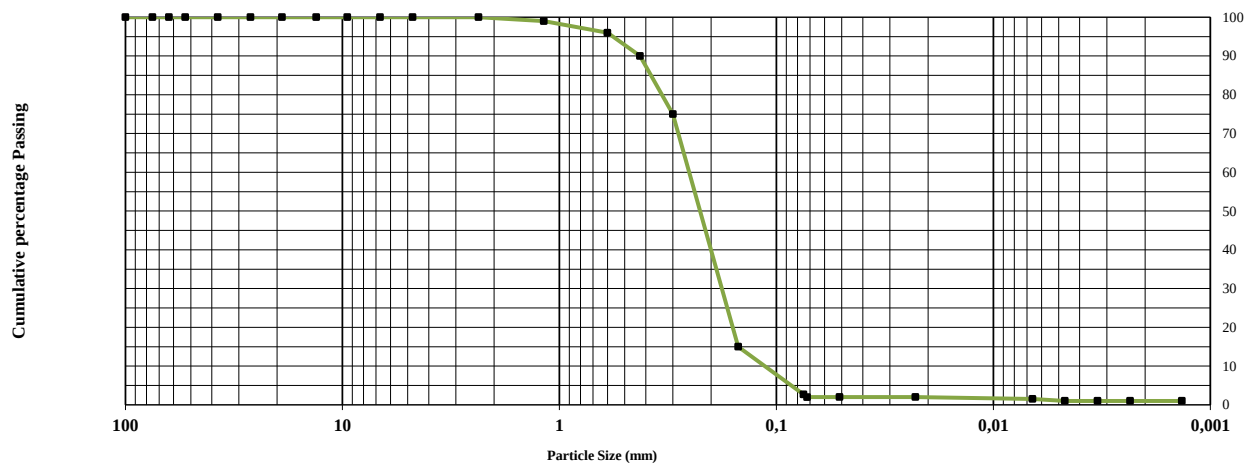
MOD / CBR / FOUNDATION INDICATOR - TMH1 A1* / ASTM D422 / SANS 3001 GR30 / SANS 3001 GR40

Material Description:	Light Brown Sand	Sample Number:	15951		
Position:	TP54	Liquid Limit	N.P	Linear Shrinkage	0,0
Depth:	0,5-1,50m	Plasticity Index	N.P	Insitu M/C%	5,8

PH (TMH1 A20)*	-	(TMH1 A21T)* Conductivity s.m ⁻¹	-	SG (TMH1 A12T)*	2,604
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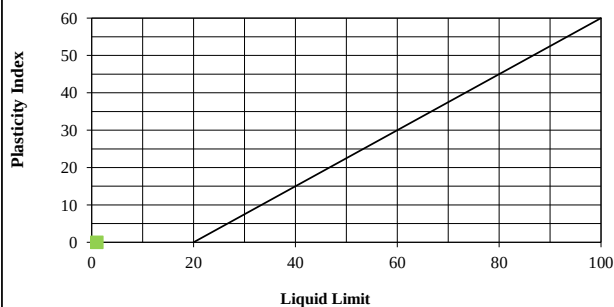
SIEVE ANALYSIS (TMH 1 A1a)*																		HYDROMETER ASTM D422									
100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,072	0,051	0,023	0,007	0,005	0,003	0,002	0,001		
100	100	100	100	100	100	100	100	100	100	100	100	99	96	90	75	15	2,7	2	2	2	1,5	1	1	1	1		
% Passing																											
MOD AASHTO SANS 3001 GR30											CBR SANS 3001 GR40																
OMC%			12,5								COMP MC		% SWELL		100%		98%		97%		95%		93%		90%		
MDD(KG/M³)			1554								12		0		11		10		9		8		7		6		

Particle Size Distribution

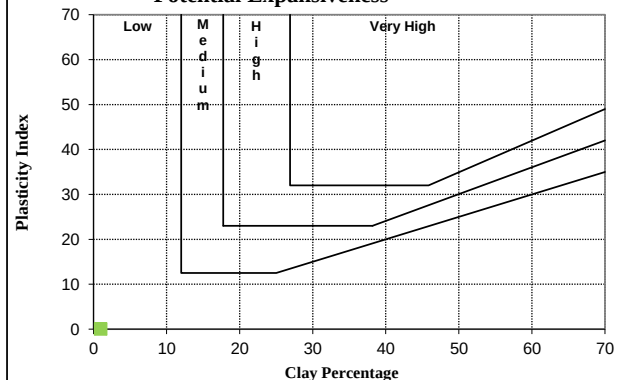


% Gravel		% Sand	98	% Silt	1	% Clay	1
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Plasticity Chart
A Line



Potential Expansiveness



NOTE: All tests marked with (*) means that those test methods are not accredited.

Customer : **SRK Consulting (South Africa) (Pty) Ltd**

P.O Box 55291, Northlands

South Africa

2116

Attention : Mr D Du Preez

Project : Enkanini Housing

Date Received : 25/05/2021

Date Reported : 03/05/2021

Req. Number : 14787

FOUNDATION INDICATOR ASTM D422

Material Description:	Light Brown Sand	Sample Number:	15952		
Position:	TP57	Liquid Limit	N/A	Linear Shrinkage	0,0
Depth:	0,6-1,20m	Plasticity Index	N/A	Insitu M/C%	2,7

PH (TMH1 A20)*

-

(TMH1 A21T)*
Conductivity
s.m⁻¹

-

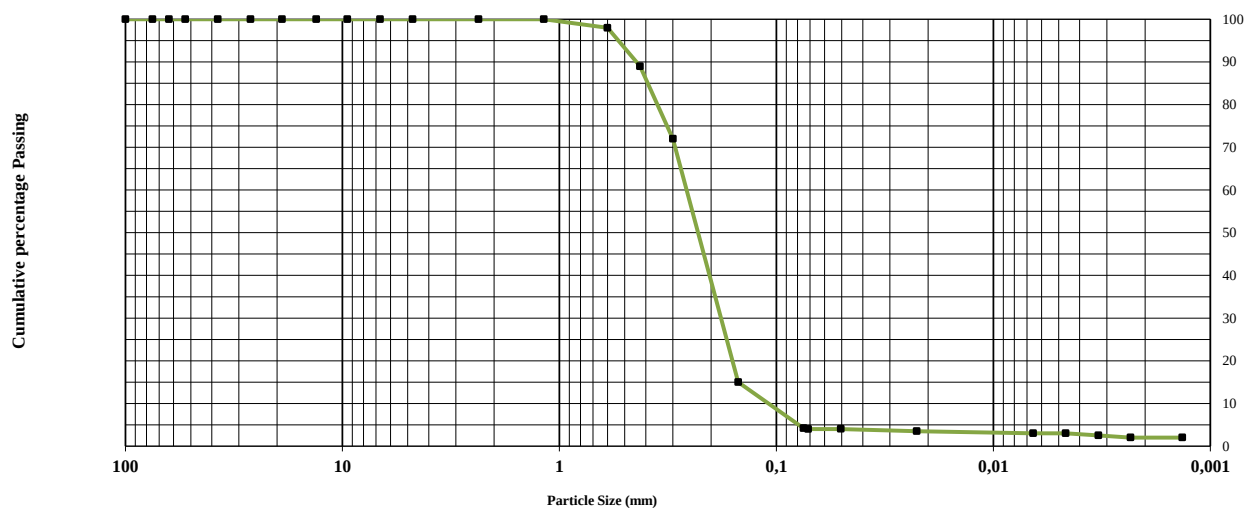
SG (TMH1 A12T)*

2,577

SIEVE ANALYSIS (TMH 1 A1a)***HYDROMETER ASTM D422**

100	75	63	53	37,5	26,5	19,0	13,2	9,5	6,7	4,75	2,36	1,18	0,60	0,425	0,300	0,150	0,075	0,071	0,050	0,023	0,007	0,005	0,003	0,002	0,001
100	100	100	100	100	100	100	100	100	100	100	100	100	98	89	72	15	4,2	4	4	4	3	3	3	2	2

% Passing

Particle Size Distribution

% Gravel

% Sand

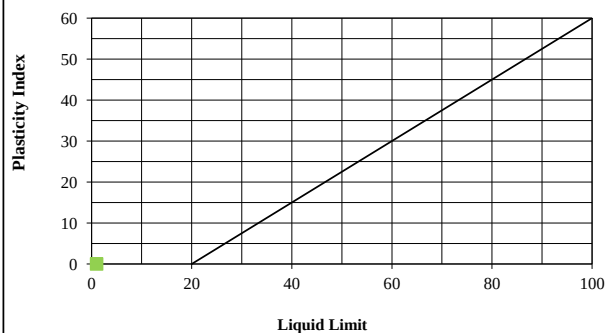
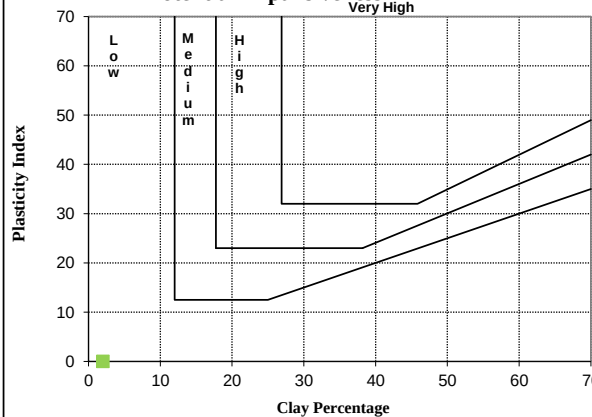
96

% Silt

2

% Clay

2

Plasticity Chart
A Line**Potential Expansiveness**
Very High

NOTE: All tests marked with (*) means that those test methods are not accredited.

SRK Report Distribution Record

Report No.

571322

Name/Title	Company	Copy	File Type	Date	Authorized by
Prakash Mohan	Bosch Projects		electronic	June 2021	John Brown
	SRK Consulting		electronic	June 2021	John Brown

Approval Signature:



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JUNCTIONS

SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation	Ground/Rim (Max) Elevation	Ground/Rim (Max) Offset	Initial Water Elevation	Initial Water Depth	Surcharge Elevation	Surcharge Depth	Ponded Area	Minimum Pipe Cover	Peak Inflow	Peak Lateral Inflow	Maximum HGL Elevation Attained	Maximum HGL Depth Attained	Maximum Surcharge Depth Attained	Minimum Freeboard Attained	Average HGL Elevation Attained	Average HGL Depth Attained	Time of Maximum HGL Occurrence	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
					(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m²)	(mm)	(cms)	(cms)	(m)	(m)	(m)	(m)	(m)	(m)	(days hh:mm)	(days hh:mm)	(ha-mm)	(minutes)
1	inlet	-27904.42	-3771299.27		8.00	10.00	2.00	8.00	0.00	10.00	0.00	0.00	0.00	0.30	0.00	8.16	0.16	0.00	2.84	8.11	0.11	1 00:00	0 00:00	0.00	0.00
2	J03	-28695.04	-3771424.83		21.00	23.00	2.00	21.00	0.00	23.00	0.00	0.00	1500.00	0.45	0.00	21.11	0.11	0.00	1.89	21.04	0.04	0 12:11	0 00:00	0.00	0.00
3	J04	-28606.43	-3771390.81		21.00	23.00	2.00	21.00	0.00	23.00	0.00	0.00	1500.00	1.14	0.74	21.05	0.05	0.00	1.95	21.01	0.01	0 12:08	0 00:00	0.00	0.00
4	J05	-28545.11	-3771398.42		20.00	22.00	2.00	20.00	0.00	22.00	0.00	0.00	1500.00	1.15	0.00	20.05	0.05	0.00	1.95	20.01	0.01	0 12:10	0 00:00	0.00	0.00
5	J06	-28334.00	-3771378.73		16.00	18.00	2.00	16.00	0.00	18.00	0.00	0.00	1500.00	1.61	0.52	16.08	0.08	0.00	1.92	16.02	0.02	0 12:10	0 00:00	0.00	0.00
6	J07	-28391.00	-3770951.02		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	1500.00	0.35	0.35	0.25	0.25	0.00	1.75	0.09	0.09	0 12:20	0 00:00	0.00	0.00
7	J08	-28183.30	-3771089.49		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	1500.00	1.17	0.00	0.01	0.01	0.00	1.99	0.00	0.00	0 12:20	0 00:00	0.00	0.00
8	J09	-28272.30	-3771040.64		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	1500.00	1.18	0.74	0.25	0.25	0.00	1.75	0.09	0.09	0 12:20	0 00:00	0.00	0.00
9	J10	-27599.24	-3771125.79		29.00	31.00	2.00	29.00	0.00	31.00	0.00	0.00	1500.00	0.63	0.63	29.02	0.02	0.00	1.98	29.01	0.01	0 12:06	0 00:00	0.00	0.00
10	J11	-27879.77	-3771341.85		7.16	9.16	2.00	7.16	0.00	9.16	0.00	0.00	0.00	3.62	0.56	7.90	0.74	0.00	2.26	7.39	0.23	0 12:34	0 00:00	0.00	0.00
11	J12	-28084.74	-3771378.14		13.91	15.91	2.00	13.91	0.00	15.91	0.00	0.00	1500.00	2.21	0.66	13.97	0.06	0.00	1.94	13.92	0.01	0 12:10	0 00:00	0.00	0.00
12	J13	-29138.17	-3771302.67		16.00	18.00	2.00	16.00	0.00	18.00	0.00	0.00	1500.00	1.13	1.13	16.07	0.07	0.00	1.93	16.02	0.02	0 12:06	0 00:00	0.00	0.00
13	J14	-29049.11	-3771586.73		9.00	11.00	2.00	9.00	0.00	11.00	0.00	0.00	1000.00	2.60	0.69	9.13	0.13	0.00	1.87	9.03	0.03	0 12:09	0 00:00	0.00	0.00
14	J15	-28918.60	-3771239.71		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	0.37	0.37	0.00	0.00	0.00	2.00	0.00	0.00	0 00:06	0 00:00	0.00	0.00
15	J16	-28829.54	-3771474.64		29.00	31.00	2.00	29.00	0.00	31.00	0.00	0.00	1500.00	0.45	0.45	29.03	0.03	0.00	1.97	29.01	0.01	0 12:06	0 00:00	0.00	0.00
16	J17	-28594.61	-3771139.14		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	0.00	0.43	0.43	0.00	0.00	0.00	2.00	0.00	0.00	0 00:06	0 00:00	0.00	0.00
17	J18	-28324.37	-3771002.38		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	1500.00	0.55	0.24	0.25	0.25	0.00	1.75	0.09	0.09	0 12:21	0 00:00	0.00	0.00
18	J19	-29564.56	-3771693.12		10.00	12.00	2.00	10.00	0.00	12.00	0.00	0.00	1000.00	0.82	0.82	10.27	0.27	0.00	1.73	10.07	0.07	0 12:08	0 00:00	0.00	0.00
19	Pond	-27958.12	-3771171.02	InfiltrationPond	8.00	12.00	4.00	8.00	0.00	12.00	0.00	40701.59	3500.00	2.65	1.72	12.32	4.32	0.32	0.00	10.25	2.25	0 19:15	0 12:09	1447.88	716.00

SUBBASINS

SN	Element ID	Description	Area	Drainage Node ID	Weighted Curve Number	Conductivity	Drying Time	Average Slope	Equivalent Width	Impervious Area	Impervious Area No Depression	Impervious Area Depression Depth	Impervious Area Manning's Roughness	Pervious Area Depression Depth	Pervious Area Manning's Roughness	Curb & Gutter Length	Rain Gage ID	Total Precipitation	Total Runon	Total Evaporation	Total Infiltration	Total Runoff	Peak Runoff	Time of Concentration
			(m²)			(mm/hr)	(days)	(%)	(m)	(%)	(%)	(mm)		(mm)		(m)		(mm)	(mm)	(mm)	(mm)	(mm)	(cms)	(days hh:mm:ss)
1	Sub A06		85418.68	J09	95.00	0.1500	7.00	4.0000	134.69	100.00	100.00	2.0000	0.1500	7.5000	0.1300	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	81.20	0.74	0 02:49:24
2	Sub A07		30760.94	Pond	95.00	0.1500	7.00	8.0000	179.16	100.00	100.00	2.0000	0.3500	7.5000	0.1300	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	83.38	0.41	0 01:44:27
3	Sub A12		102409.06	J07	95.00	0.1500	7.00	2.3000	120.55	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	70.44	0.35	0 06:36:15
4	Sub A25		19380.15	Pond	95.00	0.1500	7.00	1.7500	88.61	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	80.40	0.15	0 03:10:33
5	Sub A26		22723.13	Pond	95.00	0.1500	7.00	4.5000	252.25	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	84.00	0.36	0 01:24:17
6	Sub A27		41953.46	Pond	100.00	0.1500	7.00	0.5000	148.59	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	74.35	0.18	0 05:23:25
7	Sub A28		40052.14	Pond	95.00	0.1500	7.00	4.0000	231.26	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	82.59	0.45	0 02:09:16
8	Sub A29		9073.77	J12	95.00	0.1500	7.00	0.5000	150.00	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	82.62	0.10	0 02:08:19
9	Sub A30		54163.60	Pond	95.00	0.1500	7.00	0.5000	150.00	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	71.61	0.19	0 06:14:52
10	Sub A31		51424.35	J11	95.00	0.1500	7.00	11.0000	172.77	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	82.49	0.56	0 02:12:04
11	Sub A32		57066.59	J10	95.00	0.1500	7.00	6.0000	266.69	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	82.56	0.64	0 02:09:57
12	Sub A33		107498.29	J13	95.00	0.1500	7.00	3.0000	267.82	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	78.64	0.67	0 03:53:20
13	Sub A34		96171.76	J14	95.00	0.1500	7.00	3.0000	297.18	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	79.83	0.69	0 03:25:03
14	Sub A35		30532.38	J15	95.00	0.1500	7.00	3.0000	242.83	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	83.01	0.37	0 01:56:17
15	Sub A36		54549.65	J16	95.00	0.1500	7.00	3.0000	210.82	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	80.83	0.45	0 02:59:18
16	Sub A37		30767.08	J17	95.00	0.1500	7.00	3.0000	329.89	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	83.61	0.43	0 01:37:12
17	Sub A38		89241.73	J04	95.00	0.1500	7.00	3.0000	347.39	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	80.86	0.74	0 02:58:31
18	Sub A41		26938.68	J18	95.00	0.1500	7.00	3.0000	115.92	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	81.24	0.24	0 02:48:06
19	Sub A42		58605.85	J12	95.00	0.1500	7.00	3.0000	293.23	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	81.76	0.56	0 02:33:34
20	Sub A43		36285.59	J06	95.00	0.1500	7.00	3.0000	406.82	100.00	100.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	0.0000	83.69	0.52	0 01:34:38
21	Sub A44		57802.86	J13	95.00	0.1500	7.00	3.3000	226.45	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	11.5750	65.09	0.46	0 02:37:33
22	Sub A45		80430.85	J19	95.00	0.1500	7.00	2.1000	247.72	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	11.5750	63.19	0.46	0 03:28:28
23	Sub A46		39808.62	J19	95.00	0.1500	7.00	3.7000	176.78	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	11.5750	65.65	0.36	0 02:21:13

