- Slope Stability
- Rock Mechanics
- Soil Mechanics
- Foundations
- Roads
- Groundwater
- NHBRC
- Geotechnical Instrumentation

Geotechnical Investigation for the Upgrade and Extension of Macassar Waste-Water Treatment Works Plant, City of Cape Town, Western Cape: Final Interpretative Report

Client: Zutari

Reference: 22-1172R05

Dated: 31 October 2023

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Geotechnical Investigation for the Upgrade and Extension of Macassar Waste-Water Treatment Works Plant, City of Cape Town, Western Cape: Final Interpretative Report

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Geotechnical Investigation for the Upgrade and Extension of Macassar Waste-Water Treatment Works Plant, City of Cape Town, Western Cape: Final Interpretative Report

Reference: 22-1172R05 **Date: 31 October 2023**

EXECUTIVE SUMMARY

This report presents the results of a shallow and deep geotechnical investigation for the upgrade and extension of Macassar Waste-Water Treatment Works (WWTW) Plant for the City of Cape Town in the Western Cape and presents the conclusions and recommendations pertaining to proposed excavations and earthworks, material usage and foundations.

According to the 1:250 000 Geological Map titled "3318 Cape Town (1990)", the site is noted to be underlain by Quaternary-age sands of the Witzand Formation and further underlain by greywacke of the Tygerberg Formation, Malmesbury Group. Fieldwork revealed that the site is underlain by a layer of sandy topsoil, fill or organic fill material from the sludge ponds, which was underlain by a thick layer of aeolian sand. The aeolian sand is further underlain by estuarine soil. Drilling revealed that the transported estuarine soil is underlain by residuum and weathered fine-grained greywacke of the Tygerberg Formation at depths ranging between 7 and 18 mbgl.

*For the purpose of on-site earthworks and for the installation of services, from the test pit excavations, all of the materials on the site qualify as **SOFT** excavation material (according to SANS 1200 D, DA & DB) to depths varying between 2.5 m and 3.0 m below existing ground surface (average depth of in excess of 2.7 m), as determined by the maximum digging depth of the backacter. Further to this, the DPSH test results indicated on average a loose to dense consistency material to a further 5.0 m to 14.9 m below existing ground surface (average depth of in excess of 8.6 m), as determined by the maximum testing until refusal of the DPSH test. The loose to dense consistency material is also considered to qualify as **SOFT** excavation material in terms of excavatability. Beneath this depth, INTERMEDIATE to HARD excavation in the weathered greywacke bedrock is expected between approximately 7 m and 18 m and HARD below this depth.*

In terms of the latest Final Ground Level (FGL) information from Zutari, it would appear that major bulk earthworks with cut to fill operations up to a maximum of about 7 m will be required.

In terms of slope stability, the test pit sidewalls possess limited ability to remain stable if excavated vertically without lateral support. This is due to the low friction angle and low cohesion of the subsoils. These properties would be severely affected by water ingress due to the shallow water table, which was encountered at an average depth of 6.3 mbgl and could destabilise excavations further and could result in failure and collapse during the construction phase. It is therefore recommended that a comprehensive de-watering program be instigated prior to any bulk earthworks.

Therefore, if safe battering of the upper soil horizons above the water table is not possible (due to space constraints), then suitable temporary lateral support (such as sheet pile walls) should be considered.

About 70% of the in situ consistency tests by SPT and DPSH show a loose consistency between depths of 1 and 14 mbgl. The lower loose consistency is due to a ubiquitous esturine layer of about 3 m thickness from 10 to 13 mbgl. The proposed FGL at about 10 masl will either over-excavate a portion of these layers in areas of cut or will be buried beneath up to 7 m of bulk fill.

Conventional to deeper-than-normal strip and pad foundations *may be considered to be the most practical / economical foundation solution for the lighter structures including the guard house, dewatering building, administration and workshop buildings, sludge PS and MCC buildings. An allowable bearing pressure of* ***150 kPa*** *at a nominal depth within the compacted topsoil, fill and transported aeolian/estuarine material may be utilised for the design of the foundations with the following critical stipulations:*

- *In-situ material is to be removed to 1 m beyond perimeter and to a depth of at least 1.5 x proposed foundation width.*
- *That a comprehensive de-watering program is instigated prior to bulk earthworks.*
- *Inert backfill material (G7 or better) should be placed and compacted in 150 mm layers.*
- *The material is to be recompacted to a minimum of 97-100% of MADD at 2% above OMC in engineered layers not exceeding 150 mm thickness.*
- *Articulation joints or solid lightly reinforced masonry and fabric reinforcement in floor slabs will be required.*

.

For the assumed deeper and larger tank structures, ***reinforced concrete (RC) ring beam foundations*** *may be utilised for the primary and secondary settling tanks, circular holding tanks, gravity thickener, anaerobic digestors and gas holding tanks.*

RC raft foundations *at a similar depth may be utilised for the design of the screw lift pump station, PST splitter, primary sludge screening station, biological reactor, SST splitter, RAS return channel, UV channels, chlorine contact tank, rectangular holding tanks, guard house, sludge silos, service water p/s, main sludge p/s, scum p/s return p/s, main effluent channel treated effluent channel and bypass channel. A modulus of subgrade reaction (Kv) of* ***5 to 15 kPa/mm*** *has been used to determine the anticipated settlements beneath the RC rafts.*

Under the above load conditions settlements of <25 to 30 mm should be anticipated for most of the RC raft structures, with differential settlements being ***75%*** *of total settlements.* ***However, there are a number of critical structures to be founded on RC rafts where the estimated settlements could be significantly in excess of these maximum limits and listed below:***

Screw lift & p/s
PST splitters
PSSS
Secondary settling tanks (1-10)
Bioreactor
RAS return channel
UV channel
Sludge silos & dewatering building
Service water p/s
Scum p/s
Return p/s

In order to mitigate the predicted elastic settlements beneath these structures, a sensitivity analysis has been completed using a) the global average E modulus of 10 MPa (worst case scenario) and b) a higher E modulus of between 15 and 20 MPa (best case scenario) based on actual E modulus values derived from the SPT results.

The two scenarios have been shown on the plans in the Appendices and two different compaction methodologies are proposed for each critical structure:

- *Conventional compaction by either over-excavation and re-compaction beneath foundation footprint (usually less than 3 m depth), or*
- *Deep compaction (usually up to 9 m or more) using either vibro-compaction or vibro-replacement.*

For the promotion of a stable site, it is extremely important that a comprehensive de-watering program be instigated prior to any bulk earthworks. Also, suitable conventional drainage (both

surface and subsurface) be designed to prevent or reduce the volume of water ingress into the subsurface soil layers beneath the foundations. Surface drainage should therefore be such that any rainfall is diverted to the nearest stormwater drainage system. Areas of potential pooling or damming of rainfall on site should be carefully designed and sloped in order to sufficiently drain away from the site.

*The groundwater resides at an average depth of **6 m** below surface or at an elevation of **3 masl** and water ingress should be expected during the bulk earthworks below this average depth or elevation. Some of the water-retaining shell-like structures may also be subject to uplift due to buoyancy effects and anchoring into the greywacke/shale bedrock or mass concrete compensation of these structures should be considered.*

*Finally, the ground conditions described in this report refer specifically to those encountered at the test positions advanced on site. It is therefore possible that conditions at variance with those discussed above may be encountered elsewhere on the site. In this regard it is critical that materials management be maintained continuously on site and that **GCS Geotechnical** carry out periodic inspections of the site during construction to ensure that any variation in the anticipated ground conditions can be assessed and revised recommendations subsequently provided in order to avoid unnecessary delays and expense. Furthermore, it is important that the construction phase of the project be treated as an augmentation of the geotechnical investigation and further confirmatory investigations are recommended prior to construction at the start of the Phase B investigation planned for 2025.*

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Technical:

FGL	Final Ground Level (aka Bulk Earthworks Level)
CH	Chainage (metres)
mbgl	Metres Below Ground Level
masl	Metres Above Sea Level
NGL	Natural Ground Level
FL	Foundation Level
BH	Borehole
SPT	Standard Penetration Test
N	SPT N value (blows per 300 mm)
TLB	Tractor-mounted Loader Backhoe
TP	Test Pit
DCP	Dynamic Cone Penetrometer
EABC	Estimated Allowable Bearing Capacity
G1-G10	Standard classification of natural road building materials (TRH 14)
CBR	California Bearing Ratio
MDD	Maximum Dry Density (kg/m^3)
MADD	Modified AASHTO Dry Density
OMC	Optimum moisture Content (%)
PI	Plasticity Index
LL	Liquid Limit
LS	Linear Shrinkage
RMR	Rock Mass Rating
GSI	Geological Strength Index
mi	Hoek-Brown Constant (origin & texture dependent)
RQD	Rock Quality Designation (%)
FF	Fracture frequency
UCS	Unconfined Compressive Strength (MPa)
C (c’)	Cohesion (kPa) – total stress and (effective stress)
Φ (Φ’)	Friction Angle (degrees) – total stress and (effective stress)
Kv	Modulus of Subgrade Reaction (MN/mm or kPa/mm)
CFA	Continuous Flight Auger (pile type)
DCI	Driven Cast In situ (pile type)
Cv	Coefficient of Consolidation (m2/yr)
Mv	Modulus of Compressibility (m2/MN)
MC1	Moisture Content Before Test (%)
MC2	Moisture Content After Test (%)
ρ	Dry Density (kg/m3)
VSR	Very soft rock
SR	Soft rock
MHR	Medium hard rock
HR	Hard rock
VHR	Very hard rock
WWTW	Waste-Water Treatment Works

Geotechnical Investigation for the Upgrade and Extension of Macassar Waste-Water Treatment Works Plant, City of Cape Town, Western Cape: Final Interpretative Report

Reference: 22-1172R05 **Date: 31 October 2023**

1. INTRODUCTION & TERMS OF REFERENCE

At the request of Mr. Nasief Allie of Zutari, (hereafter referred to as *the Client*), ***GCS Geotechnical*** was asked to provide a proposal for the undertaking of a shallow and deep geotechnical investigation for the upgrade and extension of the Macassar Waste-Water Treatment Works Plant for the City of Cape Town in the Western Cape. The GCS proposal ref. 22-1172L03, dated 08 February 2023, was accepted by the Client via a Letter of Appointment dated 08 February 2023. Fieldwork was undertaken during the period from 18 April 2023 to 19 May 2023. Provisional foundation loads have been provided together with conceptual bulk earthworks drawings. Preliminary reports were sent to the Client on 24 May and 18 August 2023 for comment. The terms of reference for this investigation were as follows:

- To establish the nature and relevant engineering properties of the upper soil and rock strata underlying the site.
- To comment on suitable excavation procedures for cut excavations and for the installation of services.
- To comment on the use of the in-situ materials in the construction of bulk fill terraces, access roads and parking areas.
- To provide foundation recommendations for the proposed development.
- To comment on any other geotechnical aspects that may affect the proposed development such as lateral support for proposed deep excavations and dealing with groundwater.

2. AVAILABLE INFORMATION

2.1 General

The following information was drawn upon for the purposes of the investigation:

- Fouche, N (2020): The liquefaction potential of the upper Quaternary sand of the Cape Flats, Western Cape, South Africa: JSAICE, vol 62.
- GSSA (1990): The 1:250 000 Geological Map titled “3318 Cape Town” as compiled by the South African Geological Survey, 1990.
- Zutari (2022): Upgrade and Extension of the Macassar Wastewater Treatment Works and Associated Works – Geotechnical Investigation RFQ.
- Kantey & Templer (2018): Report on subsoil investigation for Macassar Waste-Water Reuse Plant – Report reference 15583GG.
- Kantey & Templer (2018): Exploratory Hole Location Plan – Reference 15583GG-01.
- Google Earth Imagery.

- DWAF (now DWA) (1999): The 1:500 000 scale Hydrogeological Map titled "3311 Cape Town" as compiled by DWAF (now DWA), 1999.
- Ninham Shand & Umvoto (2008): Groundwater Model Report, Volume 5: Cape Flats Aquifer Model. DWAF (now DWA) report.
- Browning, C & Roberts, DL (2015): Lithostratigraphy of the Witzand Formation (Sandveld Group), South Africa, 2015.
- Dippenaar, MA (2016): Hydrological Heritage Overview: Cape Town.
- Brink, ABA (1985): Engineering Geology of Southern Africa, Vol. 4.
- SANS 1200 D, DA & DB – Earthworks.

Table 2 below shows the available published physiographical information on the site.

Table 2: Summary of Available Desk Study Information

Parameter	Value	Reference
Development	Upgrade and Extension of Macassar WWTW Plant	Zutari
Site coordinates	34° 4'31.52"S / 18°45'52.44"E	Google Earth
Weinerts N-value	3 to 4	Weinert (1974)
Climatic Region	Moderate	TRH 2 (1978)
Rainfall	400-600 mm	3126 Kaapstad (1999) 1:500 000 scale
Temperature	7-28°C	https://climatestotravel.com
Evaporation	< 1400 mm	After DWAF (1986)
Water Balance	Deficit	Schulze (1985)
Weathering Type	Moderate to very slight weathering.	Fookes et al (1971) & Embleton et al (1979)
General geology	Quaternary age sands of the Witzand Formation	3318 Cape Town (1990) 1:250 000 scale
Soil cover	Sandy soils of transported origin and sludge, organic rich soils or rubbly fill	Kantley & Templer (2018)
Origin	Transported aeolian / imported (fill)	Kantley & Templer (2018)
Topography	Undulating with localised and scattered steep sand dunes ranging from 21.5 masl and low laying areas to 3 masl.	Google Earth & Zutari (Topo Survey Map)
Quaternary Catchment	G22H & G22E	DWAF (1999)
Hydrogeology	A4: Intergranular (2.0-5.0 L/sec)	3126 Kaapstad (1999) 1:500 000 scale
Depth to groundwater	Shallow starting from 1.5 mbgl	Barnard (2000)
Erodibility Index	Low 16-20	WRC (1992)
Seismic Intensity	VII (MMS)	Fernandez et al (1972)
Liquefaction Potential	Very likely (peak horizontal acceleration 100-200 cm/s^2)	Welland (2002)

2.2 Previous Geotechnical Investigation (Kantey and Templer, 2018)

A shallow geotechnical investigation was previously done at the Macassar WWTW (Kantley & Templer, 2018, *Report Reference 15583GG*). Nine trial holes were excavated with a 20T tracked excavator to depths up to approximately 4 m below existing ground level. Adjacent to the trail holes (at ground level), drop-weight cone penetration (DCP) tests were also undertaken along the proposed access road centreline. Another eight dynamic probe super heavy (DPSH) tests were carried out to assess the in situ consistency of the sub-soils to greater depths at the proposed locations of major structures. The in situ tests and trial holes were done at the area immediately south and west of the existing Macassar Waste Water Treatment Plant. The site was subdivided into four areas, namely Areas A, B, C and D as seen in **Appendix A**.

Area A is a low-lying pond, with some 2 to 3 m of pre-existing dune sands that have been removed. The upper 1 m or so of the profile is organic rich soils containing abundant decomposed vegetation, bullrush roots and rhizomes, which is underlain by naturally deposited sands. The organic rich horizon was found to be highly compressible and could not adequately support the weight of the excavator. The naturally deposited sand was found to be fine-grained, non-cohesive with a tendency to flow or collapse extensively where exposed below the water table.

Area B is an elevated dune area which had evidently been 'engineered' to form a large, essentially level site. The disposal of sludge has occurred here, with an average range of thickness of about 0.9 m. The sludge tends to be a dessicated, partially cemented, lightweight and extensively fissured sandy silt which contains occasional lenses of clean white sand. The sludge is underlain by medium dense to dense, non-cohesive, largely fine to medium sand.

Area C is situated in a natural dune field in the low-lying area and is located approximately fifty meters from the beach.

Area D is situated in the toe area of the existing dunes. The sand had been mined here previously with rubble imported to level the area subsequently. The rubble consists of bricks, glass shards, angular boulder fragments and cobbles, all loosely supported in a matrix of sand. The sidewalls of the test pits collapsed extensively due to the non-cohesive and largely fine- grained nature of the sand.

Groundwater was encountered in four of the nine trial holes at depths ranging from 1.5 to 2.2 mbgl while the investigation took place. The groundwater represents a seasonally fluctuating water table which is perched on clayey and silty pedogenic sands which are known to be underlying the site at depth.

It was concluded that the site is underlain by naturally transported sands to great depth. The transported sands largely comprise of fine- to medium-grained material. Certain areas of the naturally deposited sands are mantled by either sludge, organic rich soils, or rubble fill, none of which provides satisfactory foundation or subgrade support.

For excavation and foundation conditions, the shear strength of the sandy soils is considered to be very low. Significant instabilities of steeply cut unsupported slopes can be expected. Shoring and lateral support may need to be installed for deep excavations, if a safe batter of 30 degrees adjacent to existing services or roads is not possible due to space constraints (Kantey & Templer, 2018). **The aeolian dune sand can be used as selected layers and engineered fill if compacted to between 97 and 100% MADD.**

3. SITE DESCRIPTION & PROPOSED DEVELOPMENT

The site is situated just outside the small town of Macassar, located between the town and the coastline of False Bay and situated approximately 40 km to the south-east of Cape Town in the Western Cape Province. At present the site comprises the existing waste-water treatment plant surrounded by pre-existing sludge ponds and currently in-use sludge ponds as well as high sand dunes along the western and northern perimeters of the site. The area is very undulating but generally slopes from the dunes to the north to the coast in the south and is covered by sporadic patches of grass and reeds. The sand dunes are covered by dense vegetation.

The central coordinates for the site are as follows: 34°04'32"S/18°45'52"E (see plans in Appendix).

Major cut to fill bulk earthworks will be required to achieve the proposed final bulk earthworks level (BEL) upon which the foundations will be cast. Subsequently, the final ground level (FGL) of between 7 and 9 masl will be constructed by backfilling around the structures from 7 to 9 masl.

4. REGIONAL GEOLOGY

Based on the published 1:250 000 scale Geological Map Series titled, "3318 Cape Town", the site is underlain by (in chronological order):

- Quaternary age (late Pleistocene) sands of the Witzand Formation.
- Greywacke of the Tygerberg Formation, Malmesbury Group.

Fieldwork revealed that the site is underlain by (in chronological order):

- A layer of sandy topsoil.
- Fill or organic fill material from the sludge ponds.
- A thick layer of aeolian material.
- A 3 m thick estuarine material beneath most of the site from 10 to 13 mbgl.
- Deep drilling revealed that these unconsolidated soils were underlain by localised reworked/residual greywacke to weathered fine-grained greywacke of the Tygerberg Formation. The depth to weathered bedrock ranged between 7 and 18 mbgl.

5. REGIONAL HYDROGEOLOGY

The most comprehensive hydrogeological report (Ninham Shand et al, 2008) covering the area has provided the following information:

- The relevant tertiary ground water compartments are G22E to the south and G22H to the north.
- The site straddles the Eerste River Basin and the Cape Town Basin.
- The Eerste River forms the eastern boundary of the site.
- Estimated hydraulic conductivity values of between 1 and 25 m/d have been used in the model.

6. FIELDWORK

6.1 General

Test pits were excavated at positions that were pre-determined by the Client. In addition, dynamic cone penetration (DCP) tests and dynamic probe super heavy (DPSH) tests were carried out alongside some of the test pits in order to ascertain the soil shear strengths / consistencies at depth beneath the proposed location of the more significant structures. In addition, a number of rotary-cored (RC) boreholes were also drilled at the pre-determined positions across the site to ascertain the geotechnical properties at depth. A number of geophysical traverses were also completed (see layout plans in Appendices).

6.2 Test Pits

Twenty-nine test pits were excavated using a SDLG B877 tractor-loader-backhoe (TLB or backacter) supplied by a plant hire contractor. Twelve test pits were labelled as STP (or shallow test pits) and were excavated in close proximity to the proposed road alignment. Seventeen test pits were labelled as DTP (deep test pits) and were excavated in close proximity to the footprint of major structures. All test pits were excavated and terminated at about 3 m or shallower due to unstable sidewalls or the maximum reach of the backacter arm. The labelling of the test pits was kept as per the labelling of the pre-determined positions. The test pits were profiled in situ by an engineering geologist according to standard local and national practice. Soil samples were collected and tested at a soil testing laboratory in order to validate the tactile and visual assessments. The test pit positions are shown in Figure 1 in Appendices and the profiles are presented in **Appendix A**, while summaries of the test pit soil horizon depths are presented in **Tables 6.2a** to 6**.2d** shown below:

Table 6.2a: Summary of soil layers in the test pits along the proposed access road (STP)

STP No.	Topsoil (mbgl-mbgl)	Domestic Fill (mbgl-mbgl))	Aeolian Sand (mbgl-mbgl)	Estuarine (mbgl-mbgl)
1	0-0.8	-	0.8-3.0+	-
2	0-0.5	-	0.5-2.5+	-
3	0-0.6	-	0.6-3.0+	-
4	0-0.4	-	0.4-2.5+	-
5	0-0.5	-	0.5-2.8+	-
6	-	0-0.9	0.9-3.0+	-
7	-	0-1.2	1.2-3.0+	-
8	0-0.6	-	0.6-2.5+	-
9	-	0-0.5	0.5-2.0	2.0-3.0+
10	-	0-0.9	0.9-2.5+	-
11	0-0.6	-	0.6-2.5+	-
12	0-0.5	-	0.5-3.0+	
Average Depth (m)	**0.6**	**0.9**	**2.7+**	**3.0+**

Table 6.2b: Summary of soil layers in the test pits at the proposed structures (DTP)

DTP No.	Topsoil (mbgl-mbgl)	Domestic Fill (mbgl-mbgl)	Aeolian Sand (mbgl-mbgl)	Compacted Aeolian Sand (mbgl-mbgl)	Estuarine (mbgl-mbgl)
1	0-0.6	-	0.6-3.0+	-	-
2	0-0.5	-	0.5-3.0+	-	-
5	0-0.3	-	0.3-3.0+	-	-
6	0-0.5	-	0.5-3.0+	-	-
8	0-0.4	-	0.4-2.8+	-	-
12	0-0.4	-	0.4-2.5	-	2.5-3.0+
13	-	0-1.3	-	1.3-3.0+	-
14	-	0-1.1	1.1-3.0+	-	-
15	-	0-0.7	-	0.7-3.0+	-
16	0-0.4	-	0.4-3.0+	-	-
18	0-0.4	-	0.4-3.0+	-	-
19	-	0-0.8	-	0.8-3.0+	-
20	-	0-0.4	-	0.4-3.0+	-
21	-	0-0.9	-	0.9-3.0+	-
22	-	0-0.9	-	0.9-3.0+	-
24	-	0-1.3	-	1.3-3.0+	-
25	-	0-1.4	1.4-2.5+	-	-
Average Depth (m)	**0.4**	**1.0**	**2.9+**	**3.0+**	**3.0+**

Table 6.2c: Summary of average soil profile along proposed access road (STP)

Depth		Description	EABC (kPa)	CBR (%)	Class	Use
From (mbgl)	To (mbgl)					
Topsoil						
0.0	0.6	Moist yellowish-white speckled black VERY LOOSE to LOOSE intact silty **SAND**, with abundant roots and scattered gravel.	<50	30-35	SP/A.3/G8	LSSG
Domestic Fill						
0.0	0.9	Moist dark brown to brown VERY LOOSE and LOOSE to MEDIUM DENSE intact to voided clayey silty **SAND** to silty gravelly SAND, with domestic fill and rubble.	<50	30-60	SM/A.3/G8	LSSG
Aeolian Sand						
0.6	2.7+	Moist yellowish-white to light brown streaked dark brown VERY LOOSE to LOOSE intact silty **SAND**.	<100	30-35	SP/A.3/G8	LSSG
Estuarine (only present in STP9)						
2.5	3.0+	Very moist to wet greyish-brown VERY LOOSE intact silty **SAND**, with shell fragments.	<50	30-35	SP/A.3/G8	LSSG

EABC = estimated allowable bearing capacity (ignoring collapse potential)
CBR = estimated California Bearing Ratio at 93-95% MADD using PI-GM relationship (DoT, 1994)
Class = classification of USCS/PRA/TRH14
Use = suggested use in layerworks – LSSG = lower selected subgrade

Table 6.2d: Summary of average soil profile at proposed structures (DTP)

Depth		Description	EABC (kPa)	Kv (kPa/mm)	E (MPa)	C (kPa)
From (mbgl)	To (mbgl)					
Topsoil						
0.0	0.4	Moist yellowish-white speckled black VERY LOOSE to LOOSE intact silty **SAND**, with abundant roots and scattered gravel.	<50	5-16	5-20	-
Domestic Fill						
0.0	1.0	Slightly moist to moist dark brown to orange-brown and yellowish-white VERY LOOSE and MEDIUM DENSE becoming LOOSE pin-holed to voided silty gravelly **SAND** with scattered cobbles and abundant builders rubble becoming silty SAND.	<50	5-16	5-20	<2
Aeolian Sand						
0.4	2.9+	Moist yellowish-white to light brown streaked dark brown VERY LOOSE to LOOSE intact silty **SAND**.	<100	5-16	5-20	-
Compacted Aeolian Sand						
1.0	3.0+	Moist yellowish-white to light brown streaked brown MEDIUM DENSE becoming LOOSE intact silty **SAND**.	100-150	5-80	5-25	-
Estuarine (only present in DTP12)						
2.5	3.0+	Very moist to wet greyish-brown VERY LOOSE intact silty **SAND**, with shell fragments.	<50	5-16	5-20	-

EABC = in situ estimated allowable bearing capacity (ignoring collapse potential)
Kv = modulus of subgrade reaction (Bowles, 1988): E = elastic modulus (Bowles, 1988): C = cohesion (kPa)

6.3 Dynamic Cone Penetration (DCP) Test Results

Fourteen dynamic cone penetration (DCP) tests were undertaken alongside the test pit excavations (STP) along the proposed access road alignment to depths of 2 m below surface. The results of the DCP tests are presented in **Table 6.3** below, while the full set of DCP test results are presented in **Appendix C** of this report. The positions of the DCP tests are indicated on the site plan provided in **Figure 1.**

In general, the DCP test is only reliable as a quality control measure during the construction of layerworks and is not a reliable tool for the determination of in situ material consistencies of naturally occurring materials due to the possible variation in moisture content in the future. In addition (and specific to this investigation) many of the DCP elevations do not correspond or intersect the proposed access road elevation.

Table 6.3: Summary of the DCP test results

DCP No.	Termination depth (mbgl)	Blows/100 mm (average)	DN*	CBR* (%)
1	2.0	1-18 (5)	20	8
2	2.0	1-10 (7)	14	12
3	2.0	1-15 (6)	17	10
4	2.0	3-6 (4)	25	7
5	2.0	1-8 (5)	20	8
6	2.0	2-11 (5)	20	8
7	0.8 (*Ref)	1-25 (6)	17	10
8	2.0	3-15 (7)	14	12
9	2.0	1-15 (4)	25	7
10	2.0	4-16 (10)	10	17
11	2.0	2-6 (3)	33	5
12	2.0	1-8 (4)	25	7
13	2.0	1-6 (4)	25	7
14	2.0	1-16 (8)	13	14

***Penetration rate valid only for in situ moisture content: *DN = mm/blow**
***Calculated/empirical CBR (Paige-Green, et al 2009): *Ref – Refusal (possibly on coarse fill?**

The range in CBR values is 5 to 17% at an average of 9%.

6.4 Dynamic Probe Super Heavy (DPSH) Penetrometer Testing

Fourteen dynamic probe super heavy (DPSH) penetrometer tests were undertaken at the majority of the deep test pit excavations (DTP) situated in close proximity to the footprint of the proposed main structures. The DPSH tests were advanced to refusal depths varying between 1.85 mbgl (false refusal on coarse fill?) and 14.9 mbgl (average of 9.1 mbgl) in order to ascertain the soil densities/consistencies for foundation design purposes. Summaries of the DPSH test results are presented in **Table 6.4a** and **Table 6.4b** below while the full set of DPSH test results and graphical representations are presented in **Appendix D** of this report.

Table 6.4a: Summary of refusal of the DPSH tests

DPSH No.	Adjacent DTP No.	Final Refusal Depth (mbgl)	Redrive
1	1	10.7	2 & 7
2	2	14.9	1 & 3
5	5	14.4	2 & 6
8	8	12.1	3 & 7
13	13	1.85 (anomaly?)	0 & 0
14	14	8.1	1 & 3
15	15	8.9	1 & 8
16	16	5.1	0 & 2
18	18	11.7	2 & 5
19	19	7.8	2 & 2
21	21	5.0	2 & 6
22	22	8.1	3 & 5
24	24	6.3	0 & 0
25	25	5.7	0 & 7
Average Ref Depth (mbgl)	**-**	**8.6**	**1.5 & 4.5**

The dynamic probe super heavy (DPSH) penetrometer test results were used to determine the average equivalent Standard Penetration Test (SPT) 'N" value by using the following equation (MacRobert et al, 2011):

$$\text{Equivalent SPT N} = N_{30SB}/[0.02 \times N_{30SB} + 0.8]$$

In addition, the DPSH values can be increased to about 30% to provide the equivalent SPT N value (Day, 1987 and Meigh, 1987):

Table 6.4b: Summary of estimated soil strength parameters via DPSH testing

DPSH No.	Depth range (mbgl)	Average DPSH Value*	Equivalent SPT "N" Value*	Consistency	EABC* (kPa)
1	0 – 5	<9	12	Medium dense	100 - 150
	5 - 7.5	18	23	Medium dense	200 – 160
	7.5 – 10	24	31	Dense	300+
2	0 – 3	<5	7	Loose	50-100
	3 – 5	12	16	Medium dense	150-200
	5 - 9.5	22	29	Medium dense	300+
	9.5 - 14.7	11	14	Medium dense	100-150
5	0 - 1.5	<8	10	Loose	100
	1.5 – 3	17	22	Medium dense	200 – 250
	3 - 4.5	11	14	Medium dense	100 – 150
	4.5 - 5.5	20	26	Medium dense	250 – 300
	5.5 - 7.5	31	40	Dense	400+
	7.5 - 13.5	10	13	Medium dense	100-150
8	0 - 2.5	<7	9	Loose	50-100
	2.5 – 5	15	20	Medium dense	200
	5 - 8.5	25	33	Dense	300+
	8.5 - 10.5	14	18	Medium dense	150 – 200
	10.5 – 12	33	43	Dense	400+
13	0 – 1	<7	9	Loose	50-100
	1 – 2	58	75	Very dense	Unreliable*
14	0 - 2.5	12	16	Medium dense	150-200
	2.5 – 6	14	18	Medium dense	150-200
	6 - 7.5	11	14	Medium dense	100-150
15	0 – 1	<7	9	Loose	75-100
	1 – 2	31	40	Dense	Unreliable
	2 – 6	13	17	Medium dense	150-200
	6 - 8.5	10	13	Medium dense	100-150
16	0 - 1.5	14	18	Medium dense	150–200
	1.5 - 2.5	33	43	Dense	Unreliable
	2.5 - 3.5	45	56	Very dense	Unreliable
	3.5 – 4.5	53	69	Very dense	Unreliable
18	0 - 1.5	>5	7	Loose	50-75
	1.5 – 7	14	18	Medium dense	150-200
	7 – 9	26	34	Dense	300-350
	9 - 11.5	36	46	Dense	450-500
19	0 - 1.0	<7	9	Loose	75-100
	1.0 - 3.0	27	34	Dense	300-350
	3.0 - 4.5	9	12	Medium dense	100-150
	4.5 - 6.5	2	3	Very loose	25-50
	6.5 - 7.5	31	40	Dense	350-400

DPSH No.	Depth range (mbgl)	Average DPSH Value*	Equivalent SPT "N" Value*	Consistency	EABC* (kPa)
21	0 - 1.5	<8	10	Loose	75-150
	1.5 - 3.0	6	8	Loose	75-100
	3.0 - 4.5	26	34	Dense	300-350
22	0 – 1	<6	8	Loose	75-100
	1 – 3	23	30	Medium dense	250-350
	3 – 5	13	17	Medium dense	150-200
	5 - 6.5	6	8	Loose	75-100
	6.5 – 8	17	22	Medium dense	200-250
24	0 - 1.5	9	12	Medium dense	100-150
	1.5 - 2.5	26	34	Dense	300-350
	2.5 – 4	9	12	Medium dense	100-150
	4 – 6	21	27	Medium dense	250 – 300
25	0 - 1.5	<3	4	Very loose	<50
	1.5 - 2.5	9	12	Medium dense	100-150
	2.5 – 4	7	9	Loose	50-100
	4 - 5.5	14	18	Medium dense	150 – 200

***DPSH Value – Number of blows per 300 mm (raw values)**
***Equivalent SPT "N" Value – Calculated Empirical Standard Penetration Test Number (MacRobert et al, 2011 & Day, 1987)**
***Consistency determined from SPT "N" value (Braatvedt et al, 1995)**
***Estimated Allowable Bearing Capacity (in situ) in kPa (Hough, 1957)**

A number of the high results at a shallow depth are not considered representative of the Aeolian sand and may be more representative of localised coarse-grained fill and have been noted as "unreliable".

In general, the majority of the DPSH test results (over 70%) show loose conditions to between 1 and 3 mbgl (average of 1.75 mbgl). However, there are also three DPSH results (19, 22 and 25) that encountered loose conditions between 4 and 6 mbgl (see yellow highlighted sections). This could be due to the proximity of the ground water level and/or the occurrence of the softer estuarine deposit.

6.5 Rotary-Cored (RC) Boreholes

Nine rotary-cored boreholes were drilled by Geomechanics within the footprint areas of the proposed structures using a tracked Comachio P253 drilling rig. The RC boreholes were drilled to final prescribed depths varying between 12 mbgl and 24 mbgl (generally 3 m into solid rock. The boreholes were advanced through soils using sonic core barrels and were thereafter advanced through bedrock using HQ core barrels to depths ranging between 7 mbgl (BH02) and 24 mbgl (BH04). The cores were logged on-site by an engineering geologist according to standard practice in order to better understand the general engineering properties of the subsurface and deep rock conditions within the proposed structural footprints. The borehole logs are presented in **Appendix E** of this report, while summaries of the borehole details and logs are given in **Tables 6.5a** and **Table 6.5b** below:

Table 6.5a: Summary of borehole details

BH No.	X	Y	Z* (masl)	Final Depth (mbgl)
BH01	34°04'28.2"S	18°45'55.5"E	10.50	19.12
BH02	34°04'39.1"S	18°45'55.6"E	3.25	12.02
BH03	34°04'37.0"S	18°45'50.2"E	8.00	23.27
BH04	34°04'32.2"S	18°45'50.5"E	15.50	23.77
BH05	34°04'34.9"S	18°45'44.5"E	7.25	20.22
BH06	34°04'33.6"S	18°45'46.4"E	6.00	15.74
BH08	34°04'40.7"S	18°45'53.2"E	5.75	17.32
BH09	34°04'34.2"S	18°45'52.7"E	6.75	18.08
BH11	34°04'32.6"S	18°45'54.2"E	12.50	23.22

***Elevation measurements taken from the topographical survey map consisting of contours (detailed surveying is required to determine more accurate levels)**

Table 6.5b: Summary of Soil /Rock Layers in Boreholes (m = mbgl)

BH No.	Transported Aeolian (m-m)	Transported Estuarine (m-m)	Reworked residual greywacke (m-m)	Residual greywacke (m-m)	Highly weathered greywacke (m-m)	Medium weathered greywacke (m-m)	Slightly weathered greywacke (m-m)	Unweathered greywacke (m-m)
01	0-9.45	9.45-14.06	-	-	-	-	14.06-18.02	18.02-19.12+
02	0-4.50	4.50-6.15	6.15-6.70	6.70-6.97	-	6.97-7.46	7.46-10.40	10.40-12.02+
03	0-6.45	6.45-17.85	-	-	-	-	17.85-17.92	17.92-23.27+
04	0-16.50	16.50-18.00	-	18.00-18.30	-	18.33-20.36	20.36-23.77+	-
05	0-11.40	11.40-12.45	12.45-13.10	13.10-13.55	13.55-14.20	14.20-15.57	15.57-17.10	17.10-20.22+
06	0-9.80	9.80-9.95	-	9.95-10.75	10.75-14.25	14.25-15.74	-	-
08	0-7.50	7.50-10.50	-	10.50-11.76	11.76-12.62	12.62-14.32	14.32-17.32	-
09	0-9.00	9.00-12.00	12.00-12.45	-	-	-	12.45-17.13	17.13-18.08+
11	0-13.95	13.95-16.40	16.40-17.50	17.50-17.96	-	17.96-20.36	20.36-21.72	21.72-23.22+
Ave. Depth (m)	**9.8**	**10-13**	**12.4**	**13.2**	**13.7**	**15.6**	**17.9**	**19.3+**