STORAGE NODES

SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation	Max (Rim) Elevation	Max (Rim) Offset	Initial Water Elevation	Initial Water Depth	Ponded Area	Evaporation Loss	Peak Inflow	Peak Lateral Inflow	Peak Outflow	Peak Exfiltration Flow Rate	Maximum HGL Elevation Attained	Maximum HGL Depth Attained	Average HGL Elevation Attained	Average HGL Depth Attained	Time of Maximum HGL Occurrence	Total Exfiltration Volume	Total Flooded Volume	Total Time Flooded	Total Retention Time
					(m)	(m)	(m)	(m)	(m)	(m²)		(cms)	(cms)	(cms)	(cmm)	(m)	(m)	(m)	(m)	(days hh:mm)	(1000-m³)	(ha-mm)	(minutes)	(seconds)
1	J14	-29473.14	-3771728.05	Infiltration Pond	10.00	11.00	1.00	10.00	0.00	0.00	0.00	0.05	0.05	0.05	0.00	10.03	0.03	10.01	0.01	0 13:01	0.00	0.00	0.00	0.00
2	J17	-29133.71	-3771305.13		17.50	19.50	2.00	17.50	0.00	0.00	0.00	0.08	0.08	0.05	0.00	18.76	1.26	18.10	0.60	0 14:27	0.00	0.00	0.00	0.00
3	J18	-28832.32	-3771433.14		12.50	14.50	2.00	12.50	0.00	0.00	0.00	0.07	0.00	0.00	0.00	13.16	0.66	12.68	0.18	1 00:00	0.00	0.00	0.00	0.00
4	J19	-29031.76	-3771587.92		7.50	10.00	2.50	7.50	0.00	0.00	0.00	0.18	0.18	0.17	0.00	7.52	0.02	7.51	0.01	0 13:26	0.00	0.00	0.00	0.00
5	Pond	-27958.12	-3771171.02		8.00	12.00	4.00	8.00	0.00	40701.59	0.00	0.90	0.59	0.22	0.00	8.13	0.13	8.06	0.06	0 17:24	0.00	0.00	0.00	0.00
6	Stor-05	-28878.19	-3771290.26		22.00	24.00	2.00	22.00	0.00	0.00	0.00	0.09	0.05	0.00	0.00	22.78	0.78	22.26	0.26	1 00:00	0.00	0.00	0.00	0.00
7	Stor-06	-28765.63	-3771366.35		22.00	24.00	2.00	22.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	23.00	1.00	22.38	0.38	0 23:37	0.00	0.00	0.00	0.00
8	Stor-07	-28661.03	-3771332.63		14.00	16.00	2.00	14.00	0.00	0.00	0.00	0.08	0.00	0.00	0.00	14.18	0.18	14.05	0.05	1 00:00	0.00	0.00	0.00	0.00
9	Stor-08	-28728.61	-3771250.73		17.00	19.00	2.00	17.00	0.00	0.00	0.00	0.10	0.10	0.03	0.00	18.01	1.01	17.47	0.47	0 15:34	0.00	0.00	0.00	0.00
10	Stor-09	-28549.59	-3771327.71		15.00	17.00	2.00	15.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	15.69	0.69	15.17	0.17	1 00:00	0.00	0.00	0.00	0.00
11	Stor-10	-28498.12	-3771104.81		17.00	19.00	2.00	17.00	0.00	0.00	0.00	0.12	0.12	0.00	0.00	18.25	1.25	17.53	0.53	1 00:00	0.00	0.00	0.00	0.00
12	Stor-11	-28390.70	-3771197.91		15.00	17.00	2.00	15.00	0.00	0.00	0.00	0.07	0.07	0.00	0.00	15.45	0.45	15.17	0.17	1 00:00	0.00	0.00	0.00	0.00
13	Stor-12	-28117.67	-3771343.82		13.00	15.00	2.00	13.00	0.00	0.00	0.00	0.05	0.05	0.00	0.00	13.55	0.55	13.21	0.21	1 00:00	0.00	0.00	0.00	0.00
14	Stor-13	-28331.61	-3771316.97		13.00	15.00	2.00	13.00	0.00	0.00	0.00	0.04	0.02	0.00	0.00	13.50	0.50	13.18	0.18	1 00:00	0.00	0.00	0.00	0.00
15	Stor-14	-28387.12	-3771098.24		12.00	14.00	2.00	12.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	13.17	1.17	12.45	0.45	1 00:00	0.00	0.00	0.00	0.00
16	Stor-15	-28782.83	-3771257.21		17.00	19.00	2.00	17.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	17.62	0.62	17.20	0.20	1 00:00	0.00	0.00	0.00	0.00

JUNCTIONS

SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation	Ground/Rim (Max) Elevation	Ground/Rim (Max) Offset	Initial Water Elevation	Initial Water Depth	Surcharge Elevation	Surcharge Depth	Ponded Area	Minimum Pipe Cover	Peak Inflow	Peak Lateral Inflow	Maximum HGL Elevation Attained	Maximum HGL Depth Attained	Maximum Surcharge Depth Attained	Minimum Freeboard Attained	Average HGL Elevation Attained	Average HGL Depth Attained	Time of Maximum HGL Occurrence	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
					(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m²)	(mm)	(cms)	(cms)	(m)	(m)	(m)	(m)	(m)	(m)	(days hh:mm)	(days hh:mm)	(ha-mm)	(minutes)
1	inlet	-27904.42	-3771299.27		8.00	10.00	2.00	8.00	0.00	10.00	0.00	0.00	0.00	0.22	0.00	8.13	0.13	0.00	2.87	8.05	0.05	0 17:25	0 00:00	0.00	0.00
2	J03	-28695.04	-3771424.83		21.00	23.00	2.00	21.00	0.00	23.00	0.00	0.00	1500.00	0.04	0.04	21.00	0.00	0.00	2.00	21.00	0.00	0 13:38	0 00:00	0.00	0.00
3	J04	-28606.43	-3771390.81		20.50	22.50	2.00	20.50	0.00	22.50	0.00	0.00	1500.00	0.01	0.00	20.50	0.00	0.00	2.00	20.50	0.00	0 13:44	0 00:00	0.00	0.00
4	J05	-28545.11	-3771398.42		20.00	22.00	2.00	20.00	0.00	22.00	0.00	0.00	1500.00	0.03	0.00	20.00	0.00	0.00	2.00	20.00	0.00	0 13:57	0 00:00	0.00	0.00
5	J06	-28334.00	-3771378.73		16.00	18.00	2.00	16.00	0.00	18.00	0.00	0.00	1500.00	0.04	0.04	16.01	0.01	0.00	1.99	16.00	0.00	0 12:50	0 00:00	0.00	0.00
6	J07	-28391.00	-3770951.02		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	1500.00	0.18	0.07	0.16	0.16	0.00	1.84	0.05	0.05	0 12:26	0 00:00	0.00	0.00
7	J08	-28183.30	-3771089.49		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	1500.00	0.38	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0 12:28	0 00:00	0.00	0.00
8	J09	-28272.30	-3771040.64		0.00	2.00	2.00	0.00	0.00	2.00	0.00	0.00	1500.00	0.52	0.52	0.16	0.16	0.00	1.84	0.05	0.05	0 12:28	0 00:00	0.00	0.00
9	J10	-27599.24	-3771125.79		30.00	32.00	2.00	30.00	0.00	32.00	0.00	0.00	1500.00	0.15	0.15	30.01	0.01	0.00	1.99	30.00	0.00	0 12:13	0 00:00	0.00	0.00
10	J11	-27879.77	-3771341.85		7.16	9.16	2.00	7.16	0.00	9.16	0.00	0.00	0.00	0.35	0.13	7.32	0.16	0.00	2.84	7.23	0.07	0 15:03	0 00:00	0.00	0.00
11	J12	-28084.74	-3771378.14		13.91	15.91	2.00	13.91	0.00	15.91	0.00	0.00	1500.00	0.05	0.02	13.92	0.01	0.00	1.99	13.91	0.00	0 12:42	0 00:00	0.00	0.00
12	J13	-29116.08	-3771180.21		30.00	32.00	2.00	30.00	0.00	32.00	0.00	0.00	1700.00	0.04	0.04	30.01	0.01	0.00	1.99	30.00	0.00	0 12:51	0 00:00	0.00	0.00
13	J15	-29251.61	-3771701.20		9.50	11.50	2.00	9.50	0.00	11.50	0.00	0.00	1700.00	0.12	0.07	9.51	0.01	0.00	1.99	9.50	0.00	0 13:00	0 00:00	0.00	0.00
14	J16	-28907.56	-3771526.66		15.00	17.00	2.00	15.00	0.00	17.00	0.00	0.00	1700.00	0.01	0.00	17.00	2.00	0.00	0.00	15.19	0.19	0 22:57	0 23:35	2.52	64.00

SUBBASINS

SN	Element ID	Description	Area	Drainage Node ID	Weighted Curve Number	Conductivity	Drying Time	Average Slope	Equivalent Width	Impervious Area	Impervious Area No Depression	Impervious Area Depression Depth	Impervious Area Manning's Roughness	Pervious Area Depression Depth	Pervious Area Manning's Roughness	Curb & Gutter Length	Rain Gage ID	Total Precipitation	Total Runon	Total Evaporation	Total Infiltration	Total Runoff	Peak Runoff	Time of Concentration
			(m²)			(mm/hr)	(days)	(%)	(m)	(%)	(%)	(mm)		(mm)		(m)		(mm)	(mm)	(mm)	(mm)	(mm)	(cms)	(days hh:mm:ss)
1	Sub A06		85418.68	J09	68.00	0.1500	7.00	4.0000	134.69	32.00	25.00	2.0000	0.1500	7.5000	0.1300	0.00	Rain Gage-01	86.27	0.00	0.0000	34.0730	43.99	0.52	0 02:03:21
2	Sub A07		30760.94	Pond	68.00	0.1500	7.00	8.0000	179.16	0.00	25.00	2.0000	0.3500	7.5000	0.1300	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	27.48	0.15	0 00:57:39
3	Sub A12		102409.06	J07	68.00	0.1500	7.00	2.3000	120.55	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	20.91	0.07	0 06:01:15
4	Sub A13		27071.72	Stor-05	68.00	0.1500	7.00	3.6000	107.56	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	27.60	0.05	0 02:32:12
5	Sub A14		16282.74	Stor-06	68.00	0.1500	7.00	3.6000	72.86	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	27.89	0.03	0 02:21:44
6	Sub A15		26541.72	Stor-15	68.00	0.1500	7.00	2.1000	51.63	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	23.76	0.02	0 04:34:39
7	Sub A16		10815.00	Stor-08	68.00	0.1500	7.00	3.7000	53.65	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.15	0.02	0 02:12:08
8	Sub A17		22224.05	Stor-08	68.00	0.1500	7.00	3.7000	112.65	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.19	0.05	0 02:10:26
9	Sub A18		13349.19	Stor-08	68.00	0.1500	7.00	3.7000	67.31	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.18	0.03	0 02:10:51
10	Sub A19		27286.21	J06	68.00	0.1500	7.00	3.7000	78.05	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	26.67	0.04	0 03:03:52
11	Sub A20		28962.45	Stor-10	68.00	0.1500	7.00	13.4000	164.96	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	29.39	0.12	0 01:22:40
12	Sub A21		18521.09	Stor-11	68.00	0.1500	7.00	10.1000	118.21	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	29.36	0.07	0 01:24:03
13	Sub A22		11459.43	Stor-13	68.00	0.1500	7.00	0.5000	150.00	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.08	0.02	0 02:14:34
14	Sub A23		18866.19	Stor-14	68.00	0.1500	7.00	1.7500	78.09	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	26.66	0.03	0 03:04:24
15	Sub A24		26055.90	Stor-12	68.00	0.1500	7.00	3.8000	105.80	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	27.72	0.05	0 02:27:49
16	Sub A25		19380.15	Pond	68.00	0.1500	7.00	1.7500	88.61	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	26.98	0.03	0 02:53:43
17	Sub A26		22723.13	Pond	68.00	0.1500	7.00	4.5000	252.25	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	29.53	0.10	0 01:16:51
18	Sub A27		41953.46	Pond	100.00	0.1500	7.00	0.5000	148.59	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	2.4920	68.32	0.19	0 04:54:51
19	Sub A28		40052.14	Pond	68.00	0.1500	7.00	4.0000	231.26	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.52	0.10	0 01:57:50
20	Sub A29		9073.77	J12	68.00	0.1500	7.00	0.5000	150.00	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.55	0.02	0 01:56:59
21	Sub A30		54163.60	Pond	68.00	0.1500	7.00	0.5000	150.00	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	21.54	0.04	0 05:41:45
22	Sub A31		51424.35	J11	68.00	0.1500	7.00	11.0000	172.77	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.46	0.13	0 02:00:24
23	Sub A32		57066.59	J10	68.00	0.1500	7.00	6.0000	266.69	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	28.51	0.15	0 01:58:28
24	Sub A33		35872.19	J13	68.00	0.1500	7.00	1.4200	102.38	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	24.73	0.04	0 04:05:23
25	Sub A34		55627.61	J17	68.00	0.1500	7.00	3.4000	150.00	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	26.32	0.08	0 03:15:23
26	Sub A35		57157.95	J03	68.00	0.1500	7.00	0.7000	127.82	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	21.24	0.04	0 05:51:13
27	Sub A36		193344.27	J19	68.00	0.1500	7.00	2.6000	340.10	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	23.79	0.18	0 04:33:38
28	Sub A37		69257.02	J15	68.00	0.1500	7.00	2.4000	141.08	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	24.36	0.07	0 04:16:39
29	Sub A38		56410.21	J14	68.00	0.1500	7.00	1.6200	138.69	0.00	25.00	2.0000	0.3500	5.0000	0.3000	0.00	Rain Gage-01	86.27	0.00	0.0000	50.1070	24.31	0.05	0 04:17:58

ENKANINI SOUTH HOUSING DEVELOPMENT: TRAFFIC IMPACT ASSESSMENT JUNE 2021

PREPARED BY:

Mowana Engineers (Pty) Ltd
PO Box 2215
DURBANVILLE
7551

PREPARED FOR:

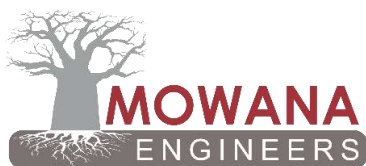
City of Cape Town
Directorate: Human Settlements
Department: Informal Settlements: Planning

CONTACT PERSON

Mr CR Tichauer
Tel No: 021 003 5094

CONTACT PERSON

Mr G Hanekom
Tel No: 021 400 2219



CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

TITLE : **ENKANINI SOUTH HOUSING DEVELOPMENT:
TRAFFIC IMPACT ASSESSMENT**

Project Team : *CR Tichauer (Pr Tech Eng)*

Client : City of Cape Town, Directorate: Human Settlements,
Department: Informal Settlements: Planning

Mowana Project No : *M20018*

Status of Report : *Draft*

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Date of this Issue : *June 2021*

For Mowana Engineers (Pty) Ltd

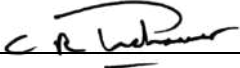
Compiled by	CR Tichauer		06 July 2021
	Initials & Surname	Signature	Date
Reviewed by	FH van Renssen		06 July 2021
	Initials & Surname	Signature	Date

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APPENDIX A: SITE DEVELOPMENT PLAN

FIGURES

1. INTRODUCTION

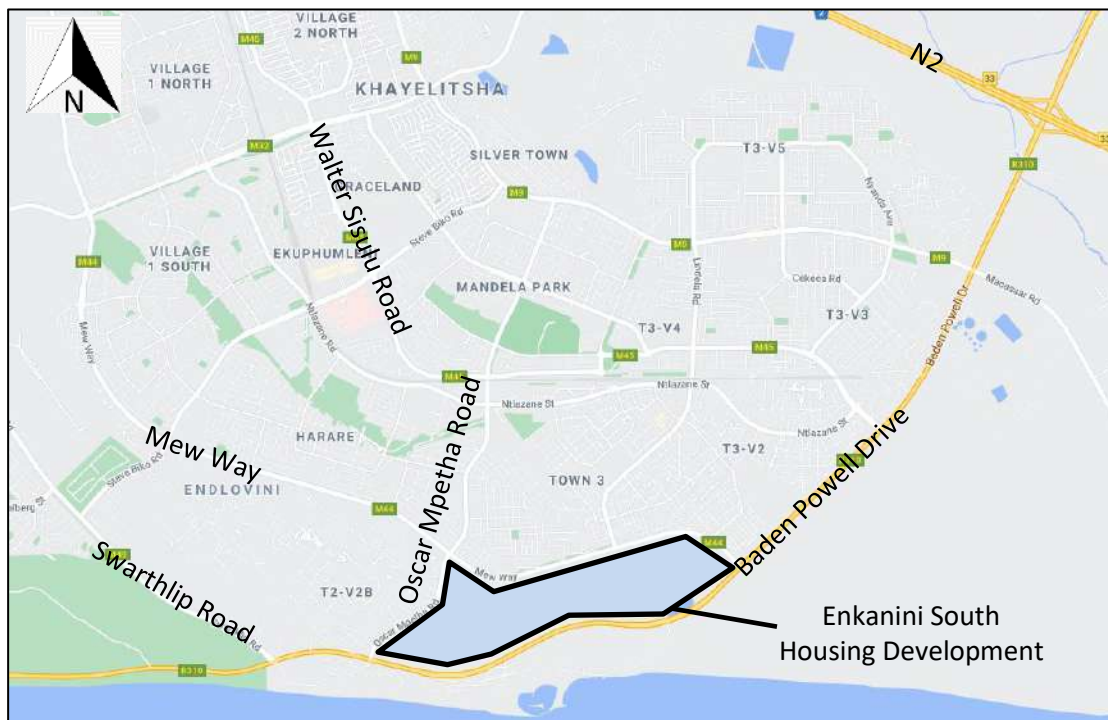
Mowana Engineers (Pty) Ltd are part of the Bosch Projects team that has been appointed by the City of Cape Town: Department of Social Services to provide Traffic Engineering Services for the Central and Eastern Regions.

The City of Cape Town has identified Enkanini South (referred to further as the “Site”) for the development of low-cost housing. They have commenced with the planning application for the rezoning of the land.

2. SITE

2.1 LOCATION

The site is located on the southern boundary of Khayelitsha, bounded by Oscar Mpetha Road, Mew Way and Baden Powell Drive.



2.2 SITE

2.2.1 Proposed Land Use

The Site Development Plan is shown in Appendix A. Based on the SDP the Site will be developed in two phases. The following assumptions have been used to determine the number of units per phase:

- Number of scholars per school 2 000
- Number of children per creche 120
- Number of worshippers per church 220

- Area of small business is 20 m² per erf with a factor of 0.9 to convert bulk to Gross Leasable Area (GLA)
- General Business has a bulk of 1.0 with a factor of 0.9 to convert bulk to GLA

	Erven		Units	Number	
	Phase 1	Phase 2		Phase 1	Phase 2
Residential	857	4574	No	857	4 574
Primary School	1	2	Scholars	2 000	4 000
Secondary School		1	Scholars		2 000
Creche	1	4	Children	120	480
Place of worship	1	3	People	220	660
Residential / Small Business	37	251	m ² GLA	666	4 518
General Business	3	4	m ² GLA	2 070	12 060

The two phases are shown below.

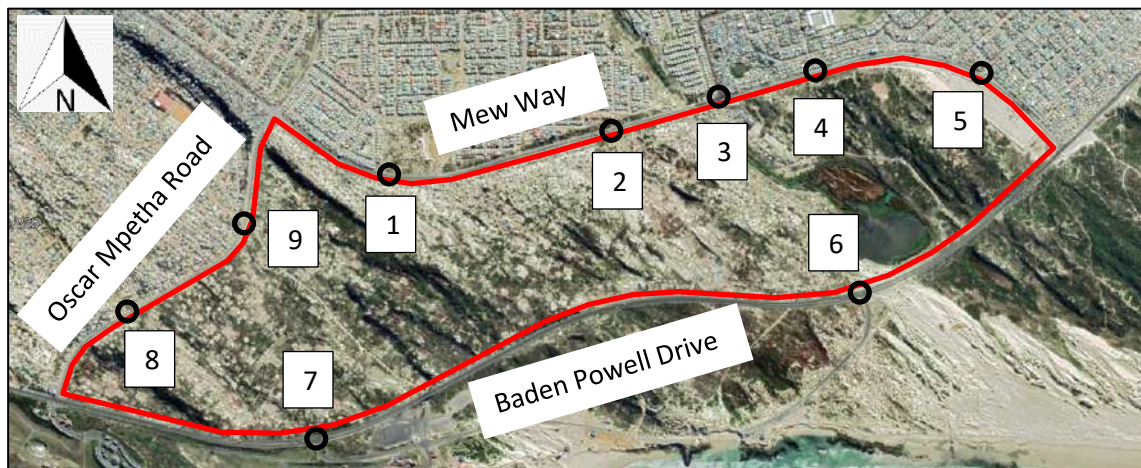


2.2.2 Proposed Access

It is proposed that access to the Site be provided on:

Mew Way:	Intersection 1	New
	Intersection 2	New
	Intersection 3	Existing (Lindela Road)
	Intersection 4	New
	Intersection 5	Existing (Tafeleshashe Road)
Baden Powell Drive	Intersection 6	Existing (Monwabisi Road (East))
	Intersection 7	Existing (Monwabisi Road (West))
Oscar Mpetha Road	Intersection 8	New
	Intersection 9	New

The location of these access intersections is shown below.



3. EXISTING ROAD NETWORK

The major road network, existing and proposed, is shown below.



Baden Powell Drive (Class2)

Baden Powell Drive is a Class 2 road, on the southern boundary of the Site, that runs east/west along the coast linking with suburbs as far west as Muizenberg. East of the Site the road runs northwards and links with Polkadraai Road, which provides access to both Kuilsriver and Stellenbosch. Adjacent to the Site, Baden Powell Drive is constructed as a single carriageway two-way road.

The cross-section for each direction is a travel lane of 3.7 m with a shoulder of 2.4 m and no sidewalks. Close to the intersection with Mew Way the shoulders narrow for a short section to between 1.5 m and 1.8 m.

Oscar Mpetha Road (Class 3)

Oscar Mpetha Road, a Class 3 route that runs north/south along the western edge of the site, connects the internal roads in Khayelitsha to Baden Powell Drive in the south and Jeff Masemola Drive in the north. It is constructed as a single carriageway with two-way traffic.

Oscar Mpetha Road has two 3.7 m wide lanes with no shoulders. There are 1.8 m sidewalks on both sides.

Along the western side of the road, between Mew way and Baden Powell Drive, there are many informal access points into the adjacent informal settlement.

Mew Way (Class 3)

Mew Way, a Class 3 route, runs east/west along the northern edge of the site and connects the internal roads in Khayelitsha to Baden Powell Drive in the south to the N2 Freeway to the north. It is constructed as a single carriageway with two-way traffic.

Mew Way has two 3.7 m wide lanes with a 2.5 m shoulder on the northern side of the road. There is a 2.0 m sidewalk also located on the northern side of Mew Way.