The drilling was supplemented with Standard Penetration Tests (SPT) in zones where soils were encountered. The SPT's were conducted every 1.5 meters using a 63.5 kg (140 lb) hammer, which is allowed to fall through a height of 726 mm, falling onto an anvil, driving a SPT rod with attached Raymond Spoon into the ground. A partially undisturbed soil sample is recovered in the Raymond Spoon sampler. The SPT is measured in six 75 mm increments, being driven a total depth of 450 mm into the ground, or shallower refusal. Blow-counts of each of the 75 mm increments are recorded. The last four 75 mm increments are summed up and this is termed the SPT-N value. The SPT results can be used (by empirical correlations) as an indication of the consistency of the soil and also a fair indication of the bearing capacity, elastic modulus (for settlement analysis) and shear strength parameters (for slope stability) of the soil as shown in **Table 6.5c** below. The raw SPT "N" values are corrected for overburden pressure and dilatation below the groundwater table by using the following equations (Shukla, 2015):

$(N_1)_{60} = C_N \times N_{60}$ (*Overburden Pressure Correction*) *where* $C_N = \left(\frac{100}{\delta}\right)^{0.5}$

$(N_1')_{60} = 15 + \frac{1}{2}[(N_1)_{60} - 15]$ (*Dilatation Correction*) *for N>15, below groundwater table*

Table 6.5c: Summary of SPT Results

BH No.	Depth (m-m)	Raw SPT N Value	Corrected SPT $(N_1')_{60}$ Value	EABC (kPa)	E* (MPa)
BH01	1.50-1.95	9	14	125-150	15-25
	3.00-3.45	21	34	325-350	15-25
	4.50-4.95	22	22	200-225	15-25
	6.00-6.45	17	15	125-175	15-25
	***WL-6.80**				
	7.50-7.95	15	14	125-150	16
	9.00-9.45	4	9	75-100	13
	12.00-12.45	6	10	75-125	13
BH02	1.50-1.95	4	7	50-75	10-15
	3.00-3.45	4	5	25-75	10-15
	***WL-3.80**				
	4.50-4.95	5	10	75-125	13
	6.00-6.28	Ref	Ref	500+	
BH03	1.50-1.95	13	22	200-225	15-25
	3.00-3.45	15	18	175-200	15-25
	4.50-4.95	26	26	250-275	15-25
	6.00-6.45	12	11	100-125	15-25
	7.50-7.95	7	6	50-75	10-15
	9.00-9.45	13	11	100-125	15-25
	***WL-9.80**				
	12.00-12.45	4	9	75-100	13
	15.00-15.45	4	9	75-100	13
	16.50-16.95	10	11	100-125	14
BH04	1.50-1.95	8	14	125-150	15-25
	3.00-3.45	15	19	175-200	15-25
	4.50-4.95	13	13	125-150	15-25
	6.00-6.45	12	11	100-125	15-25
	7.50-7.95	16	13	125-150	15-25
	9.00-9.45	22	16	150-175	15-25
	10.50-10.95	33	22	200-225	15-25
	***WL-12.20**				
	12.00-12.45	31	18	175-200	18
	13.50-13.95	30	17	150-175	17
	15.00-15.45	23	14	125-150	16
	16.50-16.95	11	11	100-125	14
	18.00-18.20	Ref	Ref	500+	
BH05	1.50-1.95	26	44	425-450	30+
	3.00-3.45	26	32	300-325	30+
	***WL-4.60**				
	4.50-4.95	19	17	150-175	17
	6.00-6.45	22	17	150-175	17
	7.50-7.95	4	9	75-100	13
	9.00-9.45	45	24	225-250	21
	10.50-10.95	4	9	75-100	13
	12.00-12.45	85	35	325-375	30+
	13.50-13.55	Ref	Ref	500+	
BH06	1.50-1.95	26	44	425-450	30+
	3.00-3.45	19	24	225-250	15-25
	***WL-3.90**				
	4.50-4.95	21	19	175-200	18

BH No.	Depth (m-m)	Raw SPT N Value	Corrected SPT $(N_1')_{60}$ Value	EABC (kPa)	E* (MPa)
	6.00-6.45	21	17	150-175	17
	7.50-7.95	41	24	225-250	21
	9.00-9.45	41	23	225-250	20
	10.50-10.95	Ref	Ref	500+	
BH08	1.50-1.95	25	43	425-450	30+
	***WL-3.30**				
	3.00-3.45	13	16	150-175	17
	4.50-4.95	19	18	175-200	18
	6.00-6.45	25	19	175-200	19
	7.50-7.95	15	14	125-150	16
	9.00-9.45	10	11	100-125	14
	10.50-10.95	Ref	Ref	500+	
BH09	1.50-1.95	35	60	500+	30+
	3.00-3.45	24	30	275-325	25
	***WL-3.90**				
	4.50-4.95	23	20	175-225	19
	6.00-6.45	32	22	200-225	20
	7.50-7.95	10	12	100-125	15
	9.00-9.45	4	9	75-100	13
	12.00-12.45	35	25	225-275	
BH11	1.50-1.95	24	41	400-425	30+
	3.00-3.45	12	15	125-175	15-25
	4.50-4.95	21	23	225-250	15-25
	6.00-6.45	16	14	125-150	15-25
	7.50-7.95	13	11	100-125	15-25
	***WL-8.70**				
	9.00-9.45	16	13	125-150	15
	10.50-10.95	22	15	125-175	16
	12.00-12.45	27	16	150-175	17
	13.50-13.95	12	11	100-125	14
	15.00-15.45	4	9	75-100	13

***WL – water level: *E modulus above the WT (Jennings et al, 1973 and E modulus below WT (Webb, 1969)**

The proposed deeper structures are to be constructed at and from depths between 0 and 5 m below FGL (or elevations between 0 and 8.25 masl). The corrected SPT $(N_1')_{60}$ values at 3 m depth ranged from 5 to 32 at an average of 21. This would imply an allowable bearing capacity of between 50 kPa and 320 kPa with an average of about 200 kPa. At a depth of 8 mbgl the corrected SPT ranged from 6 to 24 at an average of 13 or about 130 kPa (Hough, 1957).

Eight of the boreholes (90%) show SPT results indicative of loose consistencies between 6 and 14 mbgl (shown in yellow highlight) and is due to the occurrence of saturated esturine sand below the ground water level. This layer reaches maximum thickness of 10 m in the vicinity of BH03.

6.6 Geophysical Survey

The geophysical surveys were undertaken as the last phase of the fieldwork for Phase A during the period of from 09 to 19 May 2023. The geophysics consisted of two soil electrical resistivity tests (SER), nine multi-channel analysis surface wave tests (MASW) and three multi-channel analysis surface wave tests adjacent to boreholes BH01, BH05 & BH06 and additional nine locations throughout the site. Seismic refraction (SRF) data was also collected. The geophysical results are presented in **Appendix F** and a summary included below in Table 6.6 below:

Table 6.6: Summary of geophysical results

Location	Elevation (masl)	Vp (m/s)	Vs (m/s)	Comment*	EABC* (kPa)
BH01 (fig 2a)	11	800	200	Stiff soil	140
BH05 (fig 2b)	7	900	300-500	Stiff soil to soft rock	280
BH06 (fig 2c)	6	700	350-500	Stiff soil to soft rock	280
Site 2 (fig 2d)	+/-8	550	300	Stiff soil	210
Site 3 (fig 2e)	+/-8	800	300-400	Stiff soil to soft rock	245
Site 5 (fig 2f)	+/-8	600	200	Stiff soil	140
Site 6 (fig 2g)	+/-8	750	400	Soft rock	280
Site 7 (fig 2h)	+/-8	900	250	Stiff soil	175
Site10 (fig 2i)	+/-8	900	300	Stiff soil	210
Site 11a (fig 2j)	+/-8	900	300	Stiff soil	210
Site11b (fig 2k) Plant	+/-8	900	300-400	Stiff soil to soft rock	245
Site 12 (fig 2l)	+/-8	900	300-400	Stiff soil to soft rock	245

***EABC = estimate allowable bearing capacity = 0.7xVs (also $Vs = 72N^{0.4}$ and $N = (Vs/72)^{2.5}$) and EABC = 10xN (Dikmen, 2009 and Naik et al, 2014, Hough, 1957)**

SER surveys measure changes in ground resistance with depth and can be transformed into corrosion potential parameters which informs foundation and grounding specifications. MASW is a geotechnical tool which measures changes in shear wave velocities (Vs) with depth. The measurements are transformed into rock stiffness parameters which inform the load bearing capacity of an underlying formation. SRF surveys measure the propagation of percussion wave velocities (Vp) with depth from which depth to bedrock can be inferred.

In summary the geophysical surveys were successfully completed and the data are of an overall high quality. The overburden, consisting of weathered sediments and aeolian sand are mostly mildly corrosive.

Sedimentary bedrock, with percussive velocities in excess of 3 000 m/s, occurs between 12 and 25 mbgl.

Overall, the underlying formation is either stiff soil or soft rock.

There is also a 70% correlation between the shear velocity Vs and the allowable bearing capacity (Dikmen, 2009, Naik et al, 2014 and Hough, 1957).

7. GROUNDWATER & BUOYANCY EFFECTS

Groundwater seepage was encountered in only two of the test pits excavated across the site at the time of the investigation. It should be noted that a perched water table may be anticipated during the winter months and/or after periods of continuous rainfall.

The groundwater depth was measured daily in all the rotary-cored boreholes after the boreholes were flushed during the time of the investigation. The groundwater depth was noted between 3.3 mbgl (BH02) and 12.2 mbgl (BH04) and the average groundwater level was 3 masl during the time of the investigation. A summary of the water level measurements can be seen below in **Table 7**:

Table 7: Summary of water levels

Borehole No.	Water Depth (mbgl)	Water Level Elevation (masl)
BH01*	6.8	3.70
BH02	3.8	-0.55*
BH03	9.8	-1.80*
BH04	12.2	3.30
BH05	4.6	2.65
BH06	3.9	2.10
BH08*	3.3	2.45
BH09	3.7	3.05
BH11	8.7	3.80
Average WT	**6.3 mbgl**	**3.0 masl**

***BH Elevation taken from the topographical survey map consisting of contours and using water levels captured in boreholes (detailed surveying is required to determine more accurate levels)**
***Negative values indicate the depth - meters below sea level**
***Piezometers installed in BH01 and BH08**

Any shallow water level will need to be accounted for during the bulk earthworks and excavations at the proposed locations. In addition, if the structure is at risk of uplift due to hydrostatic pressures (especially when the structure is empty) then anchoring the structure into the greywacke bedrock should be considered. Alternatively, additional mass concrete could be added to the design to balance the calculated uplift forces due to buoyancy effects.

In relation to the proposed bulk earthworks level (BEL), a few areas of cut around the periphery of the site may intersect the ground water.

The proposed foundation levels that may coincide with the ground water level could occur at portions of the PST splitter, SST splitter, main sludge transfer pump station and gravity thickener tanks, but this will be mitigated by dewatering before construction.

8. LABORATORY TESTING

8.1 Soil Testing

Laboratory testing has been carried out on selected disturbed soil samples recovered from the test pits. Undisturbed soil samples could not be retrieved due to the very loose to loose consistency of the sandy material. The following tests were conducted:

- Eight foundation indicator tests (PSD, Atterberg Limits, and hydrometer) *(TMH 1; ASTM D422; SANS 3001 GR12)*,
- Five MADD/CBR tests *(SANS 3001 GR40; SANS 3001 GR30)*,
- Six chemical tests (pH & EC) *(ASTM D422)*,
- Four compactability tests *(SABS 0120)*,
- Four absorption tests *(SANS 6243)*,
- Four organic content tests *(ASTM D422)*,
- Four BRE & DIN chemical tests *(WLAB015; WLAB046; WLAB068; WLAB75; WLAB77)*.

The detailed laboratory test results are presented in **Appendix B1** of this report, and summaries of these finalised results are presented in **Tables 8.1a** to **8.1h** below:

Table 8.1a: Summary of foundation indicator test results

TP No.	Depth (m-m)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	LL	PI	GM	PE*	CBR* (%)	Classifications		
											TRH14	PRA	USCS
Topsoil													
STP01	0-0.8	1	1	98	0	NP	NP	0.98	Low	33*	G8	A.3	SP
Domestic Fill													
STP06	0-0.9	1	9	55	35	NP	NP	1.98	Low	63*	Variable	A.1.b	SM-SP
Fill Material													
DTP24	0-1.3	1	6	93	0	NP	NP	0.93	Low	31*	G8	A.3	SM-SP
Aeolian Sand													
STP03	0.6-3.0	1	2	97	0	NP	NP	0.97	Low	11-13	G8	A.3	SP
DTP01	0.6-3.0	1	1	98	0	NP	NP	0.99	Low	11-13	G8	A.3	SP
DTP02	0.5-3.0	1	1	98	0	NP	NP	0.99	Low	11-13	G8	A.3	SP
DTP06	0.5-3.0	1	1	98	0	NP	NP	0.97	Low	11-13	G8	A.3	SP
Estuarine													
STP09	2.0-3.0	1	2	97	0	NP	NP	0.98	Low	11	G8	A.3	SP

***CBR estimated from PI-GM relationship at 93% MADD.**
***PE – Potential Expansiveness**

In general, the foundation indicator test results reveal a cohesionless, poorly graded sand of low plasticity resulting in a low potential expansiveness. This is also confirmed by the generally fair classification of the material for construction purposes as G8 and A.3 **but only because of the CBR<15% at 93% MADD.**

Table 8.1b: Summary of compaction test results

TP No.	Depth (m-m)	MDD (kg/m^3)	OMC (%)	Swell (%)	CBR (%)					
					90	93	95	97	98	100
Aeolian Sand										
STP01	0.8-3.0	1523	14.2	0.0	11	13	15	17	19	22
DTP01	0.6-3.0	1505	14.4	0.0	8	11	14	16	18	22
DTP16	0.4-3.0	1537	12.3	0.0	7	11	14	17	19	24
Compacted Aeolian Sand										
DTP22	0.9-3.0	1543	12.3	0.0	8	12	14	18	20	24
Estuarine										
DTP12	2.5-3.0	1541	14.5	0.0	9	11	13	15	16	18

The compaction test results show an average MDD of 1530 kg/m^3 and an average OMC of 13.5%. The strength of the material under compaction is highlighted by a CBR of between 11 and 15% at 93 to 95% MADD. This correlates to shear strength values between 140 and 200 kPa (indicative of a stiff to very stiff soil) and equivalent allowable bearing capacity in the range 275 to 375 kPa.

Table 8.1c: Summary of chemical tests

TP No	Depth (mbgl-mbgl)	pH	EC (mS/m)	Resistivity (Ohm/cm)	Degree of Corrosivity
Fill Material					
DTP24	0-1.3	7.4	190	5263	Mildly Corrosive
Domestic Fill					
STP06	0-0.9	6.2	430	2325	Very Corrosive
Aeolian Sand					
STP03	0.6-3.0	8.0	130	7692	Mildly Corrosive
DTP02	0.5-3.0	7.3	490	2041	Very Corrosive
DTP06	0.5-3.0	7.7	120	8333	Mildly Corrosive
Estuarine					
STP09	2.0-3.0	7.5	260	3846	Very Corrosive

The chemical test show that the shallow soils are mildly to very aggressive to concrete and steel. The limited SER results, however, show generally mildly corrosive conditions (>50 Ω.m) becoming moderately corrosive (20-50 Ω.m) below about 8 mbgl.

Table 8.1d: Summary of compactability tests

TP No.	Depth (mbgl-mbgl)	Compactability	Suitability
Aeolian Sand			
STP01	0.8-3.0	0.429	Poor
DTP01	0.6-3.0	0.410	Poor to acceptable
DTP16	0.4-3.0	0.400	Acceptable
Estuarine			
DTP12	2.5-3.0	0.379	Acceptable

Table 8.1e: Summary of methylene blue adsorption tests

TP No.	Depth (mbgl-mbgl)	Methylene Blue Adsorption MBV(%)
Aeolian Sand		
STP03	0.6-3.0	0.2
DTP01	0.6-3.0	0.2
DTP06	0.5-3.0	0.2
Estuarine		
DTP12	2.5-3.0	0.2

The swell potential chart (Cokca, 1991) shows that an MBV value of 0.2% combined with a low clay content indicates only a trace presence of smectitic clay and therefore a low swell potential.

Table 8.1f: Summary of organic content tests

TP No.	Depth (mbgl-mbgl)	Organic Impurities	Satisfactory / Unsatisfactory
Fill Material			
DTP24	0-1.3	Equal to standard solution	Satisfactorily free of organic compounds
Domestic Fill			
STP06	0-0.9	Equal to standard solution	Satisfactorily free of organic compounds
Aeolian Sand			
DTP02	0.5-3.0	Lighter than standard solution	Satisfactorily free of organic compounds
Estuarine			
STP09	2.0-3.0	Lighter than standard solution	Satisfactorily free of organic compounds

Table 8.1g: Summary of BRE (2008) chemical tests

TP No.	Depth (m-m)	Paste pH	Cl	SO_4	N	Free & Saline Ammonia	Acid Soluble SO_4	NH_4	Mg	S (%)
Fill Material										
DTP24	0-1.3	8.4	38	<4	10	1.2	132	1.4	4	<0.01
Domestic Fill										
STP06	0-0.9	7.2	268	2946	2182	40	7182	52	194	0.49
Aeolian Sand										
DTP02	0.5-3.0	8.7	46	106	22	0.8	160	1.0	6	<0.01
Estuarine										
STP09	2.0-3.0	9.0	58	42	28	1.2	482	1.2	6	<0.1

***Analyses presented in mg/kg units = mg/l**
***Cl as Chloride, SO_4 as Sulphate, N as Nitrate, NH_4 as Total Ammonium Ion, Mg as Magnesium, S as Total Sulphur %.**

The majority of the soils encountered on site therefore qualify as Design Sulphate Class DS-1 and ACEC Class AC-1s, with the exception of the domestic fill which qualifies as DS-3 and ACEC Class AC-2s. For an AC-1s, the DC Class for a working life of 50 years is DC-1 and there is no minimum cement or combination required.

Table 8.1h: Summary of DIN (1985) chemical tests

TP No.	Depth (m)	pH	EC (mS/m)	Resistivity (ohm.m)	Alkalinity as $CaCO_3$	Acidity as $CaCO_3$	Cl	Water Soluble as SO_4	Acid Soluble as SO_4	Sulphide	Moisture (%)
Fill Material											
DTP24	0-1.3	8.1	23.3	42.92	64	12	19	<2	66	2.0	8.1
Domestic Fill											
STP06	0-0.9	6.7	664	1.51	108	84	134	1473	3591	0.7	33.9
Aeolian Sand											
DTP02	0.5-3	7.9	34.4	29.07	32	12	23	53	80	0.5	5.3
Estuarine											
STP09	2.0-3	8.8	30.4	32.89	32	12	29	21	241	0.2	21.1

***EC- Electrical Conductivity at 25ºC, Cl as Chloride, SO_4 as Sulphate**

The resistivity results below the fill of 20 to 50 Ω.m suggests moderately corrosive conditions and the DIN assessment shows a B_0 = -17. Any value less than -10 is a Soil Category III and is considered strongly aggressive (DIN, 1985) and special cement should be used with minimum concrete cover to steel reinforcing. The upper domestic fill, however, can be very severely corrosive and should be removed prior to bulk earthworks operations.

8.2 Rock Testing

Laboratory testing has been carried out on rock core samples recovered from the rotary-cored boreholes. The following tests were conducted:

- Four uniaxial compressive strength (UCS) tests, including deformation modulus measurements.
- Four point-load index tests.

The detailed laboratory test results are presented in **Appendix B2** of this final report while summaries of these results are presented in Tables **8.2a** & **8.2b** below:

Table 8.2a: Summary of uniaxial compressive strength (UCS) tests

BH No.	Depth (m-m)	Density (g/cm^3)	Failure Load (kN)	Tangent Elastic Modulus * (GPA)	Secant Elastic Modulus * (GPA)	Poison's Ratio Tangent*	Poison's Ratio Secant*	UCS (MPa)	Rock Strength
6	13.20-13.51	2.56	126.4	28.5	33.3	0.21	0.18	44.7	Hard rock
2	7.79-8.13	2.72	68.8	83.9	88.9	0.21	0.22	24.0	Medium hard rock
3	17.71-17.92	2.63	90.9	79.4	78.1	0.29	0.26	31.3	Hard rock
9	14.57-14.81	2.74	212.8	73.5	78.5	0.29	0.30	73.3	Very hard rock

***Tests @ 50% UCS**

Table 8.2b: Summary of point load index tests

BH No.	Depth (m-m)	Density (g/cm^3)	Failure Load (kN)	Point Load Strength $I_{s(50)}$ (MPa)	UCS* (MPa)	Rock Strength
6	13.20-13.51	2.56	6.40 0.80 1.95	1.91 0.36 0.73	45.8 8.6 17.5	Hard rock Soft rock Med hard rock
1	14.06-14.39	-	2.15 10.65	0.63 3.12	15.1 74.9	Med hard rock Very hard rock
2	7.79-8.13	2.72	6.45	1.93	46.3	Hard rock
5	15.01-15.13	-	3.40	1.02	24.5	Med hard rock

***Typically UCS = $24Is_{(50)}$**

9. FOUNDATION ANALYSIS

9.1 Potential Soil Movements

The soils present on site are classified as having a low potential expansiveness. Based on all the in situ testing and laboratory test results, the following foundation analysis is presented for the in situ soil conditions and envisaged applied loads:

9.1.1 Seismicity and Liquefaction Potential

The Cape Town area is situated in a naturally seismically active zone of intensity VII (MMS) with a very high probability of liquefaction under the right conditions (Table 2). The preliminary estimate of the peak (horizontal)ground accelerations (PGA) is between 100 and 200 cm/s^2 (Welland, 2002). Extensive reference has been made of a previous study close to Macassar on the Cape Flats (Fouche, 2020).

In terms of the site-specific liquefaction potential at the Macassar WWTW, all unconsolidated soils below the ground water table possess a potential for liquefaction under certain conditions. A summary of the criteria generally associated with liquefaction potential are listed below in Table 9.1.1.

Soil liquefaction occurs when loose silts and fine sand temporarily change from a solid state to having the consistency of a heavy liquid. Soil liquefaction is a consequence of increasing pore water pressures and corresponding decrease in effective stress induced by loose silts and sands with a tendency to decrease in volume when subjected to cyclic undrained loading (eg earthquake loading). The vast majority of liquefaction hazards are associated with saturated sandy and silty soils of low plasticity and density. Cohesive soils with clay content (particle size < 0.005 mm) greater than 15% are generally not considered susceptible to soil liquefaction. This phenomenon typically occurs in cohesionless sands, silts and fine-grained gravel deposits in the Holocene to late Pleistocene age in areas where the groundwater is shallower than about 15 metres below surface.

The resistance of the cohesionless soil to liquefaction will depend on the following:

- The density of the soil.
- Clay content >15%.
- The confining stresses.
- Soil structure (fabric, age and cementation)
- The magnitude and duration of the cyclic loading
- The extent to which shear stress reversal occurs.
- Soils with consistency shown by SPT N values in excess of 30.
- Deep water table.
- Liquidity Index <1.

Based on the information provided during the site investigation, the following summary can be provided:

Table 9.1.1: Probability of liquefaction

Parameter	Value range at this site	Average	Limit for resistance	Probability
Density	15-16 kN/m^3	16 kN/m^3	15	Unlikely
Clay content	1%	1%	>15	Very likely
Confining stress	0 to 200 kPa	100 kPa	?	
Fabric	Possibly partially cemented	-	?	
Age	Quaternary	Quaternary	Holocene to late Pliestocene	Unlikely
Cementation	N/A	N/A	?	
Seismicity	VIIMMS & 0.15g	-		Very likely
Shear stress reversal	Unknown	-	?	
SPT-N Value	4 to 50	16	>15	Unlikely
Water table	2 to 6 mbgl	6.3 mbgl		Very likely
Liquidity Index	>1	>1	<1	Likely but not relevant to sandy soils

The probability of liquefaction can be calculated more accurately using the relationship between the cyclic stress ratio or CSR and the cyclic resistance ratio or CRR (after Juang et al, 2000 and Seed & Idriss, 1971). The CSR is governed by the peak horizontal ground acceleration according to the following formula:

$$CSR = (\tau_{av}/\sigma_{vo}) = 0.65(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})r_d$$

Where:
a_{max} = peak horizontal ground acceleration (0.15g)
σ_{vo} = total vertical stress (about 100 kPa)
σ'_{vo} = effective vertical stress (50 kPa)
r_d = empirical stress reduction coefficient (commonly between 0.4 and 1.0)

Therefore substituting:

CSR = 0.65(0.15g/g)(100/50)(0.4 to 1.0)
CSR = 0.1 to 0.26

The evaluation of the CRR requires the establishment of the in situ stress state of the soil which is generally not practical and is usually determined by the SPT (Seed et al, 1982), CPT (Robertson & Wide, 1998) or the shear wave velocity (Vs). Using the average SPT N value of 16 (below the water table) and the shear wave velocity of 200 m/s, the CRR = 0.15.

Therefore, the factor of safety (FoS) against liquefaction is:

CRR/CSR = 0.15/(0.1 to 0.26) = 0.6 to 1.5 (average 1.1)

In conclusion, it is difficult to assess the risk of earthquake occurrence and magnitude at Macassar. Nonetheless, the occurrence of such an event will certainly result in cyclic liquefaction, the extent of which will depend on the magnitude of the seismic event. The limited assessment of static liquefaction in the area inhibits a true reflection of the volumetric response of the saturated sand during static or cyclic loading.

9.1.2 *Collapse Settlement*

There is some evidence to suggest that the aeolian sands possess a voided and potentially collapsible fabric. The lack of cohesion and very low silt/clay fraction (which is a pre-requite for the formation of clay bridges between the sand grains), however, indicates that the collapse potential of the upper aeolian sand is considered low.

9.1.3 *Elastic Settlement*

Elastic (or immediate) settlement usually occurs (and is completed) before the end of construction. The elastic settlement soil parameters are E modulus for isolated pad/strip footings and Kv for more extensive RC raft foundations. According to Table 10.5.1, the design bearing pressures range from 50 to 200 kPa and the E modulus can be determined or estimated below the water table using E = 537(N+15) (Webb,1969) and above the water table from the literature (Jennings et al, 1973 and Bowles, 1988), where the average SPT N value of 13 provides an E value of between 10 and 25 MPa. A typical pad footing size of 2 x 2 m is used as a general example for this site and Poisson's Ratio v = 0.3 (for loose to dense sand). The influence factor I_p is usually taken as 0.88 for rigid pad foundations. The total elastic settlement for isolated pad footings is:

$S_{pad} = qb(1-v^2)I_p/E = \{(50 \text{ to } 200)2(1-(0.3)^2)\}0.88/(10 \text{ to } 25) = 8 \text{ to } 13 \text{ mm}$

For the more extensive and flexible RC raft foundations, the more appropriate settlement parameter is the modulus of subgrade reaction or Kv. This parameter can be estimated by a number of correlations, the most reliable being Kv = 2.5 x E or Kv = 40 x bearing capacity x FoS and the literature gives a range of Kv between 4.8 and 16 kPa/mm (Bowles, 1988). Taking a conservative range of Kv = 5 to 15 kPa/mm the estimated total settlement will be dependent on foundation size and bearing pressure (see Table 10.1.1) and the Kv value as follows:

S_{raft} = pressure/Kv = (100 to 200)/(5 to 15) kPa/mm = 5 to 40 mm

The combination of 175 to 200 kPa bearing pressure and the lower Kv value of 5 kPa/mm will exceed the maximum total allowable settlement of 25 to 30 mm for the RC raft type foundation. Therefore, improvement of the foundation subgrade will be required together with the lowering of the water table by de-watering process. Alternatively, a piled solution could be considered but would not be ideal in terms of establishment costs and logistics. The critical structural elements that are at risk are listed below:

- Screw lift pump station & inlet works (15 to 75 mm settlement estimated)
- PST splitter (20 to 55 mm settlement estimated)
- Primary sludge screening station (30 to 50 mm settlement estimated)
- Bioreactor (20 to 130 mm settlement estimated)
- UV channel (30 to 85 mm settlement estimated)
- Sludge silos & dewatering building (20 to 60 mm settlement estimated)
- Service water pump station (35 to 55 mm estimated)
- Scum pump station (20 to 45 mm settlement estimated
- Return pump station (25 to 50 mm settlement estimated)
- Secondary settling tanks (30 to 55 mm settlement estimated)
- RAS return channel (35 to 70 mm settlement estimated)

A summary of the predicted elastic settlement at each of these structures (Appendix H) has considered the nett bearing pressure based on foundation depth, overburden pressure at the end of bulk earthworks and FGL construction and also the worst case scenario (ie construction completed, filled internally and backfilled up to FGL).

9.1.4 Heave

The very low amount of clay in all the samples tested suggests that any potential heave at surface is regarded as negligible.

9.2 Soil Bearing Capacity

The allowable bearing capacity of the upper aeolian sand can be estimated from a combination of the in situ test results (SPT and DPSH), geophysical seismic velocities and limited laboratory test results. Essentially, the Terzaghi bearing capacity equations can be used as follows (for a square footing):

$$Qu = 0.4\gamma BN\gamma + 1.3cNc + \gamma DNq$$

The required bearing capacity factors Nγ, Nc and Nq are reliant on the estimated angle of friction of the foundation layer (aeolian sand). From empirical correlations, the average estimated friction angle based on the SPT N values for the aeolian sand is about 32 degrees. The bearing capacity factors are therefore:

$N\gamma = 25$
$Nc = 40$
$Nq = 25$

Assuming $\gamma = 16$ kN/m^3, B = 2 m (pad foundation), c = 0 kPa (cohesionless sand) and D = 1 m (depth of foundation), the ultimate bearing capacity is:

$$Qu = (0.4x16x2x25) + (1.3x0x40) + (16x1x25) = 320 + 0 + 400 = 720 \text{ kPa}$$

The safe allowable bearing capacity will include a FoS = 3 and therefore:

$$Qa = 720/3 = 240 \text{ kPa}$$

This estimate concurs well with the seismic velocity Vs which ranged from 200 to 500 m/s and also the average SPT N value of 13, which corresponds to an allowable bearing capacity of about 135 kPa. The allowable bearing capacity below the water table at an average of 6.3 mbgl is generally reduced by 50% or 75 kPa.

9.3 Rock Mass Characteristics (RMR & GSI)

In order to determine the 'actual' rock mass characteristics, a Rock Mass Rating system (After Bieniawski, 1989) was used and considers the following rock properties:

- Uniaxial compressive strength
- Rock Quality Designation (RQD)
- Spacing of discontinuities
- Condition of discontinuities
- Groundwater (assume dry or rating of 15)
- Adjustment for orientation (assume good and rating of 0)

The Geological Strength Index (GSI) as proposed by Hoek & Brown (1997), is determined by using the following relationship (Ceballos et al, 2014):

$$GSI = RMR – 5$$

Table 9.3a below summarises the RMR and GSI for the boreholes:

Table 9.3a: Summary of RMR, GSI & rock mass parameters

BH No:	Depth (m-m)	RMR	Quality	Crm* (kPa)	Φrm* (°)	GSI
BH01	14.06-18.02	53	III (Fair)	200-300	25-35	48
	18-02-19.12	58	III (Fair)	200-300	25-35	53
BH02	6.97-7.46	40	IV (Poor)	100-200	15-25	35
	7.46-10.40	42	III (Fair)	200-300	25-35	37
	10.40-12.02+	45	III (Fair)	200-300	25-32	40
BH03	17.85-17.92	64	II Good)	300-400	35-45	59
	17.92-23.27+	64	II (Good)	300-400	35-45	59
BH04	18.33-20.36	60	III (Fair)	200-300	25-35	55
	20.36-23.77+	60	III (Fair)	200-300	25-35	55
BH05	13.55-14.20	53	III (Fair)	200-300	25-35	48
	14.20-15.57	55	III (Fair)	200-300	25-35	50
	15.57-17.10	58	III (Fair)	200-300	25-35	53
	17.10-20.22+	58	III (Fair)	200-300	25-35	53
BH06	10.75-14.25	62	II (Good)	300-400	35-45	57
	14.25-15.74+	64	II (Good)	300-400	35-45	59
BH08	11.76-12.62	60	III (Fair)	200-300	25-35	55
	12.62-14.32	62	III (Fair)	200-300	25-35	57
	14.32-17.32	65	II (Good)	300-400	35-45	60
BH09	12.45-17.13	58	III (Fair)	200-300	25-35	53
	17.13-18.08+	60	III (Fair)	200-300	25-35	55
BH11	17.96-20.36	53	III (Fair)	200-300	25-35	48
	20.36-21.72	55	III (Fair)	200-300	25-35	50
	21.72-23.22+	58	III (Fair)	200-300	25-35	53

***Crm = cohesion of the rock mass.**
***Φrm = friction angle of the rock mass.**

The RMR ranges from 40 to 65 with an average of 57 (Class III or fair rock) and the GSI ranges from 35 to 60 with an average GSI value of 50.

The rock mass characteristics are estimated based on the information of the cores retrieved from the rotary-cored boreholes which is shown in **Table 9.3b** below, including excavation characteristics and rock mass strengths:

Table 9.3b: Summary of rock mass characteristics

BH No:	Depth (m-m)	RMR	Rock Mass Quality	UCS (MPa)	Rock Mass Strength (MPa)
BH01	14.06-18.02	53	Fair Rock	15.1	7
	18-02-19.12	58	Fair Rock	74.9	40
BH02	6.97-7.46	40	Poor Rock	24-46.3	12-23
	7.46-10.40	42	Fair Rock	24-46.3	12-23
	10.40-12.02+	45	Fair Rock	>46.3	>23
BH03	17.85-17.92	64	Good Rock	31.3	16
	17.92-23.27+	64	Good Rock	>31.3	>16
BH04	18.33-20.36	60	Fair Rock	-	-
	20.36-23.77+	60	Fair Rock	-	-
BH05	13.55-14.20	53	Fair Rock	-	-
	14.20-15.57	55	Fair Rock	24.5	12
	15.57-17.10	58	Fair Rock	24.5	12
	17.10-20.22+	58	Fair Rock	>24.5	>12
BH06	10.75-14.25	62	Good Rock	8.6-17.5	5-9
	14.25-15.74+	64	Good Rock	17.5-45.8	9-23
BH08	11.76-12.62	60	Fair Rock	-	-
	12.62-14.32	62	Good Rock	-	-
	14.32-17.32	65	Good Rock	-	-
BH09	12.45-17.13	58	Fair Rock	<73.3	<35
	17.13-18.08+	60	Fair Rock	>73.3	>35
BH11	17.96-20.36	53	Fair Rock	-	-
	20.36-21.72	55	Fair Rock	-	-
	21.72-23.22+	58	Fair Rock	-	-

The rock mass output parameters are summarised below in Table 9.3c below:

Table 9.3c: Summary of rock mass parameters - greywacke

Input Parameters			Rock Mass Output Parameters			
GSI	UCS (MPa)	Mi	Φ (°)	C (MPa)	σ (MPa)	E (GPa)
35 (min)	9	18	32	0.4	1.2	1.3
50 (ave)	36	18	39	1.7	6.9	6.0
60 (max)	75	18	39	4.4	18.6	15.4

Mi = Hoek Brown constant: Φ = friction angle: C = cohesion: σ = compressive strength: E = elastic modulus

The analysis shows that the average rock mass strength is about 7 MPa or soft rock strength.

The depth to weathered bedrock ranges from about 7 to 18 mbgl (0 to 15 mbsl) with an average depth of 14 mbgl (or 7 mbsl). The thickness of weathering to the unweathered greywacke below is about 2.5 to 5 m. Therefore, assuming that the base of the various structures of the waste-water treatment works will be located at depths of between 0.5 mbpl to a localised maximum of between 5 and 7 mbpl for the screw lift pump station and WAS holding tanks, the estimated bearing capacity of the rock mass for end-bearing pile foundations can range between a localised minimum of 1.2 MPa to a maximum of almost 20 MPa.