4. BADEN POWELL DRIVE - ACCESS MANAGEMENT PLAN

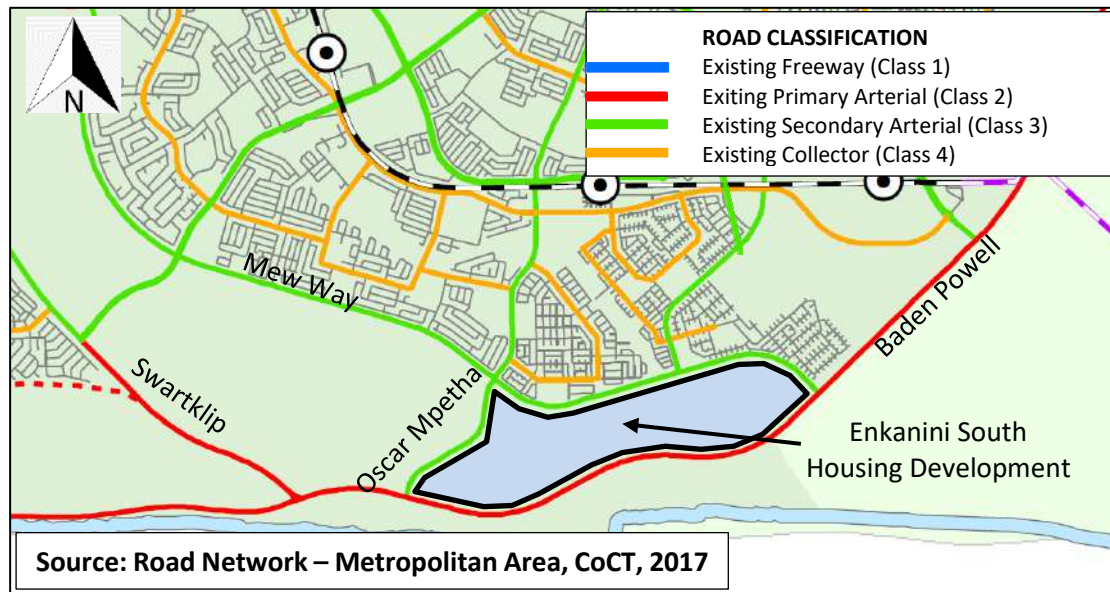
From discussion with both City and Provincial (WCG) officials it was established that there is no Access Management Plan (AMP) for the road adjacent to the Site. The discussion on the AMP is based on the following documents / plans:

- Access Management Guidelines published by the WCG in 2020
- Road Network Plan – Metropolitan Area published by CoCT in 2017
- Khayelitsha, Mitchells Plain and Greater Blue Downs (KMPGBD) – District Plan, 2012
- Khayelitsha, Mitchells Plain and Greater Blue Downs (KMPGBD) – Integrated Spatial Development Framework and Environmental Management Framework, Vol 3 - Implementation Plan, March 2021

4.1 AMP PRINCIPLES

The determination of the AMP is based on the principles of Chapter 19 of the Guidelines. For the purposes of this report the AMP will determine the intersection spacing in the vicinity of the Site:

- a) The City is responsible for determining the function, and thus the classification of the road network within the metropolitan area based on their macro-simulation transportation model. The road classification is encapsulated in their Road Network Plan, an extract of the area surrounding the Site is shown below.



- b) The land use adjacent to the high order roads in the vicinity of the Site is predominantly residential with supporting land uses such as community facilities, local business areas, etc. The exception is the area south of Baden Powell Drive which forms part of the coastline. Both the KMPGBD District Plan and the Integrated District Spatial Development Framework and Environmental Management Framework reports identify the Site as an infill housing area.
- c) Where practical, access to the Site will be provided at existing intersections. New intersections will be provided in accordance with the Guidelines.
- d) Vehicular access to the road network will be limited to approved intersections with frontage and backage roads provided where required.

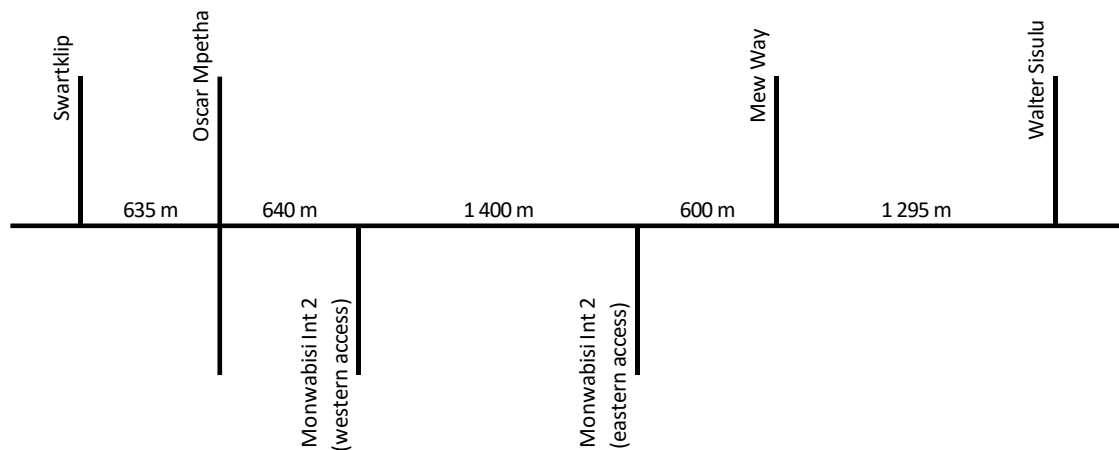
4.2 AMP STANDARDS

- a) Based on Table 6-1 of the Guidelines the roadside environment can be classified as Intermediate. This is based on the bulk for the business erven being 1.0 and the residential component having a density of between 25 – 100 dwelling units per hectare.
- b) From Table 9-7 of the Guidelines the signalised intersection spacing for Class 2 and Class 3 roads in an Intermediate environment is 549 m and 370 m respectively.
- c) From Table 12-2 of the Guidelines the minimum spacing of full intersections on a Class 2 road in an intermediate environment is 235 m.
- d) From Table 12-3 the minimum spacing between a signalised intersection and an unsignalized full intersection is 180 m.

4.3 BADEN POWELL DRIVE AMP

The existing / proposed road reserve width for Baden Powell Drive is 40 m. This will allow the construction of the typical Class 2 cross-section in accordance with the City's Standards and Guidelines for Roads and Stormwater. It is considered that the road reserve width will allow for sufficient capacity to be provided at intersections to cater for the long-term traffic forecasts.

The section of Baden Powell Drive considered includes the section adjacent to the Site and to the nearest major intersection on either side. West of the site the nearest major intersection is Swartklip Road and to the east, Walter Sisulu Road. The existing intersection spacing is shown below:



All existing intersection spacings are greater than the minimum signalised intersection spacing set out in the Guidelines for a Class 2 road.

The SDP proposes that Baden Powell Drive be accessed opposite the two Monwabisi intersections. Therefore the current intersection spacing remains valid and within the Guideline standards.

5. TRAFFIC COUNTS

5.1 2020 TRAFFIC COUNTS

Traffic counts were undertaken at the following intersections on 25 November 2020, in the vicinity of the Site:

- Mew Way / Baden Powell Drive
- Mew Way / Tafelshashe Road
- Mew Way / Lindela Road
- Mew Way / Oscar Mpetha Avenue
- Oscar Mpetha Avenue / Baden Powell Drive



The CoCT requires that counts undertaken while the country is in lockdown must be compared to pre-COVID 19 traffic volumes to determine if a conversion factor is justified. An intersection was identified close to the Site, where recent pre-COVID 19 traffic count information is available - Baden Powell Drive / Macassar Road / Govan Mbeki Road- where traffic counts were undertaken on 10 April 2019. Traffic volumes at this intersection were undertaken on the same day, 25 November 2020, as the above Site intersection traffic counts.

5.2 COVID 19 ADJUSTMENT

An annual growth rate of 3% has been applied to the 2019 traffic counts to convert them to 2020 equivalent volumes. The AM and PM counts for the Baden Powell Drive/Govan Mbeki Road intersection are set out below.

2020 Equivalent Volumes										2020 Surveyed Volumes											
AM Peak Hour										AM Peak Hour											
328	289	L	Baden Powell	152	773	Baden Powell	372	1191	407	362	L	Govan Mbeki	24	T	Govan Mbeki	21	R	Govan Mbeki	372	688	1191
	25	T		581	40		R	T		L	R		T	L							
	14	R		R	T		L	R		T	L		R	T		L					
	Govan Mbeki			Macassar			Macassar			Macassar											
18	L	T	R	R	33	Macassar	43	770	147	Macassar	43	770	147	Macassar	43	770	147	Macassar	43	770	147
	880	101	T	4	178		T	19	135		T	19	135								
	999		L	141			L	76			L	76									
	999			178			960				135										

2020 Equivalent Volumes				2020 Surveyed Volumes			
283	250	L		301	236	L	
	11	T			31	T	
	22	R			34	R	
	Govan Mbeki				Govan Mbeki		
32	L	T	R	48	L	T	R
	564		106		705		91
	702				844		
						</	

Mew Way / Lindela Road



Priority Stop Control

Mew Way / Tafelehashe Road



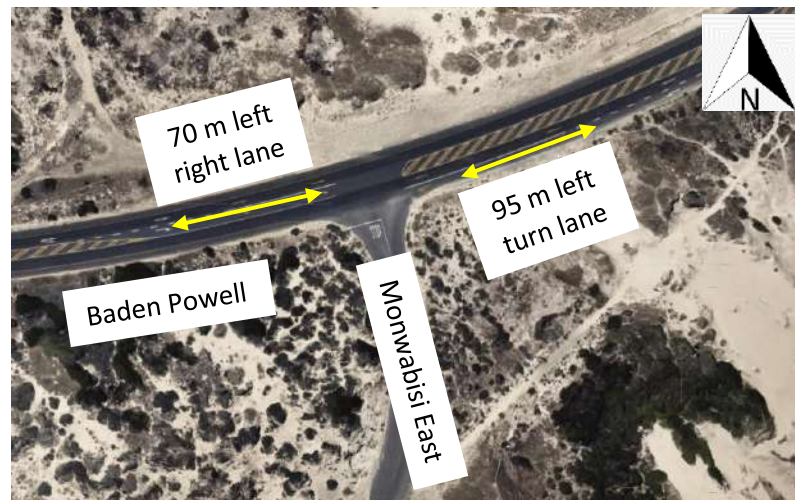
Priority Stop Controlled

Mew Way / Baden Powell



Priority Stop Controlled

Baden Powell / Monwabisi East



Priority Stop Controlled

Baden Powell / Monwabisi West



Priority Stop Controlled

Baden Powell / Oscar Mpetha



Priority Stop Controlled

7. BACKGROUND TRAFFIC 2023

7.1 TRAFFIC GROWTH

For the purposes of this report an annual growth rate of 3% per annum has been used on all roads.

7.2 DEVELOPMENTS IN THE VICINITY OF THE SITE

The Site is bounded by the coast along the southern border with access to major employment and retail nodes located to the north and northwest of the site. There are no developments in the immediate vicinity of the Site. Any trips from developments further afield will be catered for by the 3% per annum growth rate.

7.3 BACKGROUND TRAFFIC 2023

Based on the annual traffic growth rate the expected background traffic for 2023 is set out in **Figure 1** and **Figure 2** for the AM and PM peak hours respectively.

7.4 EXPECTED OPERATION AT INTERSECTIONS – BACKGROUND TRAFFIC 2023

The intersections have been analysed using the existing geometry and the 2023 background traffic volumes using the PTV Vistro software, based on the Highway Capacity Software (HCS). The summary results for the background intersection operation for 2023 is shown in Table 7-1 below. From the analysis, mitigation measures have been identified, where necessary, to achieve an acceptable Level of Service (LOS).

Table 7-1: Summary of HCS analysis – 2023 background traffic

Intersection	AM			PM		
	v/c	Delay (sec)	LOS	v/c	Delay (sec)	LOS
Mew Way/Oscar Mpetha Critical Movement: WB Critical Movement: EB Thru/Right	0.40	10.89 11.88	B B	0.41	11.61 12.931	B B
Mew Way/Lindela Critical Movement: SB Right	0.19	4.30 12.28	B B	0.20	3.84 15.53	C C
Mew Way/Tafaleshashe Critical Movement: WB Right	0.06	3.21 11.62	B B	0.08	2.63 13.15	B B
Mew Way/Baden Powell Critical Movement: SB Right	0.35	4.85 56.15	F F	0.11	3.73 44.09	E E
Baden Powell/Oscar Mpetha Critical Movement: SB Right	1.04	17.01 143.93	F F			
Baden Powell/Oscar Mpetha* Critical Approach: WB	0.57	8.40 10.11	A B	0.52	7.70 8.57	A A
* Intersection converted to roundabout						

From the above table two intersection that experience some delays are:

- a) Mew Way/Baden Powell Drive. The southbound right turn, from Mew Way into Baden Powell Drive, experiences a LOS F during the AM peak hour and LOS E during the PM peak hour. These movements however are reasonably low, 25 vehicles during the AM peak hour and 12 vehicles during the PM peak hour, therefore the expected LOS achieved is acceptable.
- b) Baden Powell Drive/Oscar Mpetha Road. During the AM peak hour the right turn from Oscar Mpetha Road (southbound) experiences significant delay. The volume undertaking this movement is significant, 163 vehicles, with a 95th percentile queue of 5.77 m . It is considered that improvements are therefore required. Further assessment showed that a single lane roundabout will provide the optimum capacity improvement.

8. DEVELOPMENT TRAFFIC

8.1 TRIP GENERATION

For the purposes of determining the number of trips that will be generated the proposed trips will be calculated using TMH 17 South African Trip Data Manual (version 1.01, dated September 2013). The proposed trip generation rates and the corresponding directional splits is shown in **Table 8-1**.

Table 8-1: Trip Generation Rates

Land use	Size Units	AM Rate			PM Rate		
		Trips	Split		Trips	Split	
			In	Out		In	Out
Residential	1 Unit	1.00	0.25	0.75	1.00	0.70	0.30
Apartments/Flats	1 Unit	0.65	0.25	0.75	0.65	0.70	0.30
Primary school	1 Student	0.85	0.50	0.50	0.30	0.45	0.55
Secondary school	1 Student	0.75	0.50	0.50	0.25	0.45	0.55
Place of worship	1 Seat	0.05	0.55	0.45	0.05	0.50	0.50
Day care	1 Student	1.00	0.50	0.50	0.80	0.50	0.50
General Business	100 m ² GLA	0.60	0.65	0.35	3.40	0.50	0.50

8.2 TRIP ADJUSTMENT FACTORS

The development within the site is expected to be low income residential with a high proportion of public transport and walking trips. It is expected that there will be a significant proportion of internal trips between the respective land uses. The site is within an area where car ownership is very low and from site observation there is a strong public transport presence. Based on TMH 17, Table 3.2, the number of trips can be reduced as follows, note that mixed-use development reduction factor will not be applied to the residential component:

Table 8-2: Trip Adjustment factors

	Mixed-use Development (PM)	Very Low Ownership (PV)	Transit Nodes or Corridors (PT)	Combined factor
Residential	0%	70%	15%	75%
Primary School	30%	80%	15%	88%
Secondary School	30%	80%	15%	88%
Place of worship	10%	80%	15%	85%
ECD	5%	80%	15%	84%
Res/Small Business	10%	60%	15%	69%
General Business	10%	60%	15%	69%

An additional reduction factor will be applied to the primary and secondary school trips. The schools are established to serve the local community and given the area and number of residential opportunities being created in the Site it is expected that the bulk of the trips will be on the internal road network of the Site and will not use the external road network. The trips on the external road network will therefore primarily be the teachers and administrative staff. For the purposes of this report a further reduction factor of 80% has been used to allow for the teachers and administrative staff only.

8.3 EXPECTED DEVELOPMENT TRIPS

8.3.1 Unadjusted trip generation

Based on the land use set out in Section 2, the trip generation rates in **Table 8-1** and the trip adjustment factors in Table 8-3: Expected Trip Generation – Phase 1 (plus the additional reduction factor for the schools) the expected new trips for each land parcel in the Site has been calculated.

Note that both phases have erven will be zoned residential and small business. Given the dual function of these erven the residential portion of the erven has been added to the residential units in and . As an example in Phase 1 the number of residential units in is 857 and the number of residential/small business erven is 37. The total number of residential erven used to calculate residential trips is 894 (857 + 37) and the total GLA for small business is 666 m² (37 x 20 x 0.9).

The expected trip generation is set out in **Table 8-3**.

Table 8-3: Expected Trip Generation – Phase 1

	Extent	AM			PM		
		Total	In	Out	Total	In	Out
Enkanini Phase 1							
Residential	8947 units	228	57	171	228	160	68
Primary School	2 000 students	40	20	20	14	6	8
Secondary School	0 students	0	0	0	0	0	0
ECD	120 students	19	10	9	16	8	8
Place of worship	220 seats	2	1	1	3	1	2
Res/Small Business	666 m² GLA	1	1	0	8	4	4
General Business	2 070 m² GLA	4	2	2	22	11	11
Total		295	91	204	290	190	100

The expected trip generation for Phase 2 is given in **Table 8-4**.

Table 8-4: Expected Trip Generation – Phase 2

	Extent	AM			PM		
		Total	In	Out	Total	In	Out
Enkanini Phase 1							
Residential	4 825 units	1 230	308	922	1 230	861	369
Primary School	4 000 students	81	40	41	29	13	16
Secondary School	2 000 students	36	18	18	12	5	7
ECD	480 students	78	39	39	62	31	31
Place of worship	660 seats	5	3	2	5	3	2
Res/Small Business	4 518 m² GLA	8	5	3	52	26	26
General Business	12 060 m² GLA	22	14	8	139	70	69
Sub-Total		1 460	427	1 033	1 530	1 009	521

8.4 TRIP DISTRIBUTION

Based in the current traffic patterns and access to the major road network the trip distribution used in this report is.

Mew Way	30%
Oscar Mpetha Road (north)	15%
Lindela Road	5%
Baden Powell Road (north)	20%
Baden Powell Road (west)	30%

8.5 DEVELOPMENT TRIPS

Using the trip generation and distribution the development trips for the AM and PM peak hours are shown on **Figure 3** and **Figure 4** respectively for Phase 1 and **Figure 5** and **Figure 6** respectively for Phase 2.

9. IMPACT OF DEVELOPMENT ON ROAD NETWORK

9.1 PHASE 1 - 2023

The 2023 background traffic volumes and the trips generated by Phase1 have been combined to obtain the total trips for 2023, refer to **Figure 5** and **Figure 6** for the AM and PM peak hour volumes respectively.

The results of the analysis of the 2023 operation with the background and Phase 1 trips are summarised in **Table 9-1**. It must be noted that Phase 1 will only access the external road network via the two eastern most intersections on Mew Way, intersections 4 and 5 on the figure below. The Phase 2 intersections have not been assessed.