10. DEVELOPMENT RECOMMENDATIONS

10.1 Material Usage

The soils encountered on site consist of transported aeolian soils of approximately 10 m thickness, which is underlain by transported estuarine material to approximately 13 m depth. The transported estuarine material is further underlain by reworked/residual greywacke and weathered greywacke bedrock from approximately 12 m below surface level. Based on visual and tactile assessments of the in-situ soil conditions, and the laboratory test results, the topsoil, transported aeolian and transported estuarine materials will likely qualify as G8 (lower selected layer) material quality at best, where the domestic fill material is assumed to qualify as G10 (sub grade) material quality due to its variable conditions. The transported aeolian and estuarine materials, reworked/residual materials may therefore be re-used as such, if required. It is however important to note that if the transported and reworked/residual material is to be re-used, then these materials would need to be carefully sorted in order to remove any oversized particles, fill material or potential zones with increased amounts of silt/clay. A summary is provided below:

Table 10.1: Materials classification and recommended usage

Material Description	Classification	Recommended Usage
Topsoil	PI = - NP GM = - 0.98 Classification: - Inferred as G8; A.3; SP; Low	Inferred as G8 (lower selected layer) material. Oversized particles to be carefully sorted and separated and **remainder to be stockpiled for re-use in landscaping.**
Fill Material	PI = - NP GM = - 0.93 Classification: - Inferred as G8; A.3; SM-SP; Low	Inferred as G8 (lower selected layer) material. Oversized particles to be carefully sorted and separated.
Domestic Fill	PI = - NP GM = - 1.98 Classification: - Inferred as G5; A.1.b; SM-SP; Low	Inferred as G10 (sub grade) material or even worse. **Cut to spoil.**
Transported Aeolian	PI = - NP GM = - 0.97-0.99 Classification: - Inferred as G8; A.3; SP; Low	Inferred as G8 (lower selected layer) material. **This will be the main source of fill material. CBR of up to 20% is achievable at 97 to 100% MADD compaction for use as bulk and foundation fill.**
Transported Estuarine	PI = - NP GM = - 0.98 Classification: - Inferred as G8; A.3; SP; Low	Inferred as G8 (lower selected layer) material. **Too deep to be encountered.**
Reworked/residual Greywacke	PI = - GM = - Classification: -	Assumed to qualify as G7 to G8 (upper selected layer) material. Oversized particles to be carefully sorted and separated. **Too deep to be encountered.**

The TRH classification of the Aeolian sand of G8 is marginal and is only declassified from a G7 due to the slightly lower CBR value of <15% but still qualifies as a selected layer. However, alternative classification methods and specifications (USBR, 1974) suggest that the SP rating implies good shear strength when compacted (c=17-29 kPa and Φ about 38 degrees), good workability as a construction material and a rating of 3/10 as relative suitability for foundations (where 1/10 is most suitable). In addition, the empirical data for SP soils after compaction show potentially a compacted CBR of 10-40% and Kv in the range 40-110 kPa/mm. The SP rating also suggests fair value for use as a subbase (USACE, 1953).

10.2 Geotechnical Site Classification and Model

The entire site appears to be covered by a layer of topsoil designated as Site Class (S2) and domestic fill/fill material designated as Site Class P(fill). The loose to medium dense transported aeolian soils are considered to be compressible and therefore designated as Site Class (S2). The underlying very loose silty SAND of transported estuarine material is also considered to be compressible and therefore also Site Class (S2), while the intact

reworked residual/residual greywacke soils are considered to be slightly to moderately compressible (S1).

In general, the site would classify as Site Class **P(fill)/S1-S2**.

A summary of the Site Classifications (per contributing layer) can be seen below:

Table 10.2: Geotechnical site class designations

Typical founding material	Character of founding material	Range of total soil movements (mm)	Differential movement (% of total)	Geotechnical Site Class
Topsoil	VERY LOOSE to LOOSE intact silty **SAND**, with abundant roots and scattered gravel.	>20	>10	**S2**
Domestic Fill/ Fill Material	VERY LOOSE and MEDIUM DENSE becoming LOOSE pin-holed to voided silty gravelly **SAND** with scattered cobbles and abundant builder's rubble becoming silty **SAND**.	Variable	Variable	**P(Fill)**
Transported Aeolian	VERY LOOSE to LOOSE intact silty **SAND**.	>20	>10	**S2**
Transported Estuarine	VERY LOOSE intact silty **SAND**, with shell fragments.	>20	<10	**S2**
Reworked/Residual Greywacke	DENSE to VERY DENSE silty gravelly **SAND** to clayey silty sandy gravel with scattered cobbles.	10-20	5-10	**S1**

***Geotechnical Site Class Designation adapted from GFSH2-NHBRC classification (2002)**

10.3 Excavatability & Earthworks

10.3.1 Excavatability

For the purpose of on-site earthworks and for the installation of services, from the test pit excavations, all of the materials on the site qualify as **SOFT** excavation material (according to SANS 1200 D, DA & DB) to depths varying between 2.5 m and 3.0 m below existing ground surface (average depth of in excess of 2.7 m), as determined by the maximum digging depth of the backacter. Further to this, the DPSH test results indicated on average a loose to dense consistency material to a further 5 m to 15 m below existing ground surface (average depth in excess of 8.6 m), as determined by the maximum testing until refusal of the DPSH test. The loose to dense consistency material is also considered to qualify as **SOFT** excavation material in terms of excavatability. Beneath this depth, INTERMEDIATE to HARD excavation in the weathered greywacke bedrock is expected between 7 m and 18 m and HARD below this depth.

10.3.2 Earthworks

The proposed final ground level (or FGL) will be between 7 and 9 masl. In order to provide this platform, significant cut to fill operations will be required. The available bulk earthworks drawings show a balanced cut to fill with a FGL at between 7 and 9 masl. The following table shows the earthworks situation beneath some of the major structures (see also geo cross sections):

Table 10.3.2: Summary of bulk earthworks

Structure	Bulk earthworks	Depth/thickness (m)
Future biological reactor 6	Cut	0-5
PST splitter	Cut	2-5
SST 5 to 11	Cut	2
PST splitter	Cut	0-5
Sludge pump station	Cut	2-5
Primary sludge screening	At grade	0
Biological reactors	Fill	0-2
Anaerobic digesters	Fill	2-5
Primary sludge screening	Fill	2-5
SST 3 to 6	Fill	2-5
SST 9 to 14	Fill	1-5
Future biological reactors 1&2	Fill	2

The critical areas in terms of subgrade preparation are those areas that will receive fill. These areas will require over-excavation of unsuitable material (topsoil and loose fill) so that the exposed subgrade can be treated and compacted before the placement of fill. In areas requiring fill, the material characteristics of the Aeolian sand would suggest that some mixing or cement stabilisation of the sand will be required so that the significant thicknesses of fill are placed, treated and compacted to at least 97 to 100% MADD. If the bulk earthworks is constructed to the required QA/QC specifications, then the compacted earthworks platform should provide an allowable bearing capacity of between 150 and 200 kPa. With the addition of geofabric reinforcement layers beneath the more critical and heavier/settlement sensitive structures and allowable bearing capacity of up to 400 kPa can be allowed for in the foundation design.

10.4 Lateral Support

Any excavations in excess of 3 mbgl will need to consider some form of lateral support, especially in areas of shallow groundwater. This is due to the low cohesion and loose consistency of the windblown sands. These properties would be severely affected by water ingress due to the shallow water table at an average depth of 6 mbgl or at 3 masl. This situation could destabilise any excavations further and result in failure and collapse during the construction phase.

Therefore, if safe battering of the upper soil horizons above the water table is not possible (due to space constraints), then suitable temporary lateral support in the form of soil nails and reinforced gunite should be considered. Alternatively, the perimeter of the excavation line could be stabilised by the installation of driven sheet-piled walls prior to the start of the bulk earthworks, especially if the excavated foundation depth is below the groundwater level. The structures requiring deep excavation to reach the proposed foundation level are as follows:

Table 10.4: Summary of deep excavations requiring lateral support.

Structure	Depth of excavation below FGL (m)	Water level below FGL (m)
PST 6-way splitter	5.3	Dry
PST	5	5
SST splitter	Up to 5	Dry
SST	Up to 5	Dry
Gravity thickener	Up to 5	Dry
Main sludge p/s	5-10	2

10.5 Foundation Recommendations

10.5.1 Infrastructure Components

The upgrade and extension of the Macassar WWTW comprises a number of structures. The structures presented in **Table 10.5.1a** are the main new infrastructure components.

The yellow highlighted figures are those RC raft foundations that exceed the maximum allowable of 25 to 30 mm.

Table 10.5.1a: Summary of the structures (Zutari, 27 Sept 2023 and GCS, 30 Sept 2023)

Structure	Approximate Plan Area (m x m / m^2)	Type of Foundation	Founding Level (MASL)	Depth Below FGL (m)	Approximate Bearing Pressure (kPa)	Anticipated Settlement (mm) GCS
Screw Lift Pump Station and Inlet Works	155 x 27.94	Reinforced concrete (RC) Raft, pad footing, strip footing	1st screw lift and pad footings of balance of structure: 7.1	3	175 (peak)	15-75 raft 10-20 pad
Primary Settling Tank 6-way Splitter	155 m^2	RC Raft	4.65	5.3	150 200	20-30 raft 150 kPa 35-55 raft 200 kPa
6 x 32m Ø Primary settling tanks	828.5m^2 (each)	Circular RC Ring footing, conical surface bed with central sump	Central Sump: 3.6 Circular RC Ring Footing: 7.6 Floors: Varies from 6.0 – 7.6	6.4 2.4 2.4-4.0	Central Sump: 150 Circular RC Ring Footing: 150 (peak under circular walls) Floors: 75 (under floors due to water load)	13-35
Primary Sludge Screening Station	128.1 m^2	RC Raft / pad footings	7.2	2.8	150	30-50 raft 12-25 pad
Biological Reactors	94.5 x 55 (each)	Jointed Raft Slab, RC floor slab, pad footings	5.0	5	Jointed raft slab: 175 (peak, can be reduced to under 100kPa under RC floor slab, i.e., away from walls)	45-130 raft 175 kPa 20-130 raft 150 kPa 15-35 pad
3 x Secondary Settling tank splitter	35 m^2	RC Raft	4.1		150	10-30
18 x 35m Ø secondary Settling tank	1063.6 m^2 (each)	Circular RC Ring footing, conical surface bed with central sump	CRCR footing 5.3 Floors 5.3 to 3.5		Floor: 50 (under floors due to water load)	15-40

Structure	Approximate Plan Area (m x m / m^2)	Type of Foundation	Founding Level (MASL)	Depth Below FGL (m)	Approximate Bearing Pressure (kPa)	Anticipated Settlement (mm) GCS
			Sump 0.73	5	RC circular footing: 150 (peak under circular walls) 150 (under central sump)	15-55
RAS Return channel	460 x 4.5	RC Raft	6.9	1.5	150	35-70
UV channels and Building	12 x 7	RC Raft, RC pad footings	RC pad footings: 3.65 Lower Raft Slab: 3.65 Higher Raft Slab: 5.0	1.5	RC pad footings: 150 Raft slab: 150	30-85 raft 10-30 pad
Chlorine contact tank	47 x 66	RC Raft	3.75	2.5	150 (peak)	10-30
Holding tanks (circ) **Holding tanks (rect)**	1300 m2 30 x 44	RC circ footing & RC Raft	6.75 6.75	1.5 1.5	75-150 75-150	15-30 circ footing 10-30 raft
Guard House	10 x 5	RC raft	12.5	1.5	100	5-20
Weigh Bridge building	7 x 5	RC Raft, surface bed / strip footing	8.25	1.5	100	5-25
Administration building	46 x 15	RC Pad footing, strip footing, surface bed	8.5	1.5	RC Pad footings: 200	15-40
Workshop and store building	34 x 15	RC Pad footing, strip footing, surface bed	6.5	1.5	RC Pad footings: 150	10-15
MV Substation Building	15 x 12.5	RC Pad footing, strip footing, surface bed	7.5	1.5	RC Pad footings: 150 – 200	10-15
Inlet works MCC room and Generator Building	32 x 15	RC Pad footing, strip footing, surface bed	7.5	1.5	RC Pad footings: 150	10-20

Structure	Approximate Plan Area (m x m / m^2)	Type of Foundation	Founding Level (MASL)	Depth Below FGL (m)	Approximate Bearing Pressure (kPa)	Anticipated Settlement (mm) GCS
Dewatering Building	105 x 52	RC Pad footing, strip footing, surface bed	7.5	1.5	RC Pad footings: 200 (peak)	20-60
4 x Sludge Silos	13 x 9 (each)	RC Raft, Pad footing, strip footing, surface bed	6.575	1.5	Raft slab: 150 – 200 (peak) 60 – 75 kPa (min value away from conc loads)	20-60 raft 5-10 pad
Chlorination Building	21 x 9	RC Pad footing, strip footing, surface bed	5.3	2.5	RC Pad footings: 150 – 200	5-15
Service water pump station	15 x 10	RC raft (sump), pads, strip footing, surface bed	3.0 (sump) 4.0 (pads)	2.5	RC Pad footings: 150 RC raft: 150	5-10 pad 35-55 raft
TSE pump station and filter building	18 x 36	RC Pad footing, strip footing, surface bed	2.525 (sump) 4.5 (pads)	2.5	RC Pad footings: 150	5-10
Blower building	36 x 14	RC Pad footing, strip footing, surface bed	7.5	1.5	RC Pad footings: 150 – 200	5-20
Combined heat and power building	18 x 30	RC Pad footing, strip footing, surface bed	7.2	1.5	RC Pad footings: 150 – 200	5-15
2 x 15.5m Ø Gravity Thickener	176.7 m^2 (each)	RC Circular footing, Floors, Central Sump	5.64 (sump) 6.75 – 7.6 (floors) 7.6 (RC circular)	2.5	Central Sump: 100 Floors: 75 (under floors due to water load) RC circular footing: 150 (peak under circular walls)	10-30
3 x 23m Ø Anaerobic Digesters	350 m^2 (each)	RC Circular footing, Floors, Central Sump	5.6 (sump)		Central Sump: 150	

Structure	Approximate Plan Area (m x m / m^2)	Type of Foundation	Founding Level (MASL)	Depth Below FGL (m)	Approximate Bearing Pressure (kPa)	Anticipated Settlement (mm) GCS
			5.9 (floors) 6.25 (RC circular)	1.5	Floors: 75 – 100 (under floors due to water load) RC circular footing: 175 (peak under circular walls)	15-40
2 x 25 Ø Gas Holding tanks	491 m^2 (each)	RC Circular footing, Floors, Central Sump	5.375	1.5	Central Sump: 150 Floors: 75 – 100 (under floors due to water load) RC circular footing: 175 (peak under circular walls)	15-40
Main Sludge pump station	15 x 15	RC raft (sump) RC pads	2.75 7.5	5-10	150 200	10-30 raft 5-10 pads
Scum pump station	8 x 6 48 m2	RC raft (sump)	3.47	3	150	20-45
Return pump station	8 x 6 48 m2	RC raft (sump)	0.0	1.5	150	25-50
UV Electrical bldg.	16 x 12 192 m2	RC pad footing, strip footing, surface bed	4.1	1.5	150-200	5-25
Service Water Electrical bldg.	26 x 12 312 m2	RC pad footing, strip footing, surface bed	4.1	1.5	150-200	5-25

Structure	Approximate Plan Area (m x m / m^2)	Type of Foundation	Founding Level (MASL)	Depth Below FGL (m)	Approximate Bearing Pressure (kPa)	Anticipated Settlement (mm) GCS
Main Effluent Channel	1490 m2	RC raft	3.15	1.5	150	10-30
Treated Effluent Channel & River Outlet Structure	555	RC raft	2.25	1.5	150	10-30
Bypass Channel	1550 m2	RC raft	TBC	?	150	10-30
Gas Cleaning Facility	TBC	RC pad footing, strip footing, surface bed	8.25	1.5?	150-200	5-25
MV Collector Substation bldg.	TBC	RC pad footing, strip footing, surface bed	8.25	1.5?	150-200	5-25
Generator bldg.	TBC	RC pad footing, strip footing, surface bed	8.25	1.5?	150-200	5-25
Isolator Transformer	TBC	RC pad footing, strip footing, surface bed	8.25	1.5?	150-200	5-25
Reactor Electrical bldg.	20 x 20	RC pad footing, strip footing, surface bed	7.5	1.5?	150-200	5-15

***Foundation type recommended by Zutari: (last update 27 Sept 2023) *Settlement estimates: GCS (30 Sept 2023)**

The following **Table 10.5.1b** shows the breakdown of input data used for the settlement analysis of the RC raft foundations of the critical structures that exceed the maximum allowable settlement using two values of E modulus, namely a) best case scenario using average E modulus values derived from SPT and b) worst case scenario using global minimum average of 10 MPa. The standard Settle D spreadsheet equation (Terzaghi, 1943) was used for the iterations and sensitivity analysis.

Table 10.5.1b: Summary of input data for settlement analysis of critical structures

Structure	Pressure P (kPa)	Size (mxm)	L/B	Found depth (mbfgl)	E 13-20MPa	Compaction depth (mbfl)	E 10MPa	Compaction depth (mbfl)	Relevant BH/DPSH
Screw lift	150	3x3	1	3	15-20	0	15-20	0	BH01 & 02
		3.5x3.5	1	3	15-20	0	20-25	0	
		3x5	1.7	3	15-20	0	20-25	0	
		5x5	1	3	25-30	0	30-35	1	
		6.7x6.7	1	3	25-30	0	40-45	2	
		11.6x13.9	1.2	3	45-50	2	60-65	6	
		7.7x14.3	1.9	3	30-35	1	50-55	6	
		9x14.3	1.6	3	35-40	1.5	70-75	6	
SST	150	2.8x126	45	4.7	30-35	1	50-55	2.5	BH08 & 09
PST splitters	150	12x12	1	5.3	20-25	0	25-30	0	BH02, 03 &04
	200	12x12	1	5.3	35-40	1.5	50-55	2.5	
PSSS	150	11x11	1	2.8	30-35	1.5	45-50	3.5	BH01 & 02
Bioreactor	80-175	9x109	12	4.5	65-90	8	100-130	10	BH01 & 11
		9x120	13	4.5	65-90	8	100-130	10	
		12x40	3.3	4.5	20-70	0-6	30-100	0-8	
		12x120	10	4.5	20-70	0-6	30-100	0-8	
		15x40	2.7	4.5	0-45	0-2	0-70	0-7	
RAS return	150	4.5x460	102	1.5	35-40	1-2.5	65-70	4.5	BH09
UV channel	150	7x12	1.7	1	45-50	4-5.5	80-85	5.5-7	BH08
	150	7x12	1.7	3	30-35	0-1	55-60	2.5-4.5	
Sludge silos	110	9x13	1.4	2.5	20-25	0	35-40	1-2	BH05
	150	9x13	1.4	2.5	30-40	0-2	55-60	4-4.5	
Service water p/s	150	10x15	1.5	2.5	35-40	1-2	50-55	4	DPSH25
Scum p/s	150	6x8	1.3	3	20-25	0	40-45	0-2.5	BH08
Return p/s	150	6x8	1.3	1.5	25-30	0	45-50	2.5-3	BH08 & DPSH12

The required design foundation pressures range between 50 and 200 kPa and comprise settlement sensitive water retaining RC tanks with total settlements not to exceed 25 to 30 mm and differential movements not more than 10 mm.