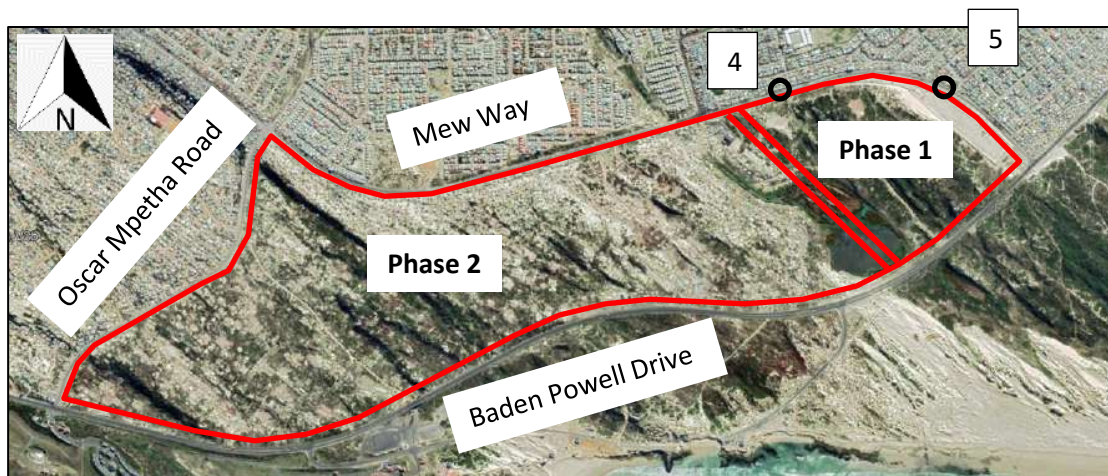


Table 9-1: Summary of HCS Analyses – Phase 1

Intersection	AM			PM		
	v/c	Delay (sec)	LOS	v/c	Delay (sec)	LOS
Mew Way/Oscar Mpetha Worst Approach: WB Worst Approach: EB Thru/Right	0.49	12.59 13.95	B B	0.53	13.49 15.86	B B
Mew Way/Lindela Worst Movement: SB Right	0.20	3.84 15.53	C C	0.25	3.76 19.05	C C
Mew Way/Access 4 Worst Movement: NB Right**	0.00	2.97 11.56	B B	0.00	2.05 14.17	B B
Mew Way/Tafaleshashe/Access 5 Worst Movement: NB Right	0.19	4.90 13.49	B B	0.12	3.21 14.62	B B
Mew Way/Baden Powell Worst Movement: EB Right	0.35	39.91 56.15	F F			
Mew Way/Baden Powell* Worst Movement: SB Right	0.65	10.25 11.49	B B	0.63	9.80 10.56	A B
Baden Powell/Oscar Mpetha Worst Approach: WB	0.62	9.18 11.36	A B	0.54	8.21 8.99	A A
* Intersection converted to roundabout						
** No volumes assigned to this movement - HCS indicates it as critical movement						

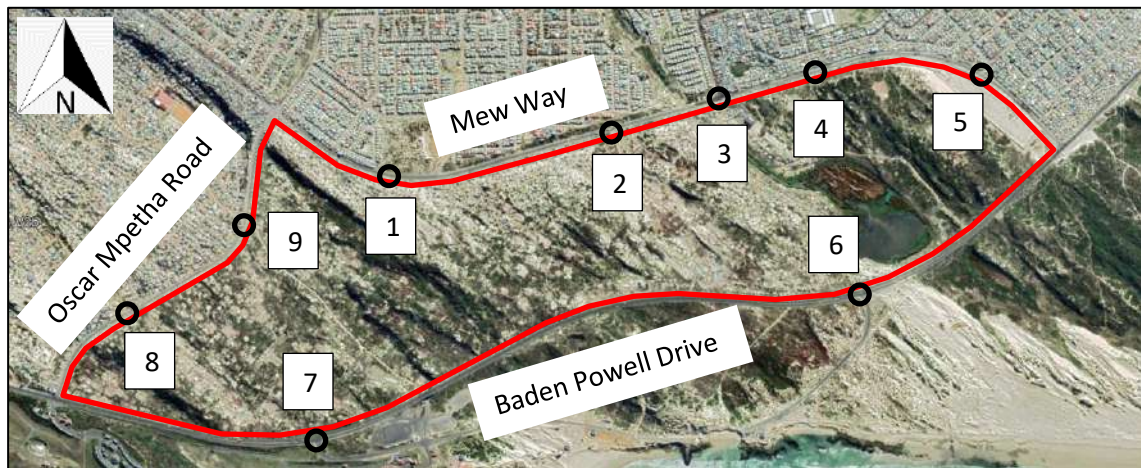
From the above table the intersection that experiences unacceptable delays is:

- a) Mew Way/Baden Powell Drive. With the addition of the Phase 1 trips the right turn from Mew Way into Baden Powell Drive experience significant delays and queuing, with a 95th percentile queue length of 15.57 vehicles during the AM peak hour. Consideration was given to upgrading the Mew Way approach to the intersection by providing a 60 m left turn lane (separate the left and right turn movements) The 95th percentile right turn queue length reduces to 6.29 vehicles however, this is still considered to be excessive. The intersection is converted to a single lane roundabout.

9.2 PHASE 2 - 2028

The background trips have been grown with the application of the 3% per annum traffic growth rate to 2028, refer to Figure 7 and Figure 8 for the AM and PM peak hour volumes. The trip generation for Phase 1 and Phase 2 have been added to these background traffic volumes to obtain the total traffic volumes for 2028, refer to Figure 9 and Figure 10 for the 2028 total traffic volumes for the AM and PM peak hours respectively.

The access intersections are shown below.



The results of the analysis of the 2023 operation with the background and Phase 1 trips are summarised in **Table 9-2**.

Table 9-2: Summary of HCS Analyses – Phase 1 & Phase 2 (2028)

Intersection	AM			PM		
	v/c	Delay (sec)	LOS	v/c	Delay (sec)	LOS
Mew Way/Oscar Mpetha Worst Movement: WB	>1.2	136.56	F F			
Mew Way/Oscar Mpetha* Worst Approach: WB	0.66	12.09 14.86	B B	0.80	16.01 20.36	C C
Mew Way/Access 1 Worst Movement: NB Right	0.07	2.93 19.19	C C	0.05	2.01 26.06	D D
Mew Way/Access 2 Worst Movement: NB Right	0.02	1.05 14.98	B B	0.01	0.75 18.08	C C
Mew Way/Lindela/Access 3 Worst Movement: SB Right	0.44	7.46 24.12	C C	0.61	8.83 46.1	E E
Mew Way/Access 4 Worst Movement: NB Right**	0.00	2.34 12.86	B B	0.0	1.68 16.64	C C
Mew Way/Tafaleshashe/Access 5 Worst Movement: NB Right	0.24	4.73 16.03	C C	0.16	3.30 18.38	C C
Mew Way/Baden Powell Worst Approach: WB	0.83	18.40 19.60	C C	0.89	19.64 23.87	C C
Baden Powell/Access 6 Worst Movement: SB Right	0.21	1.72 66.69	F F	0.12	1.09 63.96	F F
Baden Powell/Access 7 Worst Movement: SB Right	>1.2	70.40 574.83	F F			
Baden Powell/Access 7* Worst Movement: SB Right	0.75	12.23 15.72	C C	0.69	11.44 12.45	B B
Baden Powell/Oscar Mpetha Worst Approach: WB	1.03	32.81 58.09	D F	0.76	15.68 16.23	C C
Oscar Mpetha/Access 8 Worst Movement: WB Right	0.18	3.17 13.87	B B	0.10	2.02 13.35	B B
Oscar Mpetha/Access 9 Worst Movement: WB Right	0.41	7.91 16.94	C C	0.27	5.13 23.90	C C
* Intersection converted to roundabout						
** No volumes assigned to this movement - HCS indicates it as the critical movement						

Based on the analyses of the intersections all the study intersections are operating at an acceptable LOS except for those discussed below:

- a) Mew Way/Oscar Mpetha Road. The all-way stop control operation results in a LOS F for all approaches. Conversion to a single lane roundabout is expected to result in an acceptable LOS on all approaches.
- b) Mew Way/Lindela Road/Access 3. The poor LOS E, during the PM peak hour, for the intersection is the result of a single movement - the right turn from Lindela Road into

Mew Way. The 95th percentile queue length for this movement is 3.49 vehicles with the second longest for any other movement being 0.99 vehicles. It is considered that this intersection will operate at an acceptable LOS.

- c) Baden Powell/Monwabisi East/Access 6. There are currently no vehicles using the approach to the intersection from the Monwabisi Resort during the peak hours as the facility is a recreational area (the road between the intersection and the resort is also washed away). The critical movement at this intersection is the southbound right turn from the Site into Baden Powell Drive. This movement is low during both peak hours and the longest queue is expected to be experienced in the AM peak hour where the 95th percentile queue is 1.76 vehicles. The alternative for vehicles exiting the Site, if the motorist considers the delay too high, is at the Baden Powell Drive/Access 7 intersection where it is recommended that the current intersection be converted to a single lane roundabout.
- d) Baden Powell Drive/Monwabisi West/Access 7. During the AM peak period the intersection, as a two-way stopped controlled intersection, is expected to operate with excessive delays to the southbound right turn from the site into Baden Powell Drive. This right turn demand is predicted to be 185 vehicles with a 95th percentile queue length of 18.97 vehicles. Separating the right turn from the left/thru movements on this approach will have negligible impact on reducing the delays and queue length. The intersection method of control has therefore been converted to a single lane roundabout.
- e) Baden Powell Drive/Oscar Mpetha Road. During the AM peak hour the westbound approach is at capacity (with a LOS F) while the overall intersection LOS is D. All the other approaches are expected to operate at a LOS B. The 95th percentile queue length is expected to be 21.27 vehicles. During the PM peak hour the overall intersection LOS is expected to be C with the worst approach also experiencing a LOS C. The intersection is therefore approaching the capacity of a single lane roundabout but does not require upgrading yet.

10. NON-MOTORISED TRANSPORT (NMT)

10.1 PEDESTRIANS

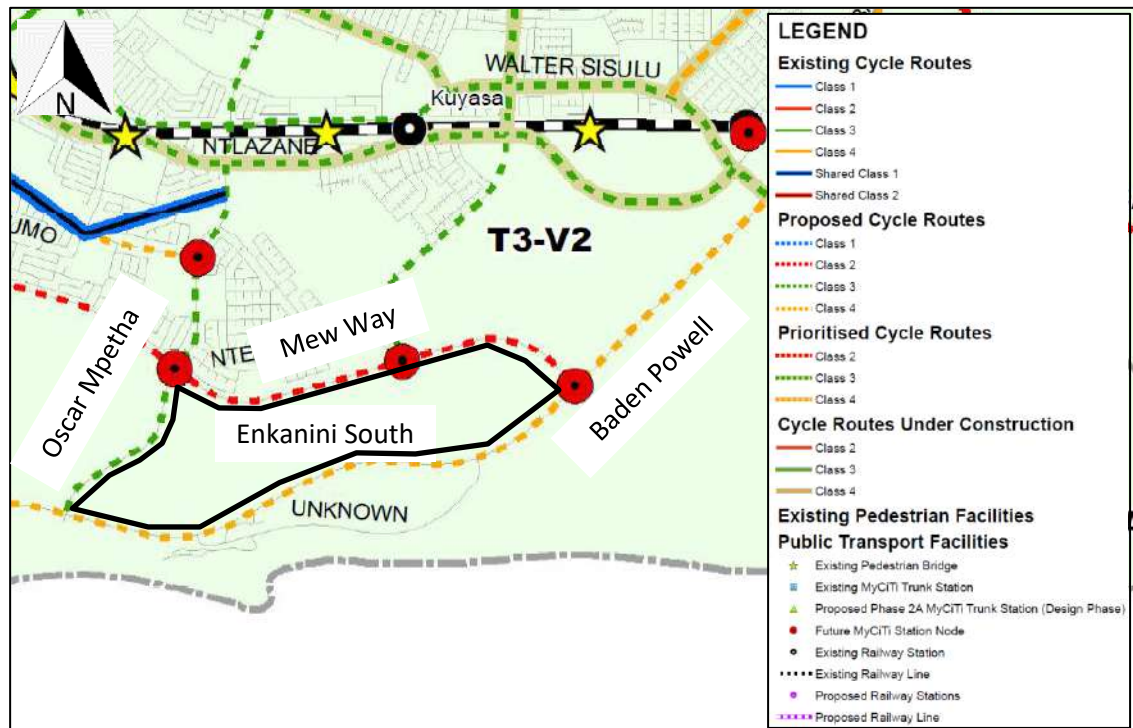
Within the Site walking will be the major mode of transport.

It is recommended that the internal roads be constructed with sidewalks on both sides of the road.

It is recommended that a sidewalk be constructed on the side of Mew Way and Oscar Mpetha Road immediately adjacent to the Site parallel with the phased implementation of the Site.

10.2 CYCLISTS

Below is an extract from the NMT Network Plan Cycle Routes for the Eastern Region, dated February 2017 and maintained by the City of Cape Town. The three external roads that bound the Site are all designated future cycle facilities, either Class 2 or Class 3. It is recommended that the shoulder be designated as cycle lanes on both Mew Way and Oscar Mpetha Road.

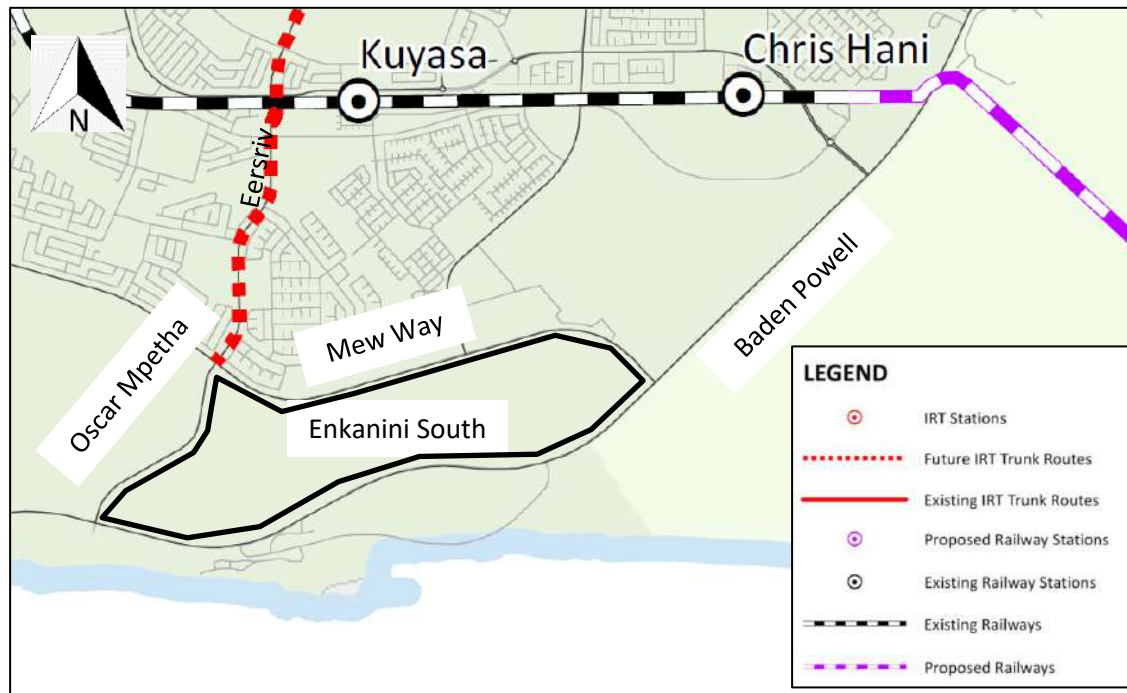


11. PUBLIC TRANSPORT

11.1 IRT

Below is an extract from the Integrated Rapid Public Transport Network (IPTN) for the study area.

From the extract it can be seen that, in the future, a IRT trunk route will be established on Oscar Mpetha Road, northwards from Mew Way. When the trunk route is implemented it is recommended that the feeder routes for the IRT service be incorporated into the design.



11.2 RAIL

The closest, existing, rail stations are Kuyasa and Chris Hani to the north of the Site. The Kuyasa Station is approximately 23 minutes from the Mew Way/Oscar Mpetha Road intersection and 20 minutes from the Mew Way/Lindela Road intersection.

11.3 BUS AND TAXI

Given the expected low vehicle ownership in the proposed developments road-based public transport will play the major role in the movement of people between the proposed developments and work and shopping opportunities outside the area.

The primary road-based public transport routes in the area are currently Mew Way. There are no other public transport facilities in the area. It is recommended that a location be identified on the site that can be reserved for a public transport interchange. It is recommended that embayments be constructed on all intersections where the internal road network intersects with the external road network. Additionally embayments must be provided at the Mew Way/Oscar Mpetha Road intersection.

It is recommended that embayments be constructed on the higher order internal roads, particularly adjacent to community facilities such as schools, clinics and retail/business nodes.

12. CONCLUSIONS

Based on the assessment undertaken in the this report the following can be concluded:

- a) The development is expected to be developed in two phases, Phase 1 to be completed in 2023 and Phase 2 by 2028.
- b) The Access Management Plan for Baden Powell Drive shows that the minimum requirements for a Class 2 route are met.
- c) Traffic counts were undertaken in November 2020 and included a control intersection. The count at the control intersection was compared to a traffic count undertaken in 2019. The comparison of the traffic counts shows the 2020 traffic volumes to be higher than the 2019 traffic counts. The 2020 traffic counts are therefore considered acceptable for undertaking the traffic assessment in this report.
- d) The annual traffic growth rate used in this report is 3% per annum.
- e) The proposed developments are expected to generate the following trips:

Phase 1

	Total	In	Out
AM Peak Hour	295	91	204
PM Peak Hour	290	190	100

Phase 2

	Total	In	Out
AM Peak Hour	1 460	427	1 033
PM Peak Hour	1 530	1 009	521

- f) The analysis of the intersection operation for the 2023 background traffic volumes all intersections are expected to operate at an acceptable Level of Service once the following intersection improvements have been done:

Baden Powell/Oscar Mpetha Road – convert to single lane roundabout

- g) Once the expected Phase 1 trips are assigned to the 2023 network all intersections are expected to operate at an acceptable Level of Service once the following intersection improvements have been done:

Mew Way/Baden Powell Drive – convert to single lane roundabout

- h) In the assessment of the 2028 total traffic demand all intersections will operate at an acceptable level of service once the following intersections improvements have been undertaken:

Mew Way/Oscar Mpetha Road – convert to single lane roundabout

Baden Powell Drive/Monwabisi West/Access 7 - convert to single lane roundabout

- i) Walking will be the major mode of transport within the proposed developments.

- j) Road-based public transport will be the primary transport mode between the proposed developments and work/shopping opportunities outside the area.

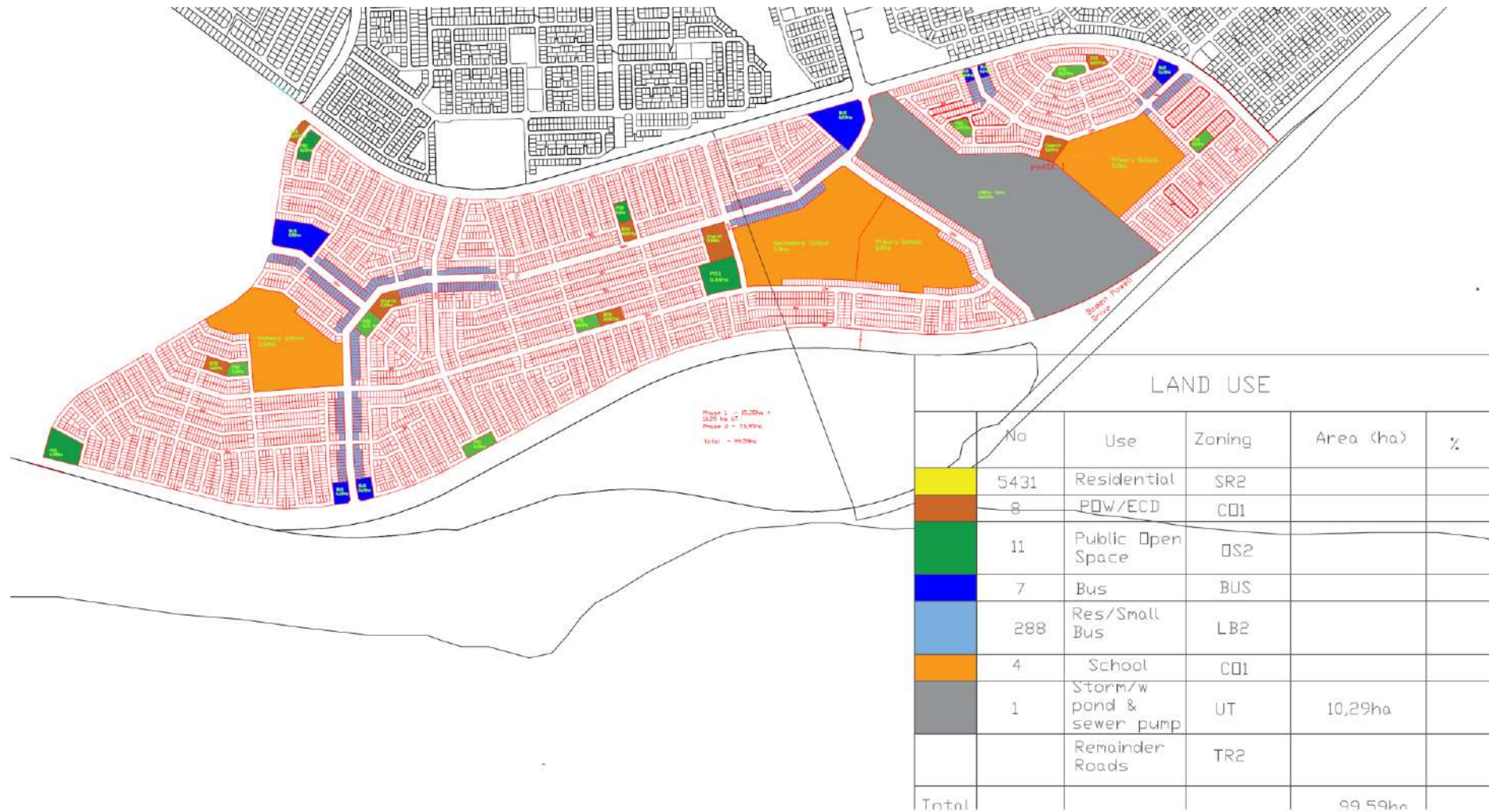
13. RECOMMENDATIONS

Based on the assessment undertaken in this report the following is recommended:

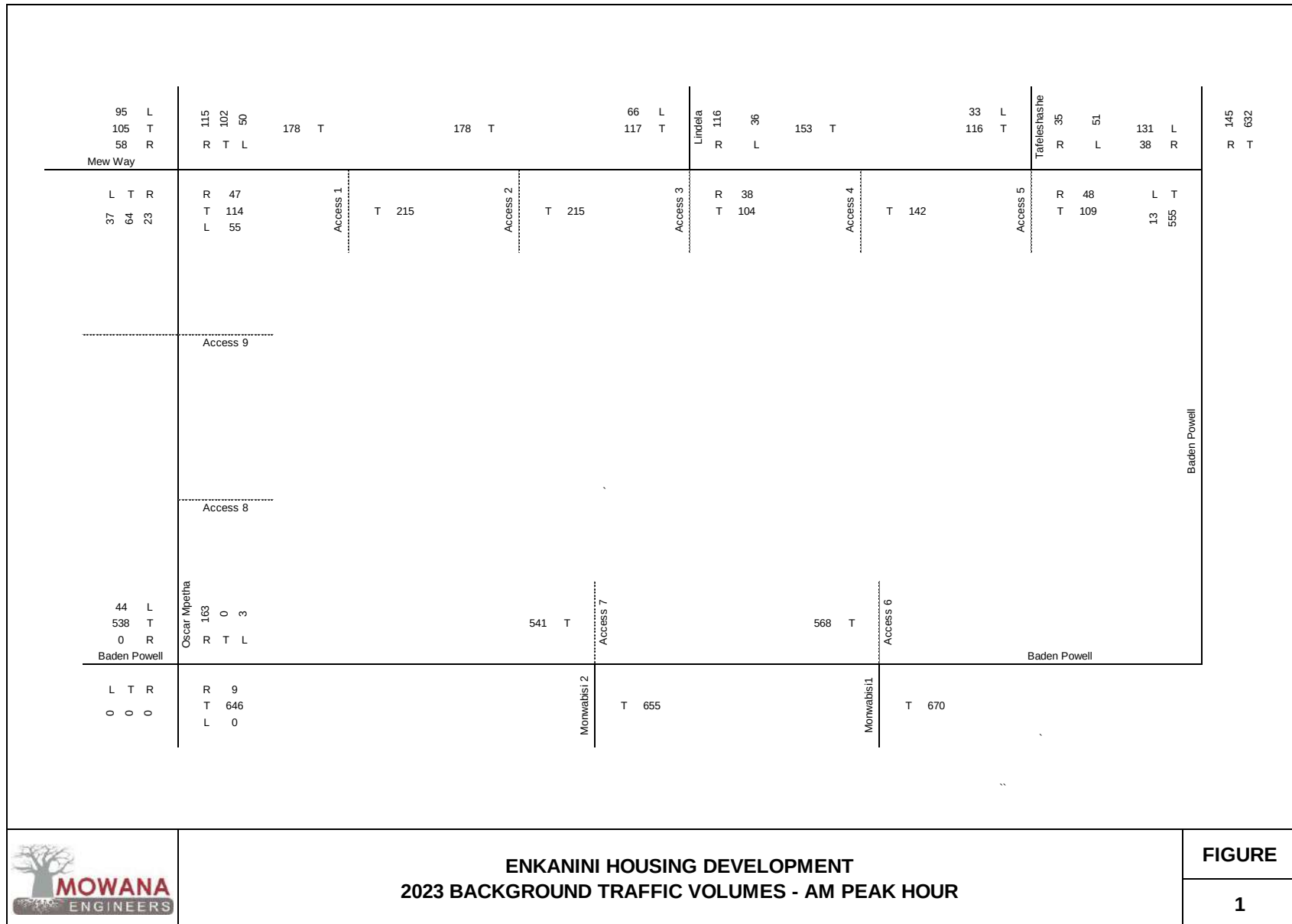
- a) The Access Management Plan for Baden Powell Drive be accepted.
- b) The following intersection improvements be implemented to accommodate:
 - i. Background growth
 - Baden Powell/Oscar Mpetha Road– convert to single lane roundabout
 - ii. Phase 1
 - Mew Way/Baden Powell Drive – convert to single lane roundabout
 - iii. Phase 2
 - Mew Way/Baden Powell Drive – convert to single lane roundabout
 - Baden Powell Drive/Monwabisi West/Access 7 – convert to single lane roundabout
- c) Provide sidewalks on both sides of internal roads.
- d) Provide sidewalks on Mew Way and Oscar Mpetha Road, immediately adjacent to the Site.
- e) Provide embayments on the higher order internal roads , particularly in the vicinity of community facilities such as schools, clinics and retail/business nodes.

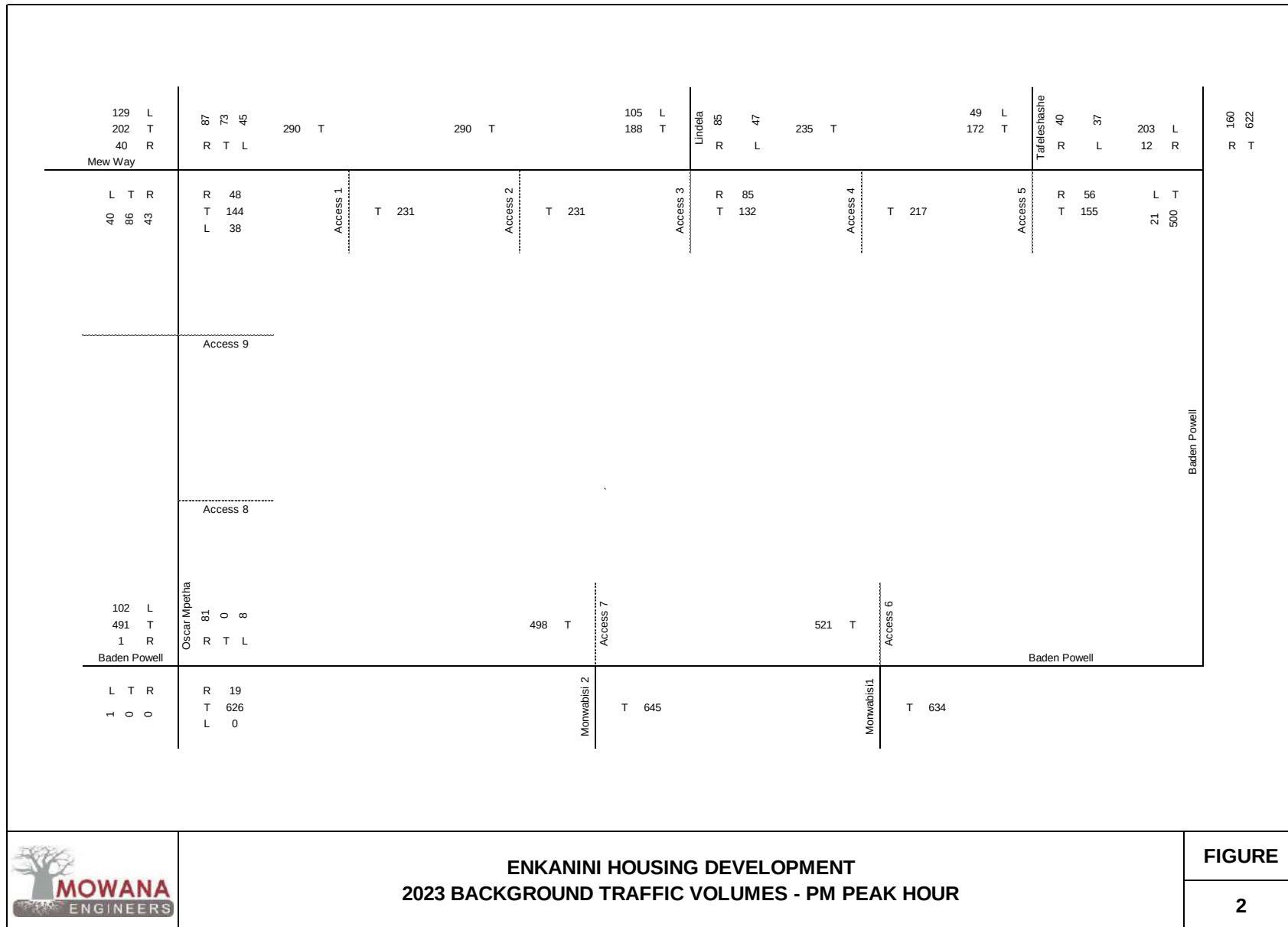
With the implementation of the above improvements the application for the development of the area included in the report are supported from a traffic engineering perspective.

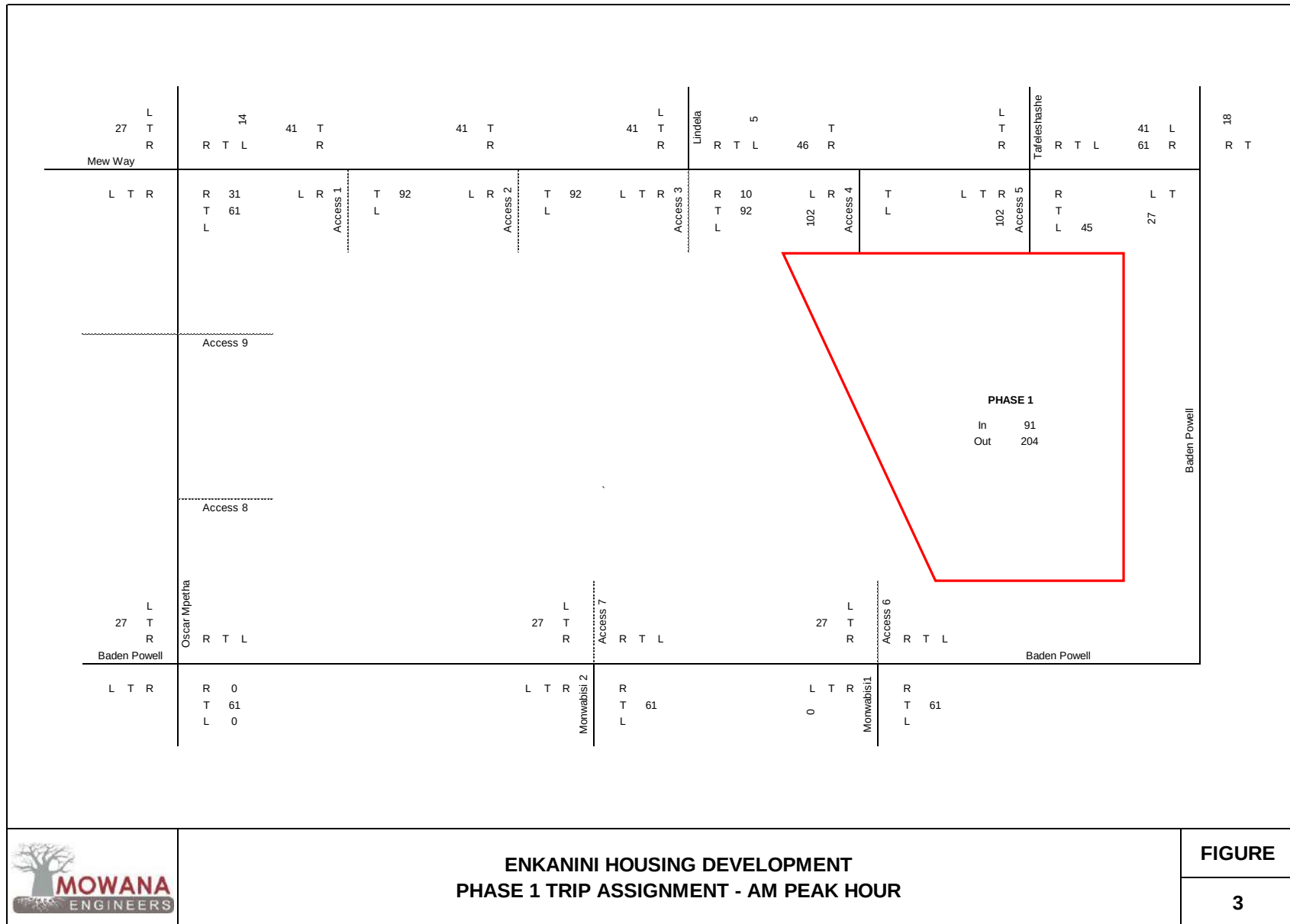
APPENDIX 1: SITE DEVELOPMENT PLAN

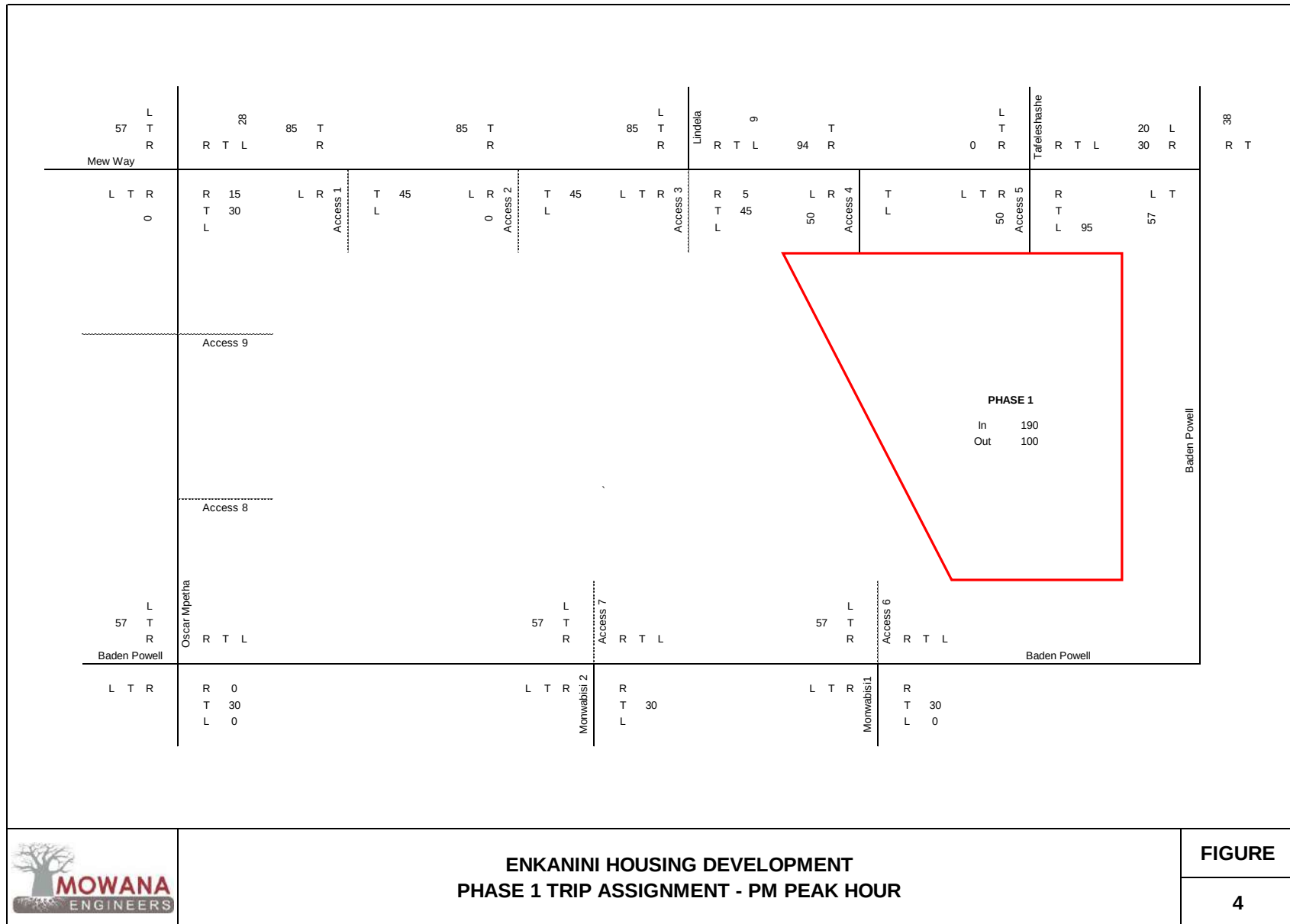


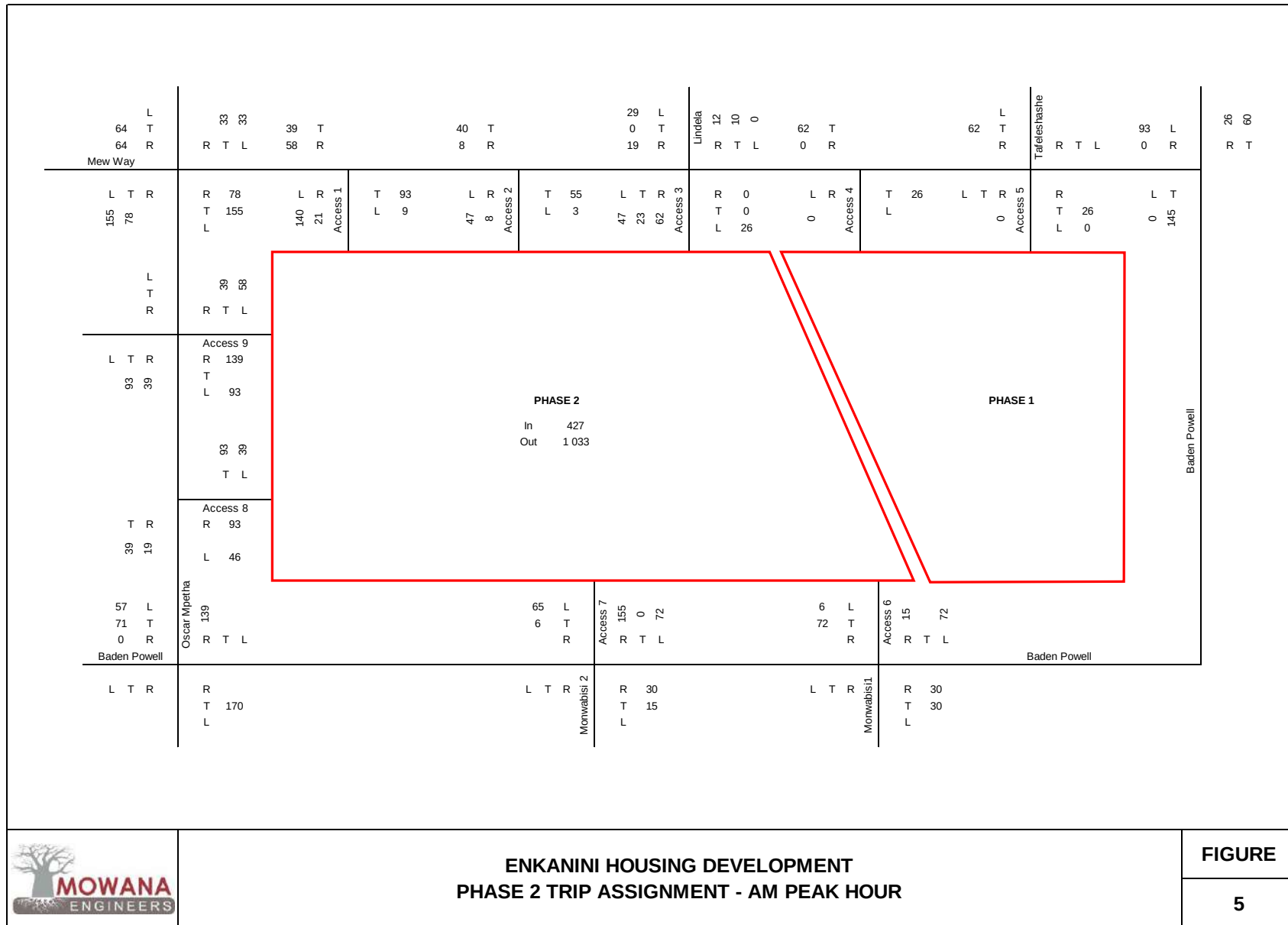
FIGURES

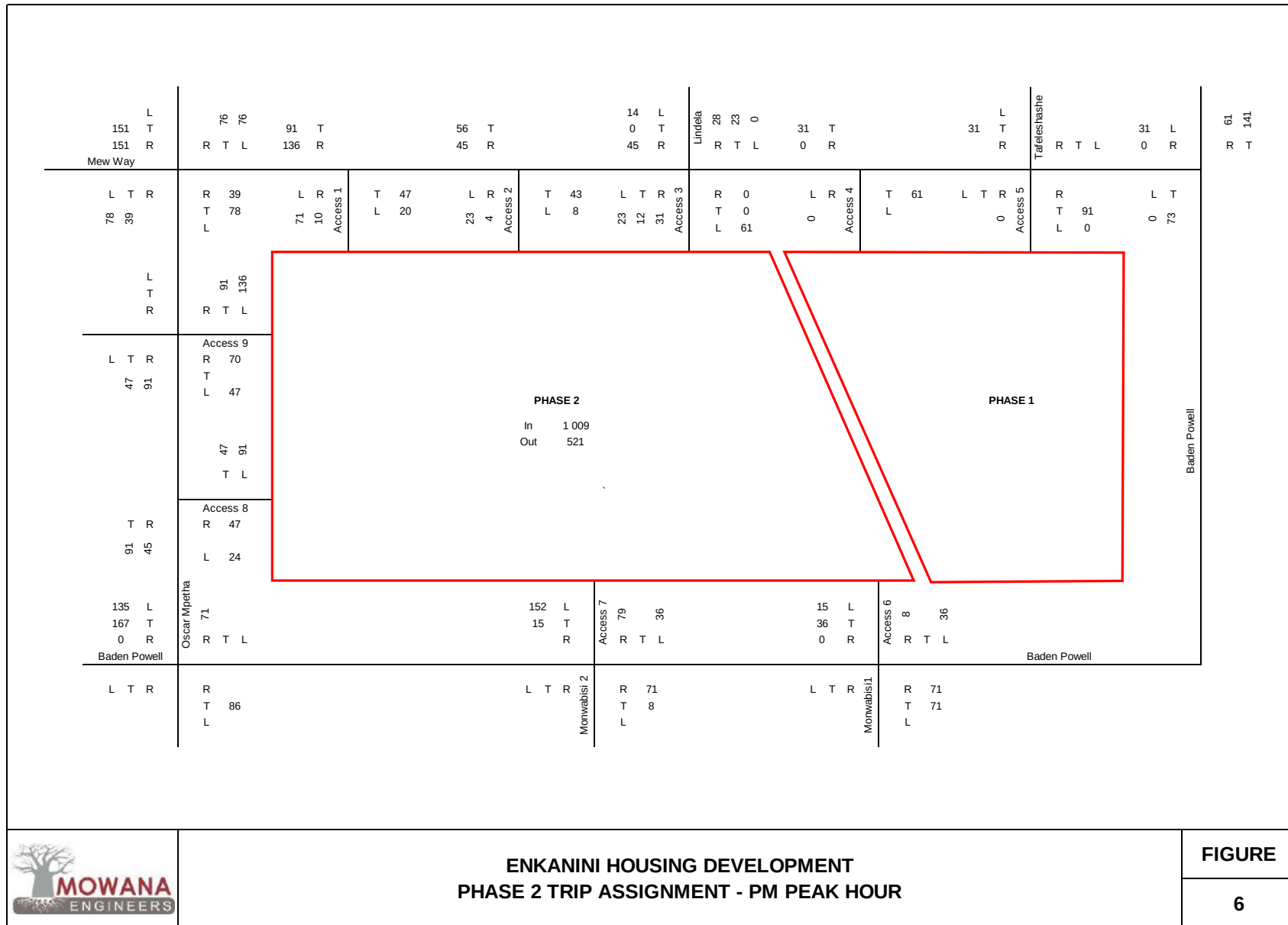


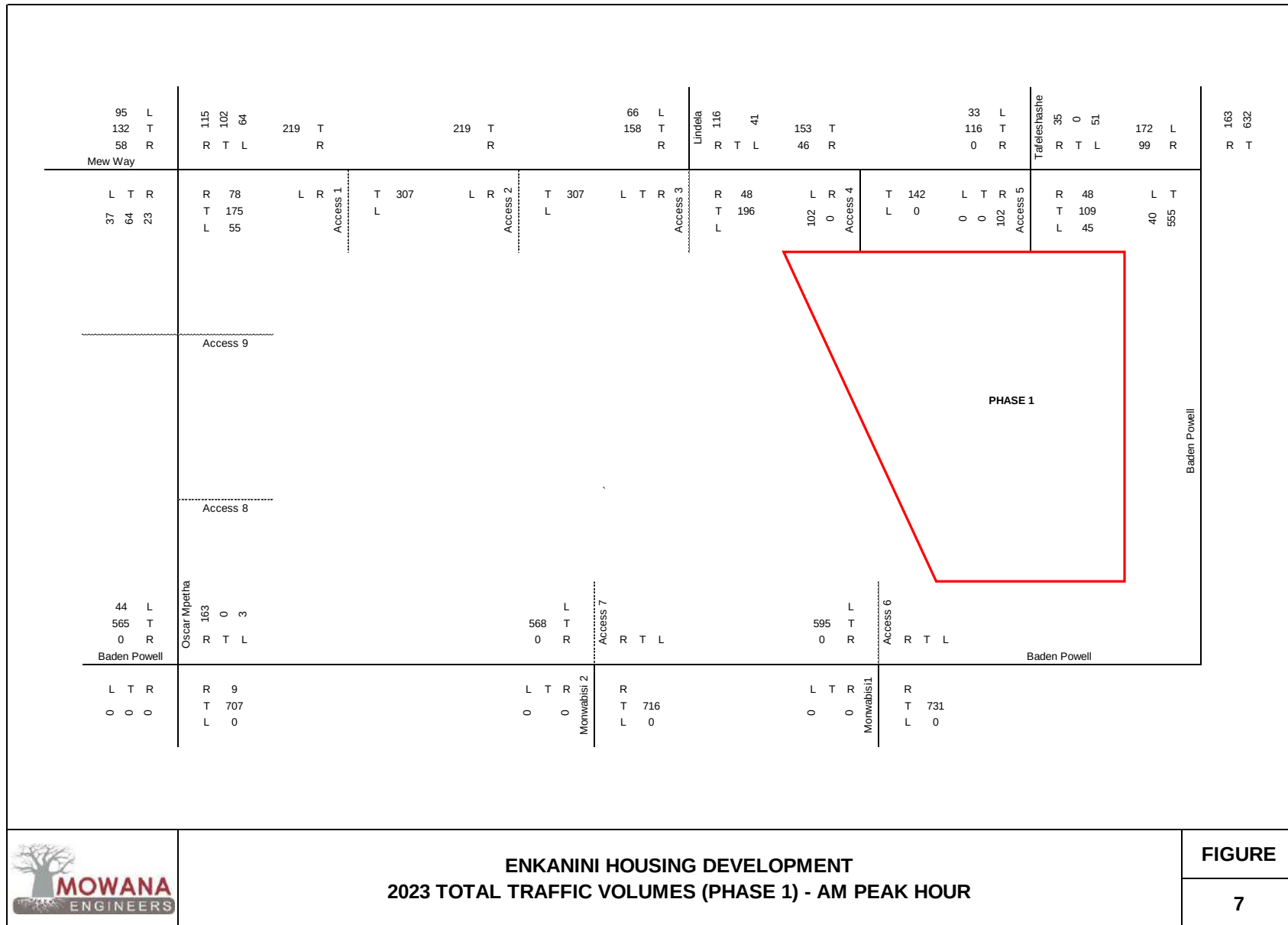


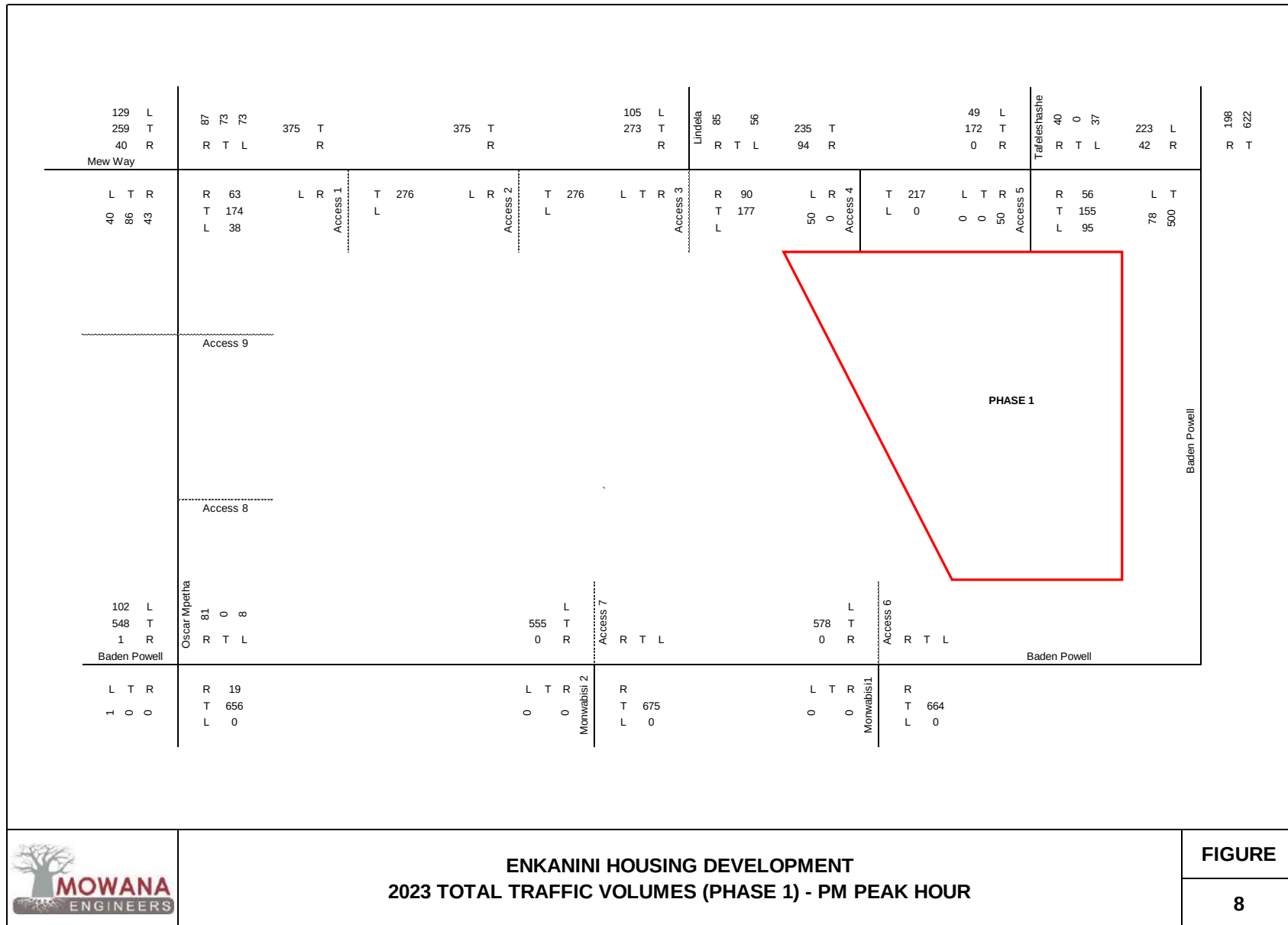


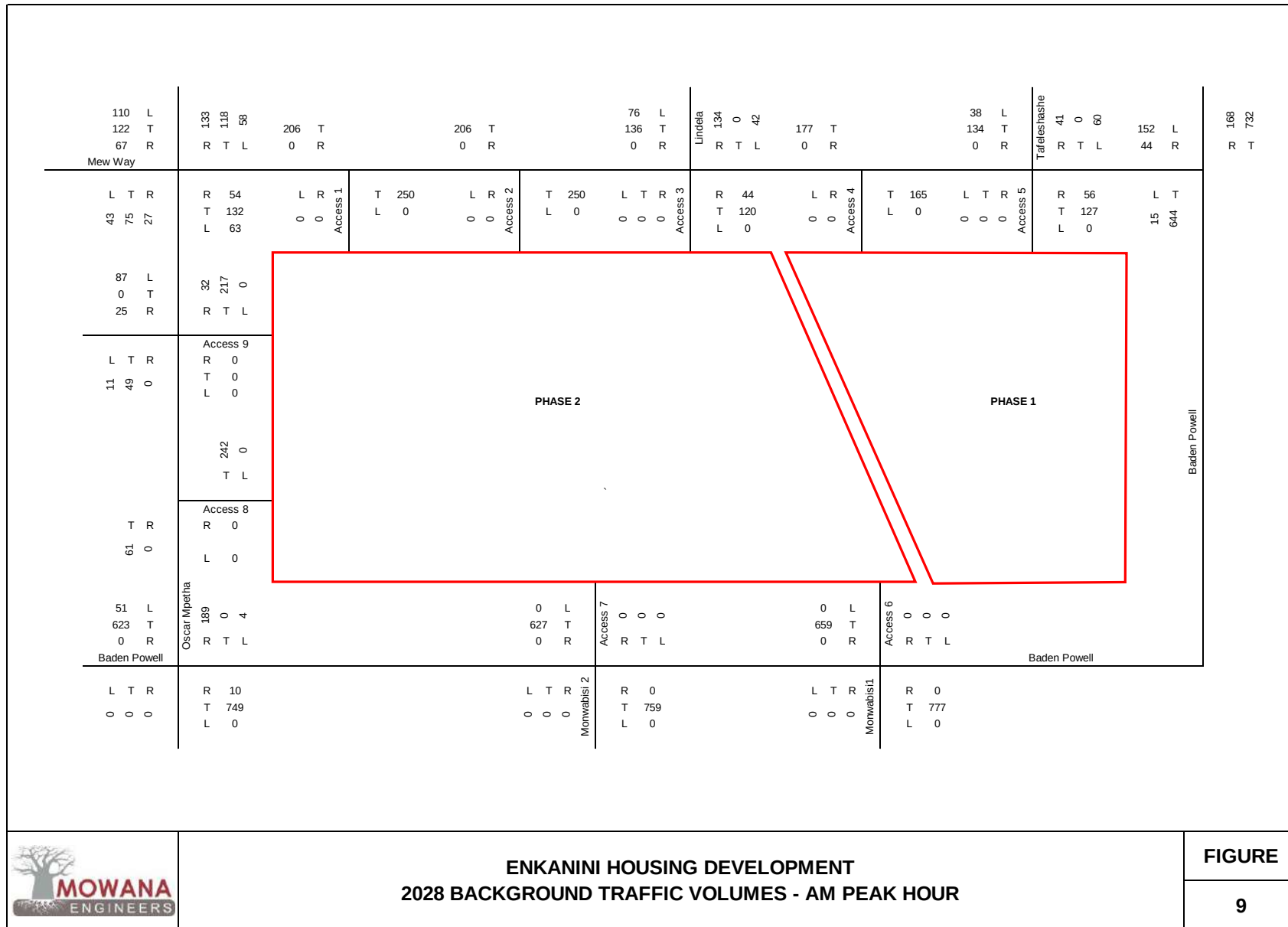


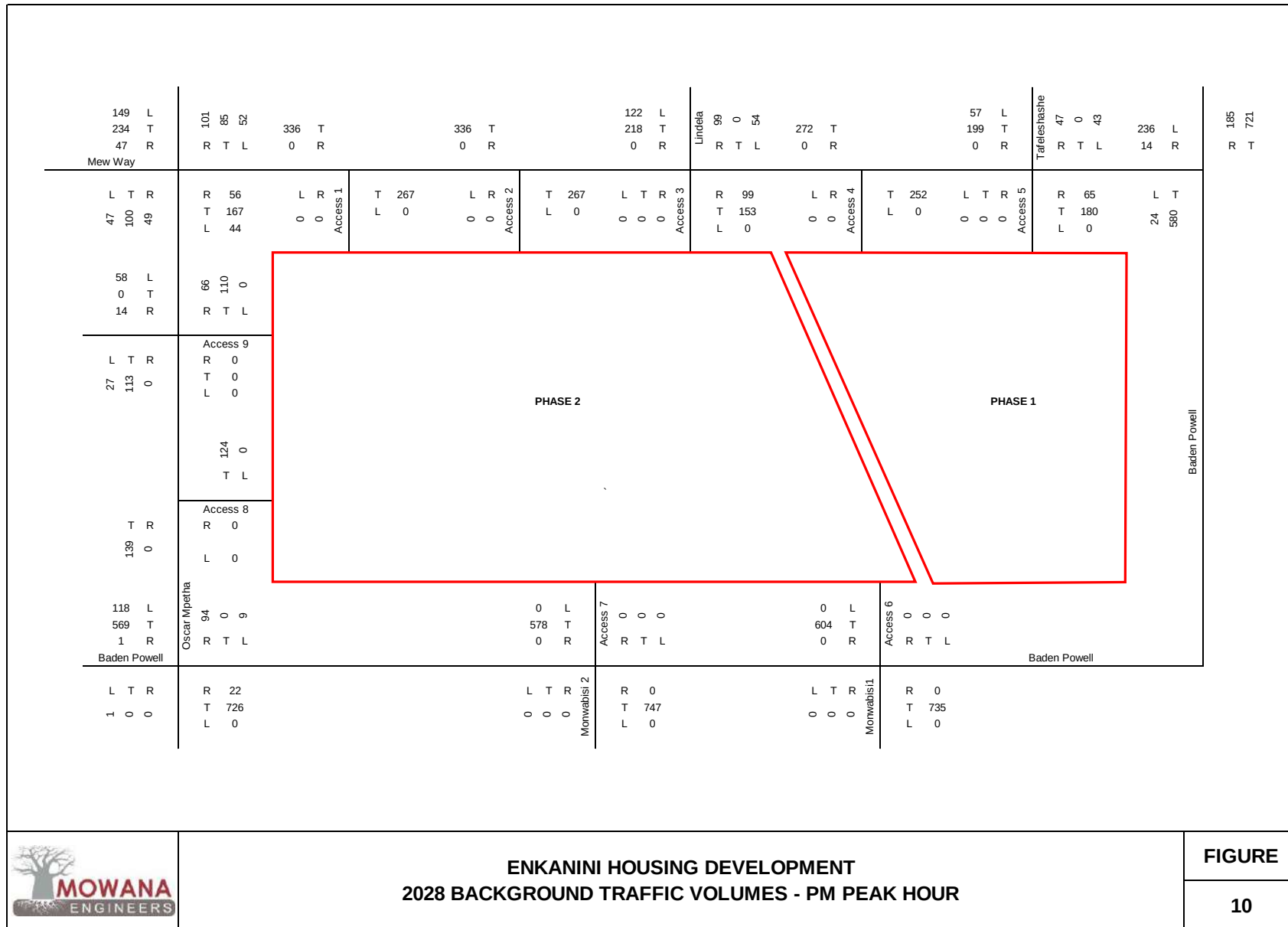




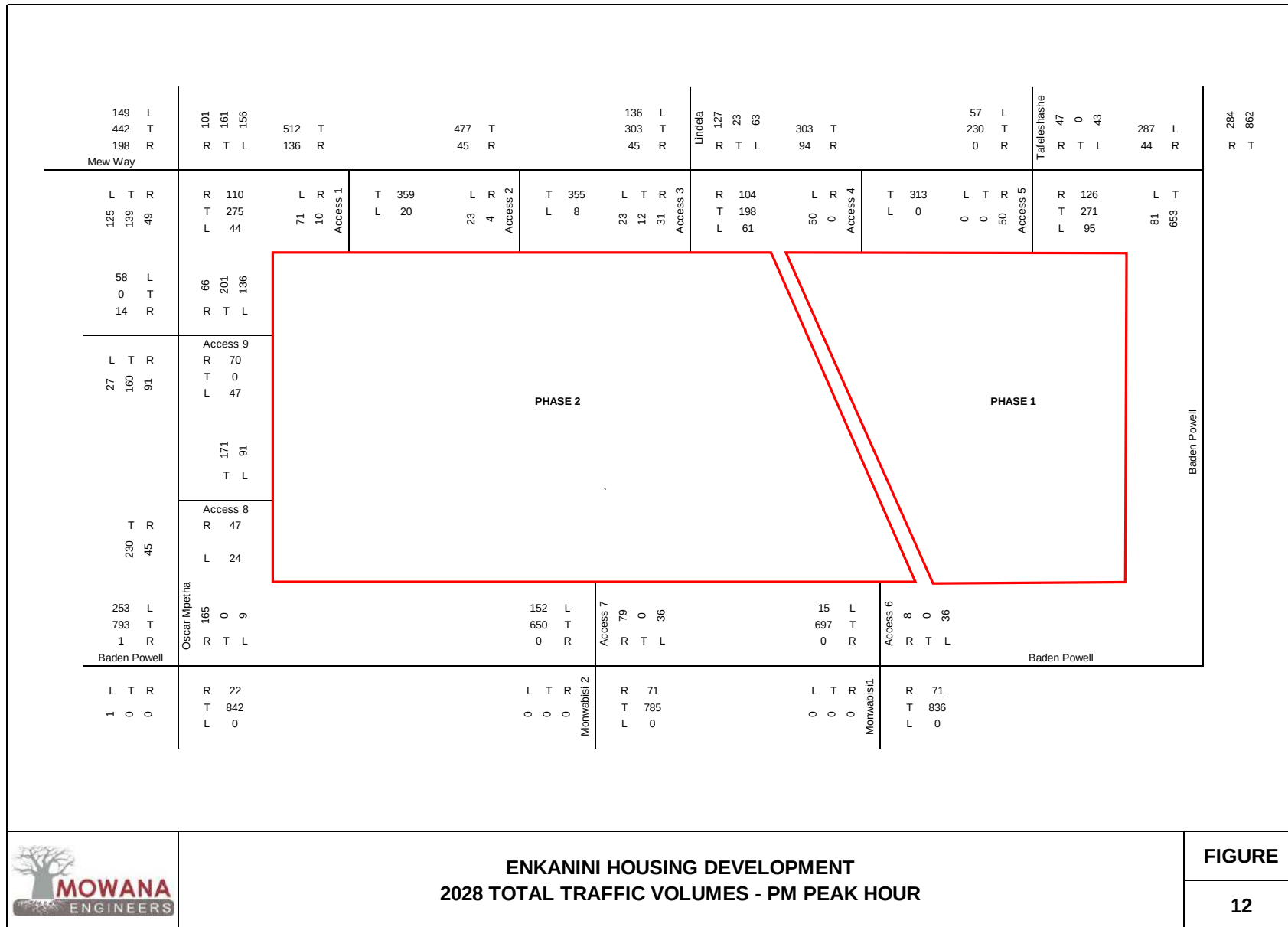












JUNE 2021



CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

CITY OF CAPE TOWN

ENKANINI SOUTH GREENFIELD DEVELOPMENT

BULK SERVICES REPORT FOR WATER AND SANITATION

PROJECT N° 9002/15/35

JUNE 2021

CITY OF CAPE TOWN

**ENKANINI SOUTH GREENFIELD DEVELOPMENT
BULK SERVICES REPORT FOR WATER AND SANITATION**

BOSCH PROJECTS N°: 9002/15/35	DATE: Jun-2021	REPORT STATUS: DRAFT		
CARRIED OUT BY: Bosch Projects Pty Ltd PO Box 27158 GREENACRES 6057 Tel: 041 363 0598 Fax: 041 363 7646		COMMISSIONED BY: City of Cape Town Private Bag X0181 CAPE TOWN 8000 Tel: 086 010 3089 Fax: 086 201 1017		
AUTHOR: Mr Rowan Bode		CLIENT CONTACT PERSONS: Mr Diaan Rangolie		
SYNOPSIS: Water and Sanitation Bulk Service Report for Enkanini South Greenfield Development				
FUNCTION: Civil Engineering				
© COPYRIGHT: Bosch Projects (Pty) Ltd 				
QUALITY VERIFICATION This report has been prepared under the control of the Bosch Projects Quality Management System which meets the requirements of ISO 9001:2015 as independently certified by international auditors				
Verification	Capacity	Name	Signature	Date
By Author	BP PM	R Bode		
Checked by	BP Director	G Cummings		
Authorised by	BP Director	G Cummings		
Received by	CoCT PM	D Rangolie		

CITY OF CAPE TOWN
ENKANINI SOUTH GREENFIELD DEVELOPMENT
BULK SERVICES REPORT FOR WATER AND SANITATION

JUNE 2021

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CITY OF CAPE TOWN
ENKANINI SOUTH GREENFIELD DEVELOPMENT
BULK SERVICES REPORT FOR WATER AND SANITATION

1. EXECUTIVE SUMMARY

The Enkanini South Greenfields Development is located south-east of Khayelitsha between Cape Town and Strand and situated just north of Baden Powell Drive and south of Mew Way. Access to the proposed development is from the N2 off Baden Powell Drive.