The topsoil, domestic fill/ fill horizon should be removed over the footprint of the development and prior to any bulk earthworks or foundation preparation. This is due mainly to the highly variable nature of this material in mechanical properties, thickness, lateral extent and corrosivity.

The foundation recommendations are reliant on the foundation type and load, dimensions, settlement tolerance, bearing capacity of cut or fill subgrade, position of the ground water level and depth to solid bedrock (in the case of wide foundations). If the in situ or reconstituted and compacted subgrade cannot produce a reliable allowable bearing capacity, then deep foundations in the form of piles will need to be considered. Typically, the type of pile suitable for the anticipated loads and subsurface conditions will be the Driven Cast in Situ or DCI (aka Franki pile) or the continuous flight auger or CFA pile.

Various methods of in situ ground improvement (both prior to and after the placement of significant layers of fill) should be considered. These could include rapid impact compaction (RIC), deep dynamic compaction or impact rolling. The latter could be considered to densify the partially saturated aeolian sand prior to the de-watering program. **Any form of deep compaction from surface will need to be effective to depths of up to 8-10 m below foundation level to ensure that maximum settlements beneath the raft foundations of critical structures does not exceed 25 to 30 mm. The required compaction beneath the raft foundations should be at least medium dense with a re-compacted E modulus of at least 30 MPa.**

10.5.2 Areas of Cut

The areas of cut range in depth from 1 to 5 m (see Table 9.5.2 above) and would suggest that the upper topsoil and fill areas would have been removed and these materials should be sorted and either re-used (topsoil) or carted to spoil (refuse fill). The exposed subgrade will comprise loose to medium dense aeolian sand with an average allowable bearing capacity of about 135 kPa (based on DPSH, SPT, seismic velocities and laboratory test results).

The main concern will be that the cut operations will bring the base of the foundations closer to the groundwater level with a consequent 50% reduction in allowable bearing capacity due to the reduction in shear strength and buoyancy effects. Therefore, the de-watering program is considered essential.

10.5.3 Areas of Fill

The areas of fill will generally be less problematic because the material derived from cut (Aeolian sand) can be placed and compacted to specification to provide a stable platform with allowable bearing capacity in the region of 150 to 200 kPa **but may need some form of cement stabilisation to provide the necessary cohesion for adequate compaction.**

If some of the heavier structures require up to 200 kPa, then the following foundation preparations should be considered:

- After the bulk earthworks has been completed, individual restricted excavations beneath the footprint of the structure can be completed to a depth of 1.5 times the width of the foundation. The excavated material can be returned to the excavation in standard 150 mm layers but with at least 3No layers of geofabric every 300 mm. An allowable bearing pressure of up to 300 kPa may then be employed but only for individual discreet pad/strip foundations.
- As above but with cement stabilisation of the backfill material (3 to 5 % by mass OPC). An allowable bearing capacity of 300 kPa can be employed.

In light of the above, **conventional to deeper-than-normal strip and pad foundations** may be considered to be the most practical / economical foundation solution for the lighter structures including the guard house, dewatering building, administration and workshop buildings, sludge PS and MCC buildings. An allowable bearing pressure of **150 kPa** at a nominal depth within the compacted aeolian sand may be utilised for the design of the foundations, with the following critical stipulations:

- The topsoil and transported aeolian/estuarine materials are to be over-excavated and carted to spoil.
- That a comprehensive de-watering program is implemented prior to bulk earthworks.
- Oversized particles are to be removed prior to re-use.
- The material is to be recompacted to a minimum of 98% of MADD at 2% above OMC in engineered layers not exceeding 150mm thickness.

Under the above load conditions settlements of <25 **mm** should be anticipated, with differential settlements 50 to 75% of total settlements.

For the assumed deeper and larger tank structures, **reinforced concrete (RC) ring beam foundations** may be utilised for the primary and secondary settling tank, primary and secondary splitter, anaerobic digester tank and gas holding tank structures. An allowable bearing pressure of **150 kPa** may be utilised for the design of the foundations.

RC raft foundations at a similar depth may be utilised for all structures listed as RC rafts in Table 10.5.1a but excluding the structures listed in Table 10.5.1b. A modulus of subgrade reaction (K_v) of 5 to 15 kPa/mm was used for the calculation of settlements together with an E modulus range of 10 to 20 MPa to simulate loose sand (Bowles, 1988) Design details of the raft foundations should consider the following critical stipulations:

- In-situ material is to be removed to 1 m beyond perimeter and to 1 m depth.
- That adequate de-watering of the site is completed to a suitable level.
- Inert backfill material (G7 or better) should be placed and compacted in 150 mm layers.
- The material is to be compacted to a minimum of 98% of MADD at OMC in engineered layers not exceeding 150mm thickness.
- Articulation joints and fabric reinforcement in floor slab may be required.

Under the above load conditions settlements of <25 mm should be anticipated, with differential settlements being 75% of total settlements.

10.5.4 Foundation Improvement

The RC raft structures suggested for the structures listed in Table 10.5.1b will require additional remediation/compaction beneath foundation level to achieve at least medium dense consistency and an E modulus of at least 30 MPa to depths ranging from 1.5 to 10 m below foundation level. The proposed deep remediation methods may include the following:

- Dynamic compaction (economical but may affect existing structures)
- Vibratory replacement (widely used in coastal areas in RSA since 1980)
- Vibratory compaction (fast and economical)
- Mix-in-Place (with admixtures)
- Jet grouting (relatively expensive)
- Compaction grouting (low production rate).

In order to ensure the efficacy of the remediation to at least a stiffness of 30 MPa to ensure that the maximum allowable settlements are not exceeded, the commonly accepted control method is the DPSH penetrometer. The DPSH is light, quick, maneuverable and inexpensive. The results can be easily converted to an equivalent SPT N value and converted to a E modulus. The main methods listed above are compared below and the applicable areas and structures shown in Figures 8 and 9:

Dynamic Compaction (or DDC):

- Deep dynamic compaction requires the establishment of a crane to drop a heavy pounder through a height of 20 m.
- Very effective, economical and fast in the right conditions.
- Depth of effectiveness 3 to 5 pounder widths (typically 4 to 8 m).
- Primary, secondary and ironing phases required on a grid pattern.
- Due to the vibratory energy imparted, this methodology should not be considered within 30 to 50 m of existing structures.
- Compaction can be done above or below the water table.

Vibratory Replacement:

- Commonly known as vibrocompaction.
- Replacement method using crushed stone.
- Reliable , method used in coastal areas in South Africa since 1980.

- Ideally suited to structures with a large area and uniform loads such as tanks and silos.
- Fast and economical.

Vibratory Compaction:

- Compaction to considerable depths using a vibratory immersion probe.
- Degree of compaction depends on the grading and natural resonant frequency of the soil and the level of energy available.
- The method is fast and economical.
- Relative improvement up to 3 times is possible.
- Allowable bearing pressure of up to 250 kPa can be achieved.

For smaller, lighter structures requiring conventional and semi-conventional compaction to depths of up to 3 m below foundation level, the following methods can be considered:

Over-Excavation & Compaction:

- Excavate to 1.5 times foundation width to temporary stockpile.
- Base of excavation to be ripped and recompacted.
- Excavated material to be returned to excavation in 150 mm layers and compacted to between 97 and 100% MADD.
- Allowable bearing pressure of 150 kPa can be achieved.
- This can be increased by the addition of 3% OPC to produce a soilcrete or introduce multi-layers of geofabtic.

Smooth-Wheeled Vibratory Rollers:

- Self-propelled units generally range from 10 to 20 t and can be static or vibratory.
- Fewer passes at lower speed more effective.
- Continuous compaction control (CCC) enables the performance of the fill to be monitored during compaction in real time. The increase in compaction of the fill can be recorded as the work progresses, and weak areas can be identified in relative terms.

High Energy Impact Compaction (HEIC) Rollers:

- Usually presented as three or five-sided drum activated by a combination of vibration and a dynamic cam effect as the drum rotates.
- Effective compaction depth of up to 4 m.
- Conventional ironing out of the final layers is required.

The areas and structures suitable for this type of compaction are shown in Figures 8 and 9 for best and worst-case scenarios.

10.6 Layer Works for the Proposed Road Section

The investigation, sourcing and testing of potential borrow pits was not part of the scope of works. The topsoil, domestic fill/fill material, transported aeolian and transported estuarine soils have been provisionally classified in terms of their suitability for use in construction on the basis of field observation, laboratory test results and analysis.

The layer works for the proposed road section will be design-dependent and should be designed by a competent pavement engineer. In summary, GCS is of the considered opinion that the in-situ materials may be utilised as per **Table 10.6** below:

Table 10.6: Material Quality and Potential Usage

Typical In-situ material	Character of In-situ material	TRH14 Classification	CBR at 97-100% Mod AASHTO	Range in Material Usage
Topsoil	silty **SAND**, with abundant roots and scattered gravel.	Inferred G8	Inferred 10 to 13	Landscaping
Fill Material	silty gravelly **SAND** with scattered cobbles and abundant builders' rubble becoming silty **SAND**.	Inferred G8	Inferred 10 to 13	Upper selected layer
Domestic Fill	silty gravelly **SAND**, with domestic fill and rubble	Highly variable	-	Not recommended to be used
Transported Aeolian	silty **SAND.**	G8	16-24	Upper selected layer & engineered fill
Transported Estuarine	silty **SAND**, with shell fragments.	G8	15 to 18	Upper selected layer & engineered fill

10.7 Drainage

For the promotion of a stable site, it is extremely important that a comprehensive de-watering program be instigated prior to bulk earthworks. Also, suitable conventional drainage, both surface and subsurface, should be designed to prevent or reduce the volume of water ingress into the subsurface soil layers beneath the foundations. Drainage should therefore be such that any rainfall is diverted to the nearest stormwater drainage system. Areas of potential pooling or damming of rainfall on site should be carefully designed and sloped in order to sufficiently drain away from the site.

Drains suitable for the soil type encountered on site would be perforated netlon PVC pipes wrapped in geofabric with a gravel packing to act as either cut off drains up slope of any excavations and also for under drainage beneath structures to dissipate any hydrostatic uplift pressures. These could take the form of a herringbone pattern of pipes or a blanket layer of crushed stone and a geofabric separation layer.

11. FURTHER INVESTIGATIONS

The initial layout of the structures was to be investigated by strategically placed boreholes and DPSH tests designed by the Client. During the preliminary design process the position of some of the more critical structures required relocation. The number of usable boreholes and DSPH results therefore has become diminished since the relocation of certain critical structures. This is evident for the bioreactor, secondary settling tanks and splitter, electrical building, anaerobic digestor, gas holding tanks and CHBP.

Phase B of this investigation has been planned for 2025 to allow time for the draining and excavation of the existing ponds and unsuitable material. This phase will include additional borehole drilling, test pitting, DPSH penetrometer testing, geophysical investigations and laboratory testing.

It is recommended that sufficient additional boreholes and/or DPSH tests be carried out to cover the new location of the above-mentioned structures and possibly alternative in situ testing such as CPTu and pressure meter testing.

12. CONCLUSIONS & RECOMMENDATIONS

General

- This report presents the results of a shallow and deep upgrade and extension of the Macassar Waste-Water Treatment Works Plant for the City of Cape Town in the Western Cape and presents the conclusions and recommendations pertaining to proposed excavations and earthworks, material usage and foundations.

Geology & Ground Conditions

- According to the 1:250 000 Geological Map Series titled, "3318 Cape Town", the site is to be underlain by Quaternary age sands of the Witzand Formation. The Tygerberg Formation of the Malmesbury Group underlays the Witzand Formation. Fieldwork revealed that the site is underlain by a layer of sandy topsoil, fill or organic fill material from the sludge ponds, which was underlain by a thick layer of transported aeolian material. The transported aeolian material is further underlain by transported estuarine material. Deep drilling revealed that the transported estuarine material is underlain by reworked/residual to weathered fine-grained greywacke of the Tygerberg Formation.

Excavatability & Earthworks

- Materials on the site qualify as **SOFT** excavation material (according to SANS 1200 D, DA & DB) to depths varying between 2.5 m and 3.0 m below existing ground surface (average depth of in excess of 2.7 m). DPSH test results indicated on average a loose to dense consistency material to a further 5.0 m to 14.9 m below existing ground surface (average depth of in excess of 8.6 m) which also considered to qualify as **SOFT** excavation material in terms of excavatability. Beneath this depth, INTERMEDIATE to HARD excavation in the weathered greywacke bedrock is expected between 6.97 m and 17.90 m and HARD below this depth.

It is essential for the Aeolian sand to be compacted sufficiently to attain a CBR of at least 15% to be used as upper selected layers or engineered backfill. This will require between 97 and 100% MADD compaction.

Lateral Support

Any extensive bulk earthworks excavations deeper than 1.5 m will require temporary lateral support in the form of safe batters if space allows. Alternatively, sheet pile walls should be considered.

Foundations

- **Conventional to deeper-than-normal strip and pad foundations** may be considered to be the most practical / economical foundation solution for the lighter structures including the guard house, dewatering building, administration and workshop buildings, sludge PS and MCC buildings. An allowable bearing pressure of **150 kPa** at a nominal depth within the compacted fill and transported aeolian/estuarine material may be utilised for the design of the foundations.

For the assumed deeper and larger tank structures, **reinforced concrete (RC) ring beam foundations** may be utilised for the primary and secondary settling tank, primary and secondary splitter, anaerobic digester tank and gas holding tank structures. An allowable bearing pressure of **150 kPa** at an approximate depth of 5.0 m below existing ground surface, on/within the medium dense intact transported soil horizon, may be utilised for the design of the foundations.

RC raft foundations at a similar depth may be utilised for the design of the aeration tank, WAS holding tank, blower building, de-watering building, primary and secondary sludge silo, inlet works, biological reactor structure and weigh bridge. A conservative modulus of subgrade reaction (K_v) range of 5 to 15 kPa/mm has been used for the predicted settlements of the raft foundations. **Estimated settlements in excess of the maximum limit of 25 to 30 mm for some of the sensitive water-retaining structures will require either 1) densification of the subsoils beneath the RC raft to depths of up to 8 m, or 2) piling of the RC raft down to bedrock.**

Drainage

- For the promotion of a stable site, it is extremely important that **a dewatering program be implemented prior to bulk earthworks.** Also, suitable conventional drainage, both surface and subsurface, should be designed to prevent or reduce the volume of water ingress into the subsurface soil layers beneath the foundations. Drainage should therefore be such that any rainfall is diverted to the nearest stormwater drainage system. Areas of potential pooling or damming of rainfall on site should be carefully designed and sloped in order to sufficiently drain away from the site.

Further Investigations

- Finally, the ground conditions described in this report refer specifically to those encountered at the test positions advanced on site which have required a certain amount of interpolation due to a change in position of some of the structures. The remainder of the investigation has been postponed by the client. **It is therefore possible that conditions at variance with those discussed above may be encountered elsewhere on the site and as a consequence has necessitated the use of conservative foundation parameters to estimate potential settlements.** In addition to this, ***GCS Geotechnical*** suggest carrying out periodic investigations and inspections during construction (possibly as part of Phase B) to ensure that any variation in the anticipated ground conditions can be assessed and revised recommendations subsequently provided in order to avoid unnecessary delays and expense. Furthermore, it is important that the construction phase of the project be treated as an augmentation of the geotechnical investigation.

N Welland: Pr.Eng. / Pr.Sci.Nat

Hendré Human: Cand. Pr.Sci.Nat

19 October 2023

For GCS Geotechnical (Pty) Ltd

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APPENDIX A:

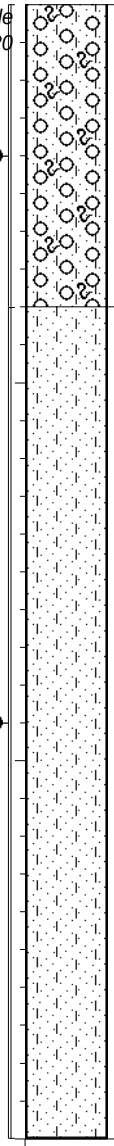
Test Pit Soil Profiles

Zutari
Macassar WWTW

HOLE No: STP01
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00 Moist yellowish-white speckled black VERY LOOSE pinholed silty SAND with abundant roots and scattered gravel. TOPSOIL.

0.80 Moist yellowish-white to light brown VERY LOOSE to LOOSE intact silty SAND. TRANSPORTED AEOLIAN.

3.00

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.0-2.0m.
3) Final depth at 3.0m (no refusal).
4) Samples taken: Disturbed sample DS1 taken at 0.0--0.8m and DS2 taken at 0.8--3.0m.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 11m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°45'54.30"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'16.90"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 26/04/2023	*HOLE No:* STP01
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:55	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWSTPLogs.TXT	

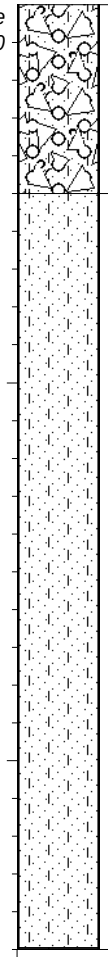
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW (Road Section)	Project Name: Macassar WWTW
Test Pit No.: STP01	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Topsoil underlain by aeolian material.* *Very loose to loose slightly silty SAND.*	

Zutari
Macassar WWTW

HOLE No: STP02
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00	Moist yellowish-white speckled black VERY LOOSE to LOOSE pinholed silty SAND with abundant roots and scattered gravel and rubble. TOPSOIL.
0.50	Moist yellowish-white to light brown VERY LOOSE to LOOSE intact silty SAND. TRANSPORTED AEOLIAN.
2.50	

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.0-2.0m.
3) Final depth at 2.5m (no refusal).
4) Hole very unstable and kept on collapsing.
5) No samples taken.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 7m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°45'56.40"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'33.20"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 26/04/2023	*HOLE No:* STP02
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:55	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWSTPLogs.TXT	

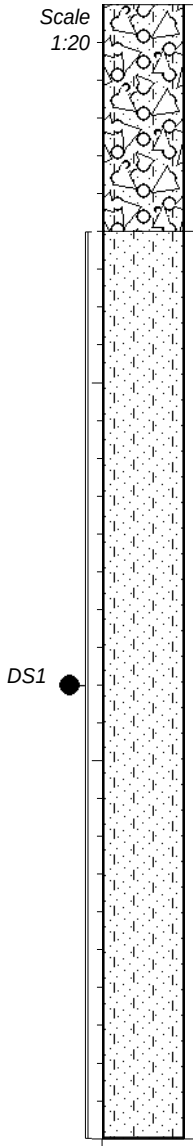
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW (Road Section)	Project Name: Macassar WWTW
Test Pit No.: STP02	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 2.5 m	General Comments: *Test pit keeping collapsing.* *Very loose to loose slightly silty SAND.*	

Zutari
Macassar WWTW

HOLE No: STP03
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00 Moist yellowish-white speckled black VERY LOOSE to LOOSE pinholed silty SAND with abundant roots and scattered gravel and rubble. TOPSOIL.

0.60 Moist yellowish-white to light brown VERY LOOSE to LOOSE intact silty SAND. TRANSPORTED AEOLIAN.

3.00

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.0-2.4m.
3) Final depth at 3.0m (no refusal).
4) Hole very unstable and kept on collapsing.
5) Samples taken: Disturbed sample DS1 taken at 0.6--3.0m.

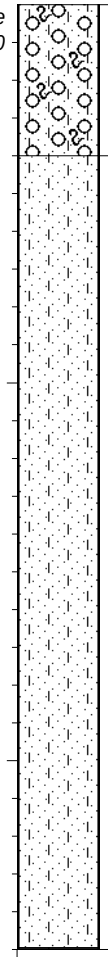
CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 17m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°45'57.80"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'25.60"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 26/04/2023	*HOLE No:* STP03
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:55	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWSTPLogs.TXT	

Zutari
Macassar WWTW

HOLE No: STP04
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00	Moist yellowish-white speckled black VERY LOOSE pinholed silty SAND with abundant roots and scattered gravel. TOPSOIL.
0.40	Moist yellowish-white to light brown streaked dark brown VERY LOOSE to LOOSE intact silty SAND. TRANSPORTED AEOLIAN.
2.50	

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.0-2.5m.
3) Final depth at 2.5m (no refusal).
4) Hole very unstable and kept on collapsing.
5) Mole holes in vicinity of test pit.
6) No samples taken.

CONTRACTOR : Sylco
MACHINE : TLB SDLG B877
DRILLED BY : -
PROFILED BY : HH (Reviewed by WK PriSciNat)
TYPE SET BY : Hendre Human
SETUP FILE : STANDARD.SET

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 26/04/2023
DATE : 07/07/2023 11:55
TEXT : ..2MacassarWWTWSTPLogs.TXT

ELEVATION : 16m
X-COORD : 18´°45'57.90"E
Y-COORD : 34´°04'26.90"S

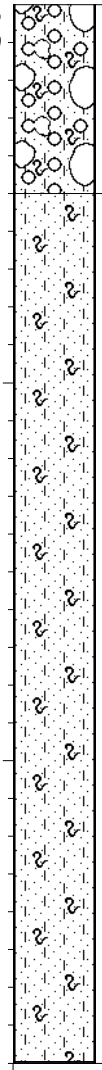
HOLE No: STP04

Zutari
Macassar WWTW

HOLE No: STP05
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00

Moist yellowish-white speckled black LOOSE pinholed silty SAND with abundant roots and scattered gravel and cobbles. TOPSOIL.

0.50

Moist yellowish-white to light brown VERY LOOSE to LOOSE intact silty SAND with scattered roots. TRANSPORTED AEOLIAN.

2.80

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0-2.6m.
3) Final depth at 2.8m (no refusal).
4) Hole very unstable and kept on collapsing.
5) Mole holes in vicinity of test pit.
6) No samples taken.

CONTRACTOR : Sylco
MACHINE : TLB SDLG B877
DRILLED BY : -
PROFILED BY : HH (Reviewed by WK PriSciNat)

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 26/04/2023

ELEVATION : 14m
X-COORD : 18´°45'58.80"E
Y-COORD : 34´°04'30.30"S

HOLE No: STP05

TYPE SET BY : Hendre Human
SETUP FILE : STANDARD.SET

DATE : 07/07/2023 11:55
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Client Name: Zutari	Site Location: Macassar WWTW (Road Section)	Project Name: Macassar WWTW
Test Pit No.: STP05	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 2.8 m	General Comments: *Test pit keeping collapsing.* *Very loose to loose slightly silty SAND.*	

Zutari
Macassar WWTW

HOLE No: STP06
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20

DS1

0.00 Moist dark brown to brown LOOSE to MEDIUM DENSE pinholed to voided clayey silty SAND with domestic fill. DOMESTIC FILL.

0.90 Moist yellowish-white to light brown LOOSE intact silty SAND. TRANSPORTED AEOLIAN.

3.00

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.3-2.0m.
3) Final depth at 3.0m (no refusal).
4) Samples taken: Disturbed sample DS1 taken at 0.0--0.9m.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 6m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°45'48.80"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'33.50"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 26/04/2023	*HOLE No:* STP06
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:55	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWSTPLogs.TXT	

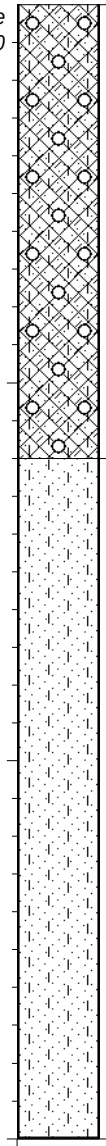
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW (Road Section)	Project Name: Macassar WWTW
Test Pit No.: STP06	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Domestic fill material underlain by transported aeolian material.* *Very loose to loose slightly silty SAND aeolian material.*	

Zutari
Macassar WWTW

HOLE No: STP07
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00 Moist dark brown to brown and orange MEDIUM DENSE becoming LOOSE pinholed to voided clayey silty SAND to silty gravelly SAND with domestic fill. DOMESTIC FILL.

1.20 Moist yellowish-white to light brown VERY LOOSE to LOOSE intact silty SAND. TRANSPORTED AEOLIAN.

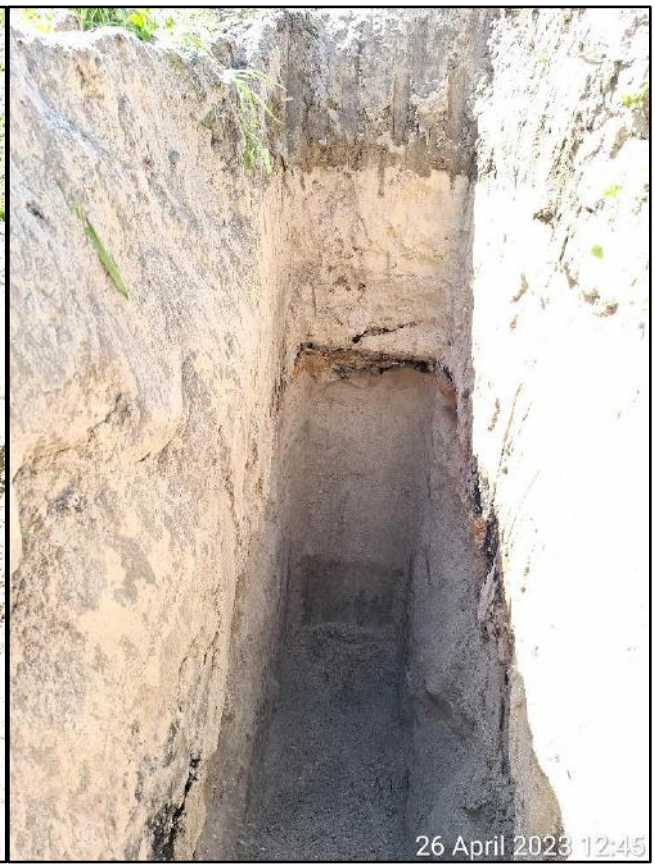
3.00

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 1.2-2.5m.
3) Final depth at 3.0m (no refusal).
4) No samples taken.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 4m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°45'43.70"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'33.40"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 26/04/2023	*HOLE No:* STP07
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:55	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWSTPLogs.TXT	

		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW (Road Section)	Project Name: Macassar WWTW
Test Pit No.: STP07	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Domestic fill material underlain by transported aeolian material.* *Very loose to loose slightly silty SAND aeolian material.*	

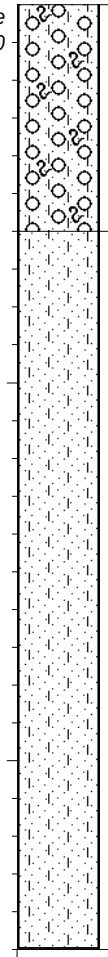


Zutari
Macassar WWTW

HOLE No: STP08
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00	Slightly moist to moist yellowish-white speckled black VERY LOOSE pinholed silty SAND with abundant roots and scattered gravel. TOPSOIL.
0.60	Moist yellowish-white to light brown streaked brown VERY LOOSE to LOOSE intact silty SAND. TRANSPORTED AEOLIAN.
2.50	

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.0-2.5m.
3) Final depth at 2.5m (no refusal).
4) Hole very unstable and kept on collapsing.
5) Mole holes in vicinity of test pit.
6) No samples taken.

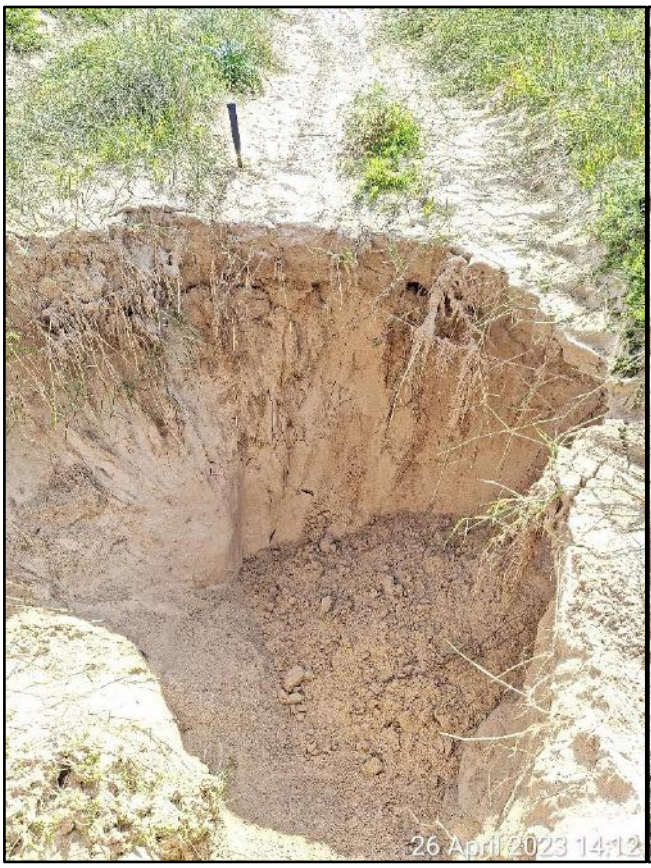
CONTRACTOR : Sylco
MACHINE : TLB SDLG B877
DRILLED BY : -
PROFILED BY : HH (Reviewed by WK PriSciNat)
TYPE SET BY : Hendre Human
SETUP FILE : STANDARD.SET

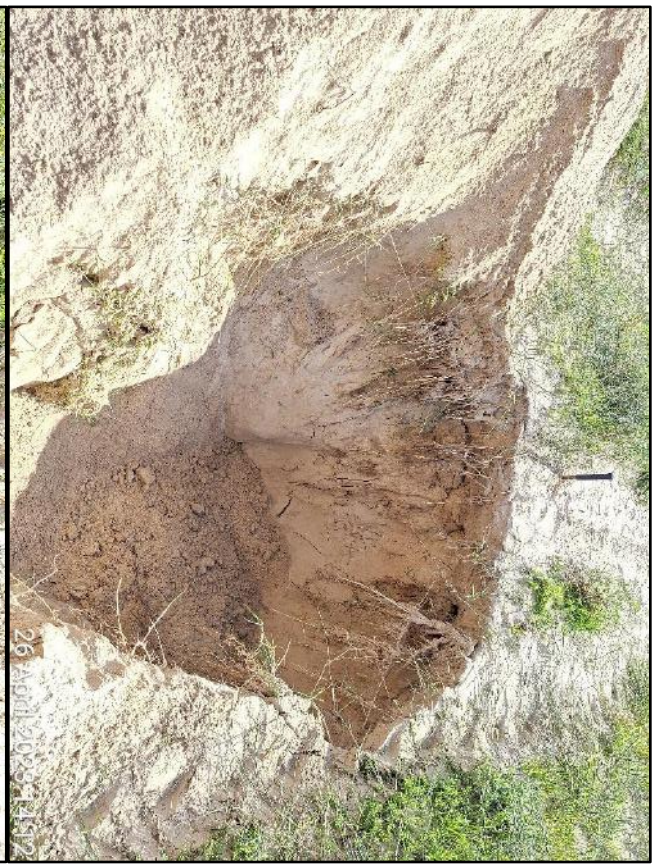
INCLINATION : -
DIAM : N/A
DATE : -
DATE : 26/04/2023
DATE : 07/07/2023 11:55
TEXT : ..2MacassarWWTWSTPLogs.TXT

ELEVATION : 16m
X-COORD : 18´°45'40.90"E
Y-COORD : 34´°04'37.60"S

HOLE No: STP08

		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW (Road Section)	Project Name: Macassar WWTW
Test Pit No.: STP08	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 2.5 m	General Comments: *Test pit keeping collapsing.* *Very loose to loose slightly silty SAND aeolian material.*	



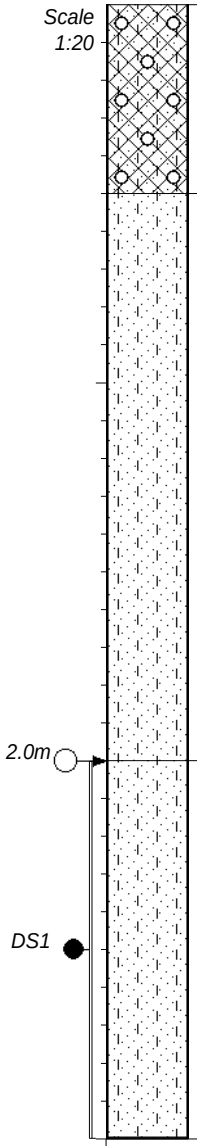


Zutari
Macassar WWTW

HOLE No: STP09
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00	Slightly moist to moist dark brown to yellowish-white VERY LOOSE pinholed to voided silty gravelly SAND to silty SAND with scattered fill (rubble). FILL MATERIAL.
0.50	Moist to very moist yellowish-white to light brown VERY LOOSE to LOOSE intact silty SAND. TRANSPORTED AEOLIAN.
2.00	Very moist to wet greyish-brown VERY LOOSE intact silty SAND with shell fragments. TRANSPORTED ESTAURINE.
3.00	

NOTES

1) Slight groundwater seepage at 2.0m.
2) Collapsing sidewalls observed at 0.0-2.0m.
3) Final depth at 3.0m (no refusal).
4) Hole very unstable and kept on collapsing.
5) Mole holes in vicinity of test pit.
6) Samples taken: Disturbed Sample DS1 taken at 2.0--3.0m.

CONTRACTOR : Sylco
MACHINE : TLB SDLG B877
DRILLED BY : -
PROFILED BY : HH (Reviewed by WK PriSciNat)

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 26/04/2023

ELEVATION : 3m
X-COORD : 18´°45'50.80"E
Y-COORD : 34´°04'41.7"S

HOLE No: STP09

TYPE SET BY : Hendre Human
SETUP FILE : STANDARD.SET

DATE : 07/07/2023 11:55
TEXT : ..2MacassarWWTWSTPLogs.TXT

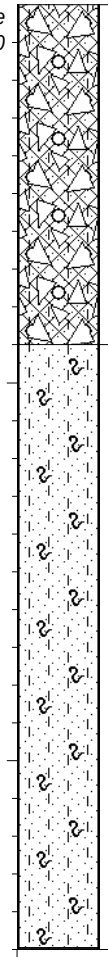
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW (Road Section)	Project Name: Macassar WWTW
Test Pit No.: STP09	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Test pit keeping collapsing.* *Very moist to wet greyish-brown very loose slightly silty SAND estaurine material.*	

Zutari
Macassar WWTW

HOLE No: STP10
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00	Moist dark brown to yellowish-white and orange LOOSE to MEDIUM DENSE pinholed to voided silty gravelly SAND to gravelly silty SAND with abundant fill (builders rubble). FILL MATERIAL.
0.90	Moist yellowish-white to light brown VERY LOOSE to LOOSE intact silty SAND with scattered roots. TRANSPORTED AEOLIAN.
2.50	

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.0-2.0m.
3) Final depth at 2.5m (no refusal).
4) Hole very unstable and kept on collapsing.
5) Mole holes in vicinity of test pit.
6) No samples taken.

CONTRACTOR : Sylco
MACHINE : TLB SDLG B877
DRILLED BY : -
PROFILED BY : HH (Reviewed by WK PriSciNat)
TYPE SET BY : Hendre Human
SETUP FILE : STANDARD.SET

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 26/04/2023
DATE : 07/07/2023 11:55
TEXT : ..2MacassarWWTWSTPLogs.TXT

ELEVATION : 6m
X-COORD : 18´°45'46.70"E
Y-COORD : 34´°04'27.90"S

HOLE No: STP10

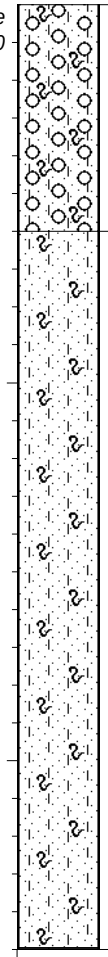
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW (Road Section)	Project Name: Macassar WWTW
Test Pit No.: STP10	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 2.5 m	General Comments: *Test pit keeping collapsing (very unstable).* *Very loose to loose slightly silty SAND aeolian material.*	

Zutari
Macassar WWTW

HOLE No: STP11
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00	Moist brown to yellowish-white speckled black VERY LOOSE to LOOSE pinholed silty SAND with abundant roots and scattered gravel. TOPSOIL.
0.60	Moist yellowish-white to light brown VERY LOOSE intact silty SAND with scattered roots. TRANSPORTED AEOLIAN.
2.50	

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.0-2.5m.
3) Final depth at 2.5m (no refusal).
4) Hole very unstable and kept on collapsing.
5) Mole holes in vicinity of test pit.
6) No samples taken.