Purchase Order 4503707448 dated 12 June 2020 and reference 030C/2018/19A and the Service Level Project Agreement dated 5 May 2020, entered between the City of Cape Town Directorate: Human Settlements Department: Informal Settlements Engineering Services and Bosch Projects Consultants for the Provision of Professional Consultant Services for Construction Projects for the City of Cape Town for the Enkanini South Greenfield Development.

In terms of Water and Sanitation provision the Bulk Services report has considered 6000 residential units planned for Enkanini South Greenfield Development. Bosch Projects has carried out investigations required for the Bulk Water and Sanitation provision.

1.1 Conclusion

Bulk Water

An additional 3.6Ml/day (AADD) water requirement for the proposed Enkanini South Development is envisaged.

There is currently a bulk water supply to the proposed development. The current peak pressure at this development in the system is approximately 24m which is sufficient.

The CoCT is to advise / clarify on the bulk water infrastructure and capacities available for the following existing infrastructure listed below in terms of Section 3 and 5 of the Bulk Services Report.

- a) Existing water treatment works (WTW).
- b) Existing bulk water supply mains.
- c) Bulk reservoir storage supply.
- d) Distribution supply system.
- e) The new 1200mm dia bulk supply reinforcement water supply under construction along Baden Powell.

Bulk Sanitation

An additional 3.42Ml/day (ADWF) sewerage flow is envisaged to be discharging from the proposed Enkanini South Development.

There is currently a bulk sanitation discharge system in the area of the proposed development. Due to the existing landscape additional pumpstations would be required or the recommissioning of the Monwabisi Pumpstation and rising main if at all possible.

The CoCT is to advise / clarify on the bulk sanitation discharge and capacities available of the following existing infrastructure listed below in terms of Section 3 and 5 of the Bulk Services Report.

- a) Existing Kuyasa sewage pump station
- b) Existing 500mm dia rising main.
- c) Existing Zandvliet Wastewater Treatment Works (WWTW).
- d) Possibility of recommissioning of the decommissioned 600mm dia sewer to Monwabisi pump station.
- e) Possibility of recommissioning of the decommissioned Monwabisi Pumpstation.
- f) Possibility of recommissioning of the Monwabisi Pumpstation rising main.

1.2 Recommendation

Bulk Water

The CoCT must advise on the existing capacities as requested in the above Conclusion for the additional 3.6Ml/day (AADD) water requirement for the proposed Enkanini South Development.

Bulk Sanitation

The CoCT must advise on the existing capacities as requested in the above Conclusion for the additional 3.42Ml/day (ADWF) sewerage discharge for the proposed Enkanini South Development.

2. INTRODUCTION

2.1 Background

The project aims to provide the services required to complete the land use application, up to conceptual design phase, in conjunction with the City of Cape Town Informal Settlements Department Planning unit.

The Bulk services Report has considered the formal development of Enkanini South in terms of serviced sites. The department is currently aiming to produce approximately 6 000 formal housing opportunities. The project team is expected to undertake viability studies, produce a conceptual design, and undertake all necessary statutory processes to obtain approval for Enkanini South development. The resulting housing opportunities will be allocated to beneficiaries emanating from the neighbouring Enkanini Informal settlement.

Due to the nature of the work involved it is estimated that only stages 1 to 3 will be completed under 30C/2018/19. The formal development will be approximately 24 months.

It shall be noted that the agreement may be amended from time to time as and when required if the Employer and/or service provider deems necessary.

- Agreement Number: WP:153
- Compiled by: Diaan Rangolie
- Revision Number:01 Date:14 May 2020

The planning has also included other developments in this area. These developments include the following:

- Residential Zone (SR2),
- Community Zone,
- Education Zone,
- Commercial / Business Zone,
- Local Business Zone, and
- Public Open Space

Considering the 6000 residential units planned for Enkanini South in terms of serviced sites the following phases have also been considered (Annexure A); namely.

- Phase 1 = 15.35 ha and 10.29 ha UT
- Phase 2 = 73.95 ha
- Total = 99.59 ha
and
- Phase 1, 1000 units,
- Phase 2, 5000 units

2.2 Project Locality

The area earmarked for the proposed housing development is located southeast of Khayelitsha between Cape Town and Strand and situated just north of Baden Powell Drive and south of Mew Way. Access to the proposed development is from the N2 off Baden Powell Drive.

Refer to the locality map, Drawing No. **9002/035/001**, which shows the project area.

2.3 Source of Information

The sources of information used to compile this report are summarised below:

- Guidelines for Human Settlement Planning and Design, referred to in this report as the “Red Book”,
- City of Cape Town Minimum Standards for Civil Engineering Services in Townships Version 1 July 2013
- Water & Sanitation Department Service Guidelines & Standards (28 May 2015 Version 3.2)

2.4 Terms of Reference

Purchase Order 4503707448 dated 12 June 2020 and reference 030C/2018/19A and the Service Level Project Agreement dated 5 May 2020, entered between the City of Cape Town Directorate: Human Settlements Department: Informal Settlements Engineering Services and Bosch Projects Consultants for the Provision of Professional Consultant Services for Construction Projects for the City of Cape Town for the Enkanini South Greenfield Development.

Anticipated initial deliverables to consist of the following:

- Bulk Services Report for Water and Sanitation

Due to the nature of the work involved it is estimated that only stages 1 to 3 will be completed under 30C/2018/19. We estimate that phase two, formal development, will be approximately 24 months.

- Civil Engineering Services
- Transport Engineering Services
- Geotechnical Engineering Services
- Electrical Engineering Services
- Occupational Health and Safety Services
- Land Surveying Services
- Heritage Practitioner
- Environmental Assessment Practitioner
- Botanist

The brief included:

2.4.1 Civil Engineering Services

Bulk Services for Water and Sanitation

The Service Provider shall carry out all the investigations necessary to determine the Bulk Services for Water and Sanitation for the Development Area at the location proposed. The report will advise where the shortfalls are of the bulk services of the project.

The deliverables from civil engineer:

- Bulk Services Report for Water and Sanitation

2.5 Stakeholder and Professional Team

DESIGNATION	NAME	TEL.	CELL.	EMAIL
CLIENT	CITY OF CAPE TOWN			
Project Manager	Diaan Rangolie	021 400 9423	072 952 9170	diaan.rangolie@capetown.gov.za
Assistant Professional Officer	Avdullah Philander	021 400 2255	083 580 3816	abdullah.philander@capetown.gov.za
Town Planner	Gerhard Hanekom	021 400 2219	082 620 2355	Gerhard.Hanekom@capetown.gov.za
Road and Stormwater - Wayleaves	Noludwe Tchongwang	021 360 1104		Noludwe.tchongwang@capetown.gov.za
Road and Stormwater - Master Planning	Wayne Davids		071 425 6929	Wayne.Davids@capetown.gov.za
GIS section	Annestatia Davies			Annestatia.Davies@capetown.gov.za
Water and Sanitation - Wayleaves	Larry Cronje	021 360 1127	084 225 2039	larry.cronje@capetown.gov.za
Water and Sanitation - Master Planning	Shamile Manie	021 400 4961		Shamile.Manie@capetown.gov.za
Water and Sanitation - Demand Management	Chanee Johnstone	021 400 5244		Chanee.Johnstone@capetown.gov.za
Water and Sanitation - Demand Management	Pamella Mshweshwe	021 400 5244		Pamella.Mshweshwe@capetown.gov.za
Bulk Water	Khanyisa TyaliFeni	021 487 2451		Khanyisa.TyaliFeni@capetown.gov.za
Electrical CoCT	Michelle Louw		076 052 2417	Michelle.Louw@capetown.gov.za
Eskom	S G Swanepoel	021 980 3913	082 909 6027	SwanepSG@eskom.co.za
CIVIL ENGINEERING SERVICES	BOSCH PROJECTS			
Project Manager	Oscar Mia	021 914 2756	078 840 5839	miao@boschprojects.co.za
Civil Engineer	Mfundo Tyaliti		071 511 9711	tyalitim@boschprojects.co.za
Civil Engineer - Water and Sanitation	Rowan Bode		082 782 4230	BodeR@boschprojects.co.za
Civil Engineer - Roads and Stormwater	Lourens Streicher		084 550 3480	StreicherL@boschprojects.co.za
ELECTRICAL ENGINEERING SERVICES	BOSCH PROJECTS			
Electrical Engineer	Jaco Kotze		082 533 9014	KotzeJ@boschprojects.co.za
GEOTECHNICAL ENGINEERING SERVICES	SRK CONSULTING			
Geotechnical Engineer	John Brown	021 659 3060	082 600 6541	jbrown@srk.co.za
TRANSPORT ENGINEERING SERVICES	MOWANA ENGINEERS			
Transport / Traffic Engineer	Colin Tichauer	021 003 5093	082 826 8100	colint@mowana-engineers.co.za
ENVIRONMENTAL ASSESSMENT PRACTITIONER	SILLITO ENVIRONMENTAL CONSULTANTS			
Environmental Practitioner	Chantel Muller	021 712 5060	071 313 4193	chantel@environmentalconsultants.co.za
Botanist				
Heritage Practitioner				
Freshwater Ecologist				
LAND SURVEYING SERVICES	JOUBERT AND BRINK			
Land Surveyor	Jimmy Brink	021 910 2934		jbsur@mweb.co.za

2.5.1 Feasibility and Preliminary (including preliminary drawings)

- Stage 1 to 3 not covered under this scope.

2.5.2 Design and Tender Stage (including working drawings)

- Stage 4 not covered under this scope.

2.5.3 Construction Stage

- Stage 5 not covered under this scope.

2.5.4 Completion Report and Record Drawings

- Stage 6 not covered under this scope.

2.5.5 Additional Services

Various additional services, as and when required, can be provided at hourly rates (Sub Clause 2.2.1 of the Scope of Services set out in Government Gazette No. 27422).

2.6 Client Requirements

The objectives of this could be defined as:

- To provide stage 1-3 services for the proposed development.

2.6.1 Technical / Client Specific Standards

The following technical/Client specific standards have been identified:

- Water borne sewer system (no mid-block sewer lines);
- Internal water network with house connections to each individual erf, and
- Level 1 gravel roads with limited Stormwater distribution (depending on available funds).

2.6.2 Unresolved requirements/client specific issues to be defined.

Nil.

2.6.3 Exclusions

Electrical reticulation, bulk services.

2.7 Statutory and Third-Party Requirements

2.7.1 South African National Roads Agency (SANRAL)

Should the proposed development require access to roads that fall under the National or Provincial Roads jurisdiction of SANRAL an application for a wayleave agreement is to be forwarded to SANRAL.

2.7.2 ESKOM

The proposed development may follow or cross existing power lines which falls under the jurisdiction of Eskom. In this case an application for a wayleave agreement will be forwarded to Eskom to obtain the necessary approvals.

2.7.3 TELKOM

The proposed development may follow or traverse overhead or underground Telkom cables and an application for a wayleave agreement will be forwarded to Telkom.

2.7.4 Department of Environmental Affairs

Environment Approval

In terms of the National Environmental Management Act (NEMA Act No 107 of 1998) Environmental Impact Assessment (EIA) regulations promulgated in July 2006, the proposed work may include listed activities in terms of GNR 386 therefore a Basic Assessment application as described in GNR 385 would be required to be submitted to the Department of Economic Development and Environmental Affairs (DEDEA) for authorization prior to the proposed works taking place.

An environmental consultant, to be appointed on behalf of CoCT to proceed with the Basic Assessment Process for the proposed project and to submit EIA application to DEDEA for approval.

Environmental Management During Construction

DEDEA requires that the contractor awarded the construction contract adhere to an Environmental Management Plan (EMP). An EMP will be prepared by the environmental consultant and to be included with the tender document. DEDEA also requires that an independent Environmental Control Officer (ECO) be appointed to monitor compliance with the EMP. An ECO is to be appointed.

2.7.5 Construction Regulations of OH&S ACT

In terms of the Occupational Health and Safety Act of 1993, Construction Regulations 2003 a OH&S agent will be appointed during the design and implementation stage.

2.7.6 Social Facilitation/Community Liaison Officer

A social facilitator could be appointed on the project.

A community liaison officer will also be appointed during implementation to act as liaison with the community for employment and labour coordination matters.

2.7.7 Job Creation

Certain works envisaged for the proposed development is machine intensive and is not justifiable using hand labour. Activities that may be undertaken using labour will be identified and performed in this manner.

As part of the conditions of contract conditions will be entered for executing works using the EPWP principles.

Preference will also be given to outsource work to local SMME's within the CoCT procurement framework. As far as is possible local suppliers and manufacturers will be utilised.

2.7.8 Training and Skills Development

Allowance will be made during implementation for the accredited/non-accredited training of local labour.

2.8 Site Information

A detailed geological investigation to be conducted to ascertain the envisaged ground conditions. A report to be compiled by Engineering Geologists to detail ground conditions and soil sample analysis to be submitted.

2.9 Topography

A detailed survey has been conducted by Joubert and Brink to ascertain the existing infrastructure, lie of the land and existing services encountered throughout the proposed development.

The slope of the site is fairly constant from north to south, at grades averaging approximately 2%. The south western side of the site is characterised by a natural valley just north that effectively splits the area under consideration in two.

The slopes are well vegetated, and show no signs of being unstable or having experienced serious erosion of the natural ground in recent years.

The community residential & social housing portion is split in two by a natural drain through the site.

3. EXISTING INFRASTRUCTURE

3.1 Existing Services

The proposed Enkanini South Greenfield Development has existing services in the vicinity and through the development as detailed below in the relevant sections.

3.2 Bulk Water Supply

Water treatment

The development will be supplied from the **????** WTW

The CoCT must advise in terms of the above and Section 5 below if the existing WTW's has sufficient capacity to supply the estimated average daily demand of 3.6 MI/day(AADD) for the proposed development.

Bulk Water Network

The supply is via the CoCT 110 system as there are several reservoirs that have been constructed to the 110m contour to supply across the city.

The main supply to Khayelitsha is via a 1065 mm dia supply main that is pressure managed. This main is supplied by more than one reservoir from a TWL of 110m.

A new 1200mm dia reinforcement supply is under construction along Baden Powell to reinforce the supply to the zone and will also have to be pressure managed. No as Built details available at present.

The closest reservoir namely the Blackhealth lower bulk reservoir (TWL= 110.6m and storage of 537.6 MI) through a network of bulk connector and distribution water mains to the proposed Enkanini South Greenfield Development. A link to the 2400mm dia bulk main to Faure reservoir also exists with TWL 110.6 m.

There are two separate 300mm dia distribution main supplies to the north and west of the development from where the development can receive a supply.

The decommissioned Monwabisi Desalination Project had a 315mm dia pumping watermain that traverses the south-west corner of the development. This main is to be accounted for and can be used within the development.

The CoCT must advise in terms of the above and Section 5 below if the existing bulk supply system has sufficient capacity to supply the estimated average daily demand of 3.6 MI/day(AADD) for the proposed development.

Reservoir Storage

The development will be supplied from several reservoirs that have been constructed on the 110m contour. Blackhealth lower bulk reservoir is the closest to the proposed development (TWL= 110.6m and storage of 537.6 MI).

The CoCT must advise in terms of the above and Section 5 below if the existing bulk storage has sufficient capacity to supply the estimated average daily demand of 3.6 MI/day(AADD) for the proposed development.

Distribution System zone

The development will be supplied from the Khayelitsha PRV Zone. The development will be supplied from the 300mm dia distribution main to the north, a 300mm dia distribution main to the west of the development and the 315mm dia watermain that traverses the south-west corner can also be used within the developmet. The incoming pressure is at about 82m and after the PRV it is reduced to about 38m.

The CoCT must advise in terms of the above and Section 5 below if the distribution supply system has sufficient capacity to supply the estimated average daily demand of 3.6 MI/day(AADD) for the proposed development.

Reticulation Present Situation

The proposed Enkanini South Greenfield Development currently does not have a water reticulation network. The current peak pressure at this development in the system is approximately 24m. There is sufficient pressure and flow capacity in the system to supply the development. There is a plan to move the 300 mm water main out of the proximity of the proposed development.

Water saving measures will be incorporated in this development.

Monwabisi Desalination Project

The 315 mm dia watermain that traverses the south-west corner of the development that was installed for the now decommissioned Desalination Project is still in the ground and should be accounted for by the Town Planner, as it can be used by the City of Cape Town in future and for this development.

3.3 Bulk Sewerage

Bulk Sewage Network

There is a 600mm dia bulk outfall sewer to the south of the development which drains to the Kuyasa Pumpstation which intern pumps the sewerage via a 500mm dia pumping main to a 600mm dia outfall sewer situated to the north-east of the development which ultimately discharges at the Zandvliet Wastewater Treatment Works (WWTW).

There is a 600mm dia bulk outfall sewer that traverses the development from North to south to the decommissioned Monwabisi Pumpstation.

Sewerage Pump Station

A portion of the development drains to the existing Kuyasa Pumpstation. The balance drains to low lying areas and would be pumped to either the existing outfall sewer or to the inlet at Kuyasa Pumpstation and in turn pumped to the Zandvliet WWTW.

The CoCT must advise in terms of the above and Section 5 below if the existing Kuyasa sewage pump station has sufficient capacity to supply the estimated average daily demand of 3.42 MI/day(ADWF) for the proposed development.

The Monwabisi Pumpstation to the south of the development has been decommissioned.

CoCT to verify if the Monwabisi Pumpstation could be recommissioned to cater for the sewerage from the proposed development.

Wastewater Treatment Plant

The proposed development is situated in the Zandvliet Waste Water Treatment Works (WWTW) drainage area. This works is currently overloaded and cannot take additional flow. Zandvliet WWTW has a capacity is 72 MI/d, the current upgrade underway is 18MI/d translating to a capacity of 90ML/d. A second Upgrade will eventually take the capacity to 150MI/d.

The current 18MI/d upgrade to the WWTW has an expected completion date of December 2024.

The CoCT must advise in terms of the above and Section 5 below if the existing Zandvliet WWTW has sufficient capacity to supply the estimated average dry weather flow of 3.42 MI/day(ADWF) for the proposed development.

Present situation

The proposed Enkanini South Greenfield Development currently does not have a sewer reticulation network. The proposed development would require a network of gravity sewers and additional pump stations to discharge the sewerage to the Zandvliet WWTW of 3.42MI/day (ADWF).

4. DESIGN CRITERIA

4.1 Water Reticulation Design

4.1.1 Adopted Design Philosophy

Relevant Codes of Practice, Policy and Guidelines used are based on the Guidelines for Human Settlement Planning and Design (Chapter 9) and CoCT document – Service Guidelines and Standards – October 2010 version 3.0. These guidelines have been used as a basis for sizing the theoretical capacity for the various elements under consideration.

4.1.2 Abbreviations

AADD = Annual Average Daily Demand
 TAADD = Total Annual Average Daily Demand
 PF_{week} = Peak week Peak Factor
 PF_{day} = Peak day Peak Factor
 PF_{hour} = Peak hour Peak Factor

4.1.3 Peak Factors

PF_{week} = 1,65 (Residential)
 PF_{day} = 2.0 (Residential)
 PF_{hour} = 4.0 (Residential)

4.1.4 Water Demand Per Erf

House connection = 600 ℓ / erf / day

4.1.5 Consumption Calculations

AADD (kL/d) = Unit Water Demand per capita (L/c/d) × population ÷ 1 000
 TAADD (kL/d) = AADD x PF

4.1.6 Fire Fighting

Fire Flows for High to Moderate Risk Groups = 1500 ℓ / min (minimum hydrant flow rate)
 Fire Flows for all Low Risk Groups = 900 ℓ / min (minimum hydrant flow rate)
 Hydrant Spacing for Fire Fighting = 120m

4.1.7 Residual Pressures

House Connections = 24m (min) and 90m (max) at zero flow
 Standpipes = 10m (min) and 90m (max) at zero flow

4.1.8 Pumping Mains

The pumping main capacity is calculated using the pumped flow to deliver the water in a 24hr day.

Rate of flow (ℓ/s) = {AADD / (24 x 3600)} x SPF x L_f x L_d

4.1.9 Gravity Bulk Supply Pipelines

The gravity main capacity is calculated to be using actual demands to deliver the water in a 24hr day.

Rate of flow (ℓ/s) = {AADD / (24 x 3600)} x PF hour

4.1.10 Service Reservoirs

The reservoir capacity is calculated as follows.

Capacity (kℓ) = 48hrs x AADD for pumped schemes
= 36hrs x AADD for gravity schemes

4.1.11 Water Reticulation

End-users, through a network of pipework will receive a reticulated water supply.

4.1.12 Pipeline Velocity

Parameters used for the sizing of gravity mains are as follows:

Maximum Velocity in pipelines = 2.0 meters/sec

Minimum velocity in pipelines = 0.6 meters/sec

Parameters used for the sizing of pumping mains are as follows:

Maximum Velocity in pipelines = 1.5 meters/sec

Minimum velocity in pipelines = 0.6 meters/sec

5. TOWN PLANNING CONSIDERATIONS

5.1 Present Situation

The study area covers an area of approximately 99.59 ha.

Table – 1 Reflects the community and residential land use for the entire development.

Land Use	Area (ha)*	No. of Stands
Community Residential	99.59	6000
	99.59	6000

5.2 Development Trends

A formal town planning layout was prepared by the City of Cape Town Planning Department and is in the process of being approved and finalised.

6. POPULATION

6.1 Rate of Development

In view of the density of this development and the fact that no further development is planned to the Enkanini South Greenfield Development, it is thus not foreseen that further growth is possible.

Table – 2 Population

Zoning	Land Use	No of Erven	Persons per Erf	Population
Community Residential	Residential	6000	5	30000
		6000.00		30000

7. WATER SUPPLY

7.1 Anticipated Water Consumption

The anticipated water demands pertaining to the use of water in the Enkanini South Greenfield Development for low-income developments are as follows:

Table – 3 Reflects the water consumption for the Enkanini South Greenfield Development.

DESCRIPTION	No OF ERVEN	ADD / ERF	AADD		PEAK FACTOR	TAADD	
			kl/day	l/s	Table J.9 Red Book	kl/day	l/s
Community Residential	6000	600	3600.00	41.67	4.0	14400.00	166.67
Business / Commercial / Industrial (BCI)	0	0	0.00	0.00	0.0	0.00	0.00
TOTAL	6000	600	3600.00	41.67		14400.00	166.67

7.2 Water Demand

For residential water demand, Table J.2, J3 and J4 in the Red Book Guidelines (2019 Rev) was referenced which stipulated a 600-800 litre / erf / day requirement.

The City of Cape Town Minimum Standards for Civil Engineering Services in Townships advised that the minimum water demand for low-cost housing is 600 litre / erf / day.

For design purposes a figure of 600l/day was therefore adopted.

Note that no allowance is made for the reduction of the AADD for on-site supplementary water sources as recommended in Section J.4.1.2 of the Red Book.

7.3 Peak Factors

The Design Criteria for calculating peak demands have been based on Table J.9 of the Red Book Guidelines (2019 Rev) for residential TAADD between 1000 kl/day – 5000 kl/day.

- PF_{week} = 1,65 (Residential)
- PF_{day} = 2.0 (Residential)
- PF_{hour} = 4.0 (Residential)

The City of Cape Town Minimum Standards for Civil Engineering Services in Townships advised that the peak factor of 4 (minimum), or as given in the Red Book.

For design purposes a Peak Factor of 4 was therefore adopted.

7.4 Design Criteria used

The following design criteria are to be adopted as per Table J.12 the Red Book Guidelines (2019 Rev) and City of Cape Town Minimum Standards for Civil Engineering Services in Townships:

- Minimum residual pressure - 24m
- Maximum static head - 90m
- Design velocity during peak demand (max) - 1.5m/s
- Hazen-Williams Roughness factor - 140

7.5 Fire Fighting Supply

The following design criteria are to be adopted as per Table J.17 the Red Book Guidelines (2019 Rev) and City of Cape Town Minimum Standards for Civil Engineering Services in Townships:

- Moderate risk 2: Cluster & low-income housing is 25 l/s
- Moderate risk 2: Duration of design fire flow is 2hr
- Hydrant Spacing for Fire Fighting (for all risk groups) is 120m
- Minimum pressure at fire hydrant is 15m

7.6 Population Projection

No growth rate has been allowed as further growth and/or densification in the area is not expected.

7.7 Water Consumption of the Business Centre

Not Applicable.

7.8 Water Consumption of the Commercial Areas

Not Applicable.

7.9 Water Consumption of the Industrial Areas

Not Applicable.

7.10 Bulk Supply Watermains

7.10.1 Capacity of the existing bulk supply water mains

The Enkanini South Greenfield Development will be supplied from a 300mm $\varnothing$ watermain located in Mew Way (M44) which is located on the northern side of the Development. An additional 300mm $\varnothing$ watermain is located in Oscar Mpetha Road which is located on the western side of the Development.

These watermains all provide water to the surrounding suburbs and township areas.

The existing 315mm $\varnothing$ watermain that traverses the western corner of the site from north to south was used from the decommissioned Monwabisi Desalination Project as a pumping watermain and CoCT has advised that this can be incorporated in the development.

It is understood that these supply pipelines are fed directly from the main supply to Khayelitsha via a 1065 mm dia supply main that is pressure managed. This main is supplied by more than one reservoir from a TWL of 110m.

A new 1200mm dia reinforcement supply is under construction along Baden Powell to reinforce the supply to the zone and will also have to be pressure managed. No as Built details available at present.

This can only be confirmed once a detailed analysis of Enkanini South Greenfield Development water reticulation is performed (outside the scope of this report).

The closest reservoir namely the Blackhealth lower bulk reservoir (TWL= 110.6m and storage of 537.6 MI) through a network of bulk connector and distribution water mains to the proposed Enkanini South Greenfield Development. A link to the 2400mm dia bulk main to Faure reservoir also exists with TWL 110.6 m.

CoCT has indicated that the existing supply water mains should have adequate capacity to supply the Enkanini South Greenfield Development and may not require upgrading or augmentation. An analysis of the supply network water mains will be conducted at implementation stage of the project (outside the scope of this report).

7.10.2 Capacity required Bulk Water Mains

The Enkanini South Greenfield Development gravity supply water mains are required to transfer a peak flow rate as detailed below.

$$\begin{aligned}\text{Rate of flow (l/s)} &= \{ \{ \text{AADD} / (24 \times 3600) \} \} \times \text{PF}_{\text{day}} \\ &= 14,400 \text{ kℓ/day} \\ &= 166.67 \text{ ℓ/s}\end{aligned}$$

The CoCT must advise in terms of the above if the existing bulk supply system has sufficient capacity to supply the estimated average daily demand of 3.6 MI/day(AADD) for the proposed development.

Depending on which route the bulk water supply for the Enkanini South Greenfield Development will eventually be fed from, certain additional lines in the existing water bulk supply network could require upgrading.

The 300mmø watermain supply in Mew Way (M44) located on the northern side of the Development and the second supply is a 300mmø watermain in Oscar Mpetha Road which is located on the western side of the Development, would supply the development.

Considering the water is supplied from a TWL of 110m and the site varies in level from 10m to 35m an average static head of 90m is available. The development is situated approximately 14km from the closest reservoir and with the above info the hydraulic gradeline is approximately 0.18% and an estimated flow of 52l/s being achieved at the development.

Should the Development be supplied from the two 300mmø water mains and not considering the supply to the surrounding suburbs and township areas the existing flow supplied could be approximately 104l/s. A shortfall of 63l/s at peak flow of the required 167l/s.

The 315mmø watermain traverses the western corner of the site from north to south has been ignored at this stage as it is supplied from the above to supply water mains.

The CoCT needs to advise on the new 1200mm dia reinforcement supply under construction along Baden Powell that is reinforcing the supply to the zone and which will also have to be pressure managed.

Once the above is known this it can then be determined should an additional bulk supply pipe line be required or not.

7.10.3 Water Reticulation

The proposed Enkanini South Greenfield Development currently does not have a water reticulation network. The current peak pressure at this development in the system is approximately 24m.

There is a plan to move the 300 mm water main out of the proximity of the proposed development.

Water saving measures will be incorporated in this development.

The CoCT must advise in terms of the above if the existing bulk supply system has sufficient capacity to supply the estimated average daily demand of 3.6 MI/day(AADD) for the proposed development.

7.10.4 Fire Fighting Supply

In terms of the Human Settlement Planning and Design Guidelines the proposed area falls in the Moderate-risk – Group 2 category (for low-income housing). Therefore, according to these guidelines hydrants to be positioned at 120m in the development. The water analysis model will be tested with one hydrant open @ 25 l/s with no point in the system falling below 15m available pressure. This complies with the Moderate-risk Group 1 category in terms of the Red Book.

7.11 Bulk Supply Storage Reservoirs

The development will be supplied from several reservoirs that have been constructed on the 110m contour. Blackhealth lower bulk reservoir is the closest to the proposed development (TWL= 110.6m and storage of 537.6 MI).

Through a network of bulk connector and distribution water mains to the proposed Enkanini South Greenfield Development. A link to the 2400mm dia bulk main to Faure reservoir also exists with TWL 110.6 m.

The CoCT must advise in terms of the above should the existing bulk storage have sufficient capacity to supply the estimated average daily demand of 3.6 MI/day(AADD) for the proposed development.

8. SANITATION

8.1 Proposed Sewage Outflow

The proposed Enkanini South Greenfield Development currently does not have a sewer reticulation network. The proposed development will therefore add additional load to the sewer network, pump stations and Zandvliet WWTW of 3.42MI/day (ADWF).

The anticipated sewage contribution for the Enkanini South Greenfield Development area is as follows (based on 95% of the expected water use):

Table – 4 reflects the proposed sewerage contribution from the entire Enkanini South Greenfield Development.

DESCRIPTION	No OF ERVEN	ADD / ERF Water Usage	ADWF / ERF Outflow	ADWF		PEAK FACTOR From CoCT	PDWF		PWWF (50% SW Infiltration)	
				kl/day	l/s		kl/day	l/s	kl/day	l/s
Community Residential	6000	600	570	3420.00	39.58	3.5	11970.00	138.54	17955.00	207.81
Business / Commercial / Industrial (BCI)	0	0	0	0.00	0.00	0.0	0.00	0.00	0.00	0.00
TOTAL	6000	600	600	3420.00	39.58		11970.00	138.54	17955.00	207.81

8.1.1 Overview of the Bulk Sewage System

There is a 600mm dia bulk outfall sewer to the south of the development which drains to the Kuyasa Pumpstation which intern pumps the sewerage via a 500mm dia pumping main to a 600mm dia outfall sewer situated to the north-east of the development which ultimately discharges at the Zandvliet Wastewater Treatment Works (WWTW) with a capacity of 72MI/day.

CoCT to advise whether Kuyasa Pumpstation and pumping main has spare capacity or not.

The 600mm dia bulk outfall sewer mentioned above also drains past the Kuyasa Pumpstation that traverses the proposed development and discharges at the Monwabisi Pumpstation to the south of the development.

The Monwabisi Pumpstation to the south of the development has been decommissioned.

8.1.2 Proposed Sewage System

The proposed development will include reticulation and collector sewers gravitating from north to south across the site and a fall from east to west as reflected from levels off google earth. These sewers will join together at the low points and this could result in one or two sewage pump stations from where it will be pumped to the existing outfall sewer and ultimately to the Zandvliet Wastewater Treatment Works (WWTW).

160mm and 200 mm ø sewers will drain all the erven to the low areas of the development. The approximate position of the sewer to be indicated once the site has been surveyed. The initial investigation indicates that a pump station and possibly two may be required, dependent on the survey.

Various routes for the reticulation would be considered and to limit the impact on the environment the proposed routes would be selected generally following existing and proposed roadways and boundaries.

The average slope of the sewer mains will be as detailed under the sewage pipeline design.

8.1.3 Sewage Treatment

The proposed development is situated in the Zandvliet Waste Water Treatment Works (WWTW) drainage area. This works is currently overloaded and cannot take additional flow. Zandvliet WWTW has a capacity is 72 MI/d, the current upgrade underway is 18MI/d translating to a capacity of 90ML/d. A second Upgrade will eventually take the capacity to 150MI/d.

The current 18MI/d upgrade to the WWTW has an expected completion date of December 2024.

The CoCT must advise in terms of the above if the existing Zandvliet WWTW has sufficient capacity to supply the estimated average dry weather flow of 3.42 MI/day(ADWF) for the proposed development.

8.1.4 Sewage Pump Stations

The proposed development would require approximately two (2) new sewage pump stations from the survey received. This is an assumption at this stage due to no formal housing / residential layout being provided.

The new pumpstations would discharge the pumped effluent to the existing Kuyasa pump station and then ultimately discharged at the Zandvliet Wastewater Treatment Works (WWTW).

Table – 5 reflects the proposed sewerage pump stations for the entire Enkanini South Greenfield Development.

Description	Erven	In Flow kℓ/d	ADWF ℓ/s	PDWF Factor	PDWF ℓ/s	Q _{pump} (Q _{in} x 2) ℓ/s	PWWF = Q _{in} (PDWF x 2.0) ℓ/s
New PS 1	2000	1140.00	13.2	3.50	46.18	92.36	92.36
New PS 2	4000	2280.00	26.4	3.50	92.36	184.72	184.72
Kuyasa PS	6000	3420.00	39.6	3.50	138.54	277.08	277.08

It has been assumed that PS1 would pump to PS2 and PS2 intern would pump to the Kuyasa pump station and then to discharge at the Zandvliet WWTW.

The flow into the pump stations have been estimated as taken a third to each pump station. This assumption at this stage is due to no formal housing / residential layout being provided.

The Monwabisi Pumpstation to the south of the development has been decommissioned.

CoCT to verify if the Monwabisi Pumpstation could be recommissioned to cater for the sewerage from the prosed development. If this is an option we will update the report and cater for this option.

8.1.5 Sump Volume

The proposed increase in the sump capacity is calculated based on the maximum number of starts per hour that will be allowed in order to prevent overheating of the motors and switchgear. This is normally limited to a maximum of 6 starts per hour. The starting frequency is a maximum when the flow into the sump is exactly half the pumping rate.

$$V = \frac{T \times Q \times N}{4} \text{ where}$$

$$T = \text{N}^\circ \text{ of starts per hour (3600 / (6 or 4))}$$

$$N = \text{N}^\circ \text{ of pumps required (N)}$$

$$Q \text{ (m}^3\text{/s)} = \text{The capacity of each pump (2 x } Q_{in}\text{)}$$

8.1.6 Emergency overflow

In line with the provisions of Section K4.3.4 (a), emergency storage should be provided for a minimum of four to six hours of the design flow rate over and above the design capacity. The required volume is thus:

$$V_e = q \times T_e \text{ where}$$

$$V_e = \text{sump emergency volume (m}^3\text{)}$$

$$q = \text{ADWF}$$

$$T_e = \text{min. emergency storage time (Kouga Municipality) (6 hours)}$$

8.1.7 Sewage Pumping Mains

Various routes for the pumping mains would be considered and to limit the impact on the environment the proposed routes would be selected generally following existing and proposed roadways and boundaries.

The effluent is to be pumped through the pumping main and to discharge into an existing sump/manhole from where it gravitates through the existing system to the WWTW.

The Darcy-Weisbach equation the anticipated friction loss will be determined by:

$$H_f = \frac{4fLv^2}{2gD} \text{ where:}$$

$$H_f = \text{friction loss (m)}$$

$$f = \text{friction factor (0.005 for uPVC pipe)}$$

$$L = \text{length of rising main}$$

$$g = \text{gravity acceleration constant (9.81m/s}^2\text{)}$$

$$D = \text{pipe diameter}$$

Table 6: Proposed Flows and velocity through the proposed and existing Rising Main

PUMPS	PIPE	FLOW	VELOCITY	SYSTEM HEAD
PS1 to PS 2	350mm Ø	92.4 l/s	1.0 m/s	20.0 m
PS2 to Kuyasa PS	500mm Ø	184.7 l/s	0.9 m/s	20.0 m
Kuyasa PS to Zandvliet WWTW	500mm Ø	277.1 l/s	1.4 m/s	25.0 m

The flow from pump station 1 and 2 has been estimated at this stage. This assumption at this stage is due to no formal housing / residential layout being provided.

Considering the inflow from the development only and not from the surrounding suburbs and township areas the velocity of 1.4m/s is slightly high for the existing Kuyasa rising main to the outfall sewer, but achievable, however the existing inflow from the surrounding area must be taken into consideration and a new rising main be installed.

The CoCT must advise in terms of the existing inflow to the Kuyasa PS to determine if the pipeline has sufficient capacity to supply the pumped supply of 277l/s for the proposed development.

8.1.8 Power Requirements

The power requirement based on a typical submersible sewerage pump with a pumps efficiency of 70% is as follows:

$$\text{Power Requirements kW} = \frac{(Q \times H \times \gamma)}{\eta} / 0.9$$

H (m)	=	Total manometric head
γ	=	Density of liquid (taken as 1002kg/m ³ x 9.81)
η	=	Pump efficiency expressed as a decimal (0,70,)
Q (m ³ /s)	=	Peak PWWF
0.9	=	Motor efficiency

8.1.9 Capacity of the Outfall Sewer

The Enkanini South Greenfield Development sewage is to be pumped from the Kuyasa Pumpstation which intern pumps the sewerage via a 500mm dia pumping main to a 600mm dia outfall sewer situated to the north-east of the development which ultimately discharges at the Zandvliet WWTW.

Considering the inflow from the development only and not from the surrounding suburbs and township areas the existing 600mm ø outfall sewer to Zandvliet WWTW must cater for a discharge of 277 l/s from Kuyasa PS and flowing at 50% of its capacity.

Table 7: Velocity and pipe capacity of the existing 600mm ø sewer pipe at an assumed minimum grade of 1 : 600.

PIPE DIA. mm	PIPE ID mm	FLOW DEPTH %	SLOPE m/m	VELOCITY m/s	FLOW (ℓ/s)
600	600	50	0.0016	1.05	148.12
600	600	93	0.0016	1.15	318.64

The 277 ℓ/s from Kuyasa PS discharged into the 600mm dia outfall sewer could be accommodated at this stage, however this considers the inflow from the development only and not from the surrounding suburbs and township areas.

The CoCT must advise in terms of the existing inflow to the 600mm dia outfall sewer to determine if the pipeline has sufficient capacity to cater for the pumped supply of 277ℓ/s for the proposed development.

8.1.10 Sewer Reticulation

The sanitation system is a fully waterborne sewerage system with separate connections to individual erven.

The main sewer line will be constructed within road reserves. Midblock sewers are generally not permitted and will only be allowed where it is impossible to drain to the road reserve.



LEGEND	
	SEWER PUMPSTATION
	RIISING MAIN
	SEWER MAIN
	BULK WATER MAIN
	ENKANINI SOUTH HOUSING
	ZANDVLIET WWTP

LAND USE					
	No	Use	Zoning	Area (ha)	%
	5431	Residential	SR2		
	8	POW/EC	CO1		
	11	Public Open Space	OS2		
	7	Bus	BUS		
	288	Res/Small Bus	LB2		
	4	School	CO1		
	1	Stormw pond & sewer pump	UT	10.29ha	
		Remainder Roads	TR2		
Total				99.59ha	

1	INTERNAL REVIEW	
REV.	BY	DESCRIPTION
		DATE

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BOSCH PROJECTS
GLOBAL ENGINEERING SOLUTIONS

P.O. BOX 27158,
GREENACRES, P.E. 6057,
BLOCK 1, FIRST FLOOR,
GREENACRES OFFICE PARK
2nd AVENUE, NEWTON PARK
PORT ELIZABETH, 6045, RSA

TELEPHONE: (041) 363 0598
TELEFAX: (041) 363 7646
e-mail: mail@boschprojects.co.za
website: www.boschprojects.co.za



DESIGNED	R.B	DRAWN	S.M
CHECKED	G.C	PROCESS ENGINEER	N/A
CIVIL ENGINEER	N/A	STRUCTURAL ENGINEER	N/A
INSTRUMENT ENGINEER	N/A	ELECTRICAL ENGINEER	N/A
MECHANICAL ENGINEER	N/A		

APPROVED	PROJECT MANAGER	DIRECTOR
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CITY OF CAPE TOWN

ENKANINI SOUTH GREENFIELD

DEVELOPMENT

BULK SERVICES FOR WATER AND SANITATION

SCHEMATIC - LAYOUT PLAN

SCALE	1 : 7500	DATE	JUN 21
DRAWING NUMBER	9002/15/34/GSD/000	REVISION	1