CONTRACTOR : Sylco
MACHINE : TLB SDLG B877
DRILLED BY : -
PROFILED BY : HH (Reviewed by WK PriSciNat)

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 26/04/2023

ELEVATION : 11m
X-COORD : 18´°45'42.40"E
Y-COORD : 34´°04'31.70"S

HOLE No: STP11

TYPE SET BY : Hendre Human
SETUP FILE : STANDARD.SET

DATE : 07/07/2023 11:55
TEXT : ..2MacassarWWTWSTPLogs.TXT

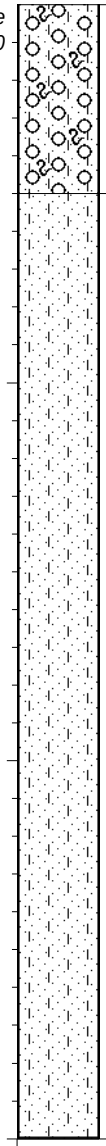
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW (Road Section)	Project Name: Macassar WWTW
Test Pit No.: STP11	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 2.5 m	General Comments: *Test pit keeping collapsing (very unstable).* *Very loose to loose slightly silty SAND aeolian material.*	

Zutari
Macassar WWTW

HOLE No: STP12
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00	Slightly moist to moist yellowish-white speckled black VERY LOOSE pinholed silty SAND with abundant fine roots and scattered gravel. TOPSOIL.
0.50	Moist yellowish-white to light brown VERY LOOSE to LOOSE intact silty SAND. TRANSPORTED AEOLIAN.
3.00	

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.0-2.5m.
3) Final depth at 3.0m (no refusal).
4) Mole holes in vicinity of test pit.
5) No samples taken.

CONTRACTOR : Sylco
MACHINE : TLB SDLG B877
DRILLED BY : -
PROFILED BY : HH (Reviewed by WK PriSciNat)

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 26/04/2023

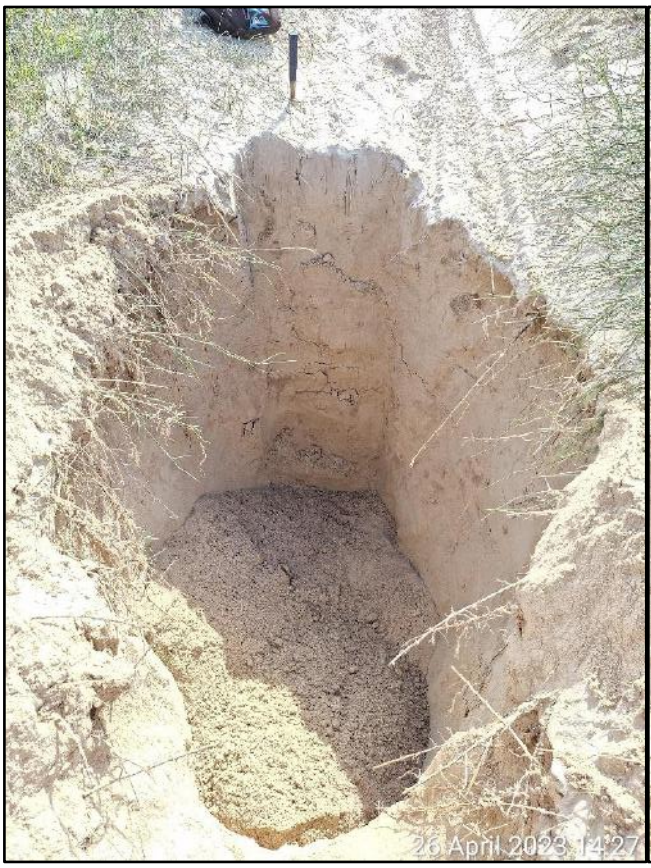
ELEVATION : 11m
X-COORD : 18´°45'42.50"E
Y-COORD : 34´°04'39.50"S

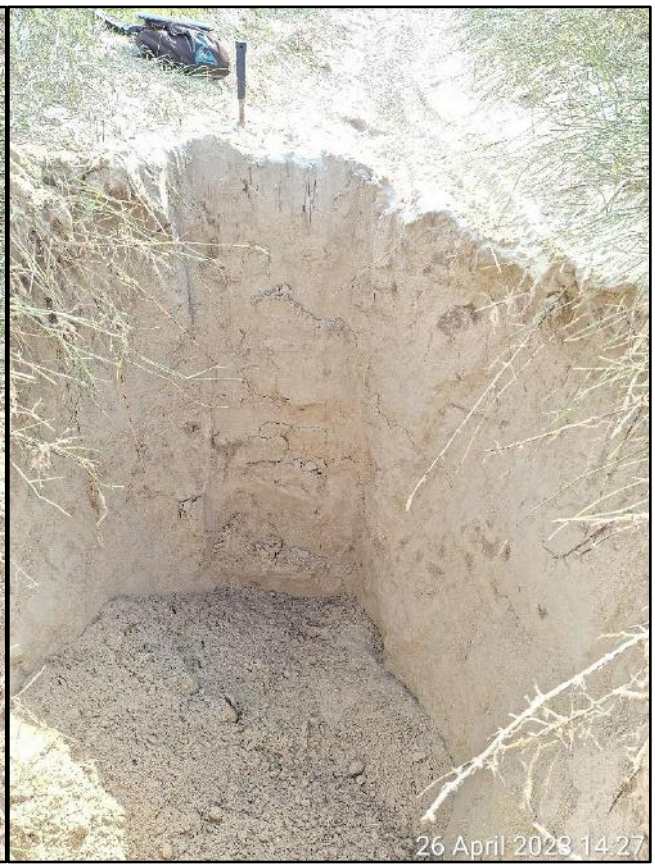
HOLE No: STP12

TYPE SET BY : Hendre Human
SETUP FILE : STANDARD.SET

DATE : 07/07/2023 11:55
TEXT : ..2MacassarWWTWSTPLogs.TXT

		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW (Road Section)	Project Name: Macassar WWTW
Test Pit No.: STP12	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Test pit keeping collapsing (very unstable).* *Very loose to loose slightly silty SAND aeolian material.*	





Zutari
Macassar WWTW

LEGEND
Sheet 1 of 1

JOB NUMBER: 22-1172

	GRAVEL	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SILTY	{SA07}
	CLAYEY	{SA09}
	RUBBLE	{SA31}
	FILL	{SA32}
Name	DISTURBED SAMPLE	{SA38}
	ROOTS	{SA40}
9.5	WATER SEEPAGE/water strike	{CH50}
	COBBLES	{SA58}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : Hendre Human
SETUP FILE : STANDARD.SET

DATE : 07/07/2023 11:55
TEXT : ..2MacassarWWTWSTPLogs.TXT

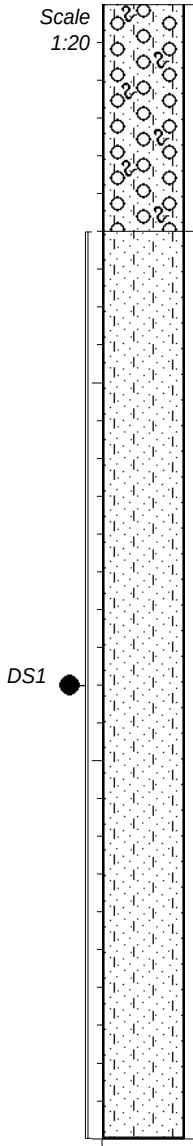
LEGEND
SUMMARY OF SYMBOLS

Zutari
Macassar WWTW

HOLE No: DTP01
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00 Moist yellowish-white speckled black VERY LOOSE pinholed silty SAND with abundant roots and scattered gravel. TOPSOIL.

0.60 Moist yellowish-white to light brown VERY LOOSE to LOOSE intact silty SAND. TRANSPORTED AEOLIAN.

3.00

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.0-2.5m.
3) Final depth at 3.0m (no refusal).
4) Hole very unstable and kept on collapsing.
5) Samples taken: Disturbed sample DS1 taken at 0.6--3.0m.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 19m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°45'57.00"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'27.50"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 27/04/2023	*HOLE No:* DTP01
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:56	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWDTPLogs.TXT	

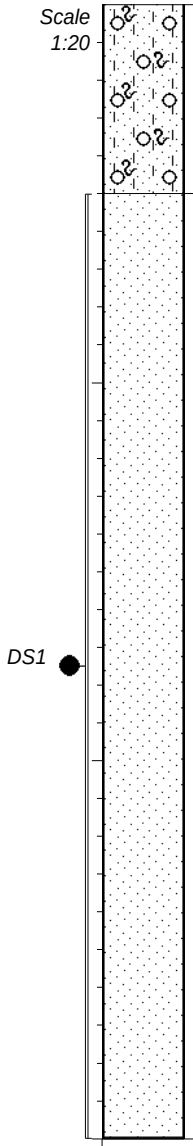
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP01	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Test Pit collapsing.* *Very Loose to Loose slightly silty SAND.*	

Zutari
Macassar WWTW

HOLE No: DTP02
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00 Moist brown to yellowish-white speckled black VERY LOOSE to LOOSE intact silty gravelly SAND with abundant roots. TOPSOIL.

0.50 Moist yellowish-white to light brown VERY LOOSE to LOOSE pinholed intact SAND. TRANSPORTED AEOLIAN.

3.00

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.0-2.8m.
3) Final depth at 3.0m (no refusal).
4) Samples taken: Disturbed sample DS1 taken at 0.5--3.0m.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 7m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°45'56.40"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'33.20"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 27/04/2023	*HOLE No:* DTP02
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:56	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWDTPLogs.TXT	

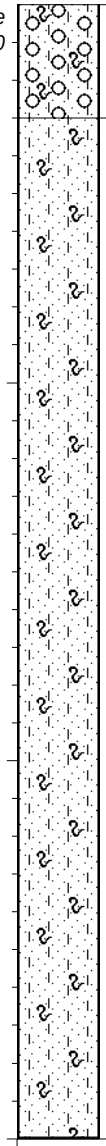
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP02	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Test Pit collapsing.* *Very Loose to Loose slightly silty SAND.*	

Zutari
Macassar WWTW

HOLE No: DTP05
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00	Moist yellowish-white speckled black VERY LOOSE pinholed silty SAND with scattered fine roots and gravel. TOPSOIL.
0.30	Moist yellowish-white to light brown streaked dark brown VERY LOOSE to LOOSE intact silty SAND with scattered fine roots. TRANSPORTED AEOLIAN.
3.00	

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 1.0-2.5m.
3) Final depth at 3.0m (no refusal).
4) No samples taken.

CONTRACTOR : Sylco
MACHINE : TLB SDLG B877
DRILLED BY : -
PROFILED BY : HH (Reviewed by WK PriSciNat)

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 27/04/2023

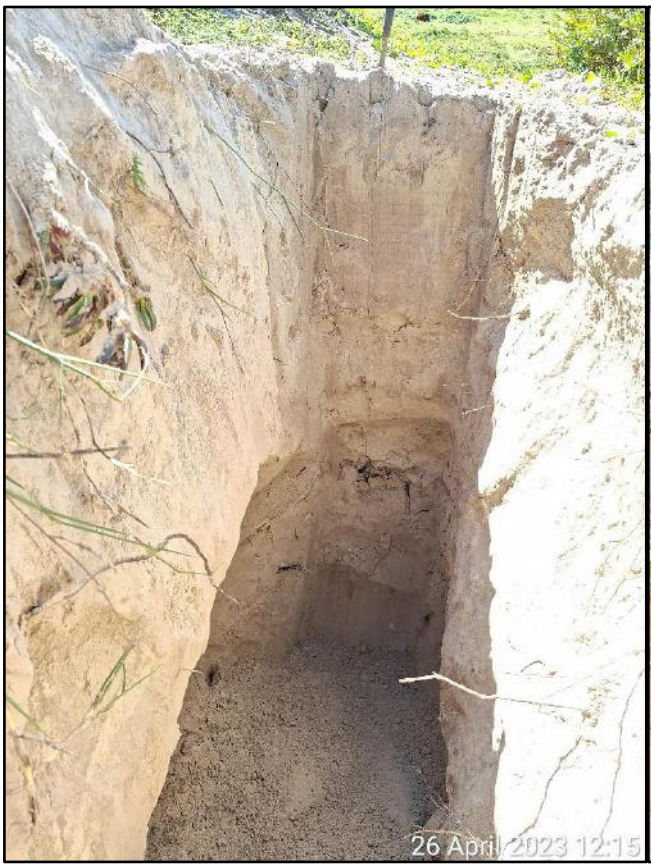
ELEVATION : 8m
X-COORD : 18´°45'49.10"E
Y-COORD : 34´°04'38.90"S

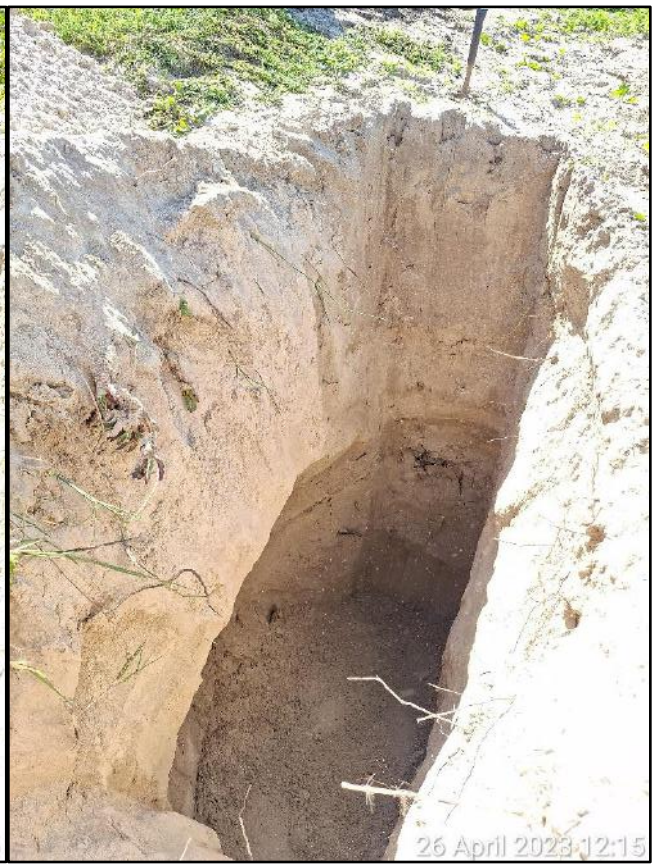
HOLE No: DTP05

TYPE SET BY : Hendre Human
SETUP FILE : STANDARD.SET

DATE : 07/07/2023 11:56
TEXT : ..2MacassarWWTWDTPLogs.TXT

		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP05	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Test Pit collapsing.* *Very Loose to Loose slightly silty SAND.*	



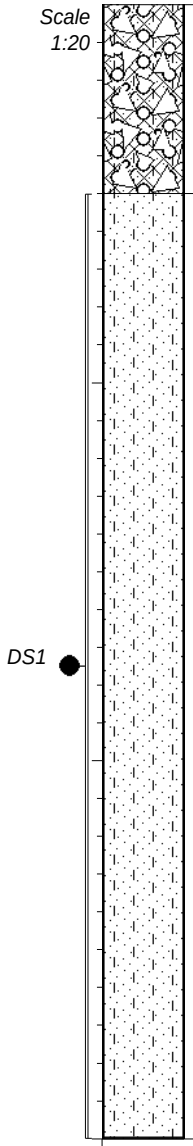


Zutari
Macassar WWTW

HOLE No: DTP06
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00 Moist yellowish-white speckled black VERY LOOSE pinholed silty SAND with abundant roots and scattered gravel and fill (builders rubble). TOPSOIL.

0.50 Moist yellowish-white to light brown VERY LOOSE to LOOSE intact silty SAND. TRANSPORTED AEOLIAN.

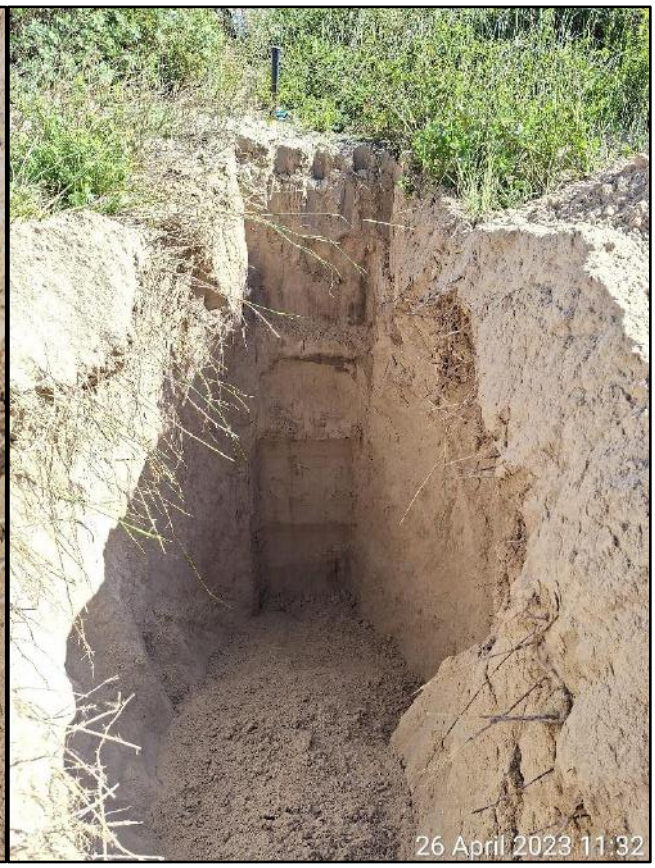
3.00

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.0-1.5m.
3) Final depth at 3.0m (no refusal).
4) Mole holes in vicinity of test pit.
5) Samples taken: Disturbed Sample DS1 taken at 0.5--3.0m.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 12m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°45'51.40"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'32.90"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 27/04/2023	
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:56	*HOLE No:* DTP06
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWDTPLogs.TXT	

		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP06	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Test Pit collapsing.* *Very Loose to Loose slightly silty SAND.*	

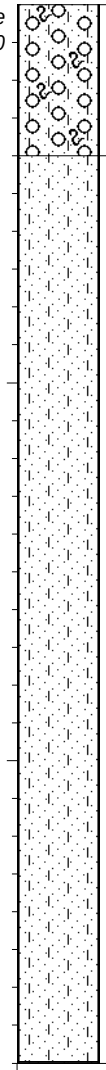


Zutari
Macassar WWTW

HOLE No: DTP08
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00	Moist yellowish-white speckled black VERY LOOSE to LOOSE pinholed silty SAND with abundant roots and scattered gravel. TOPSOIL.
0.40	Slightly moist to moist yellowish-white to light brown VERY LOOSE to LOOSE intact silty SAND with scattered shell fragments. TRANSPORTED AEOLIAN.
2.80	

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.0-2.8m.
3) Final depth at 2.8m (no refusal).
4) Hole very unstable and kept on collapsing.
5) Mole holes in vicinity of test pit.
6) No samples taken.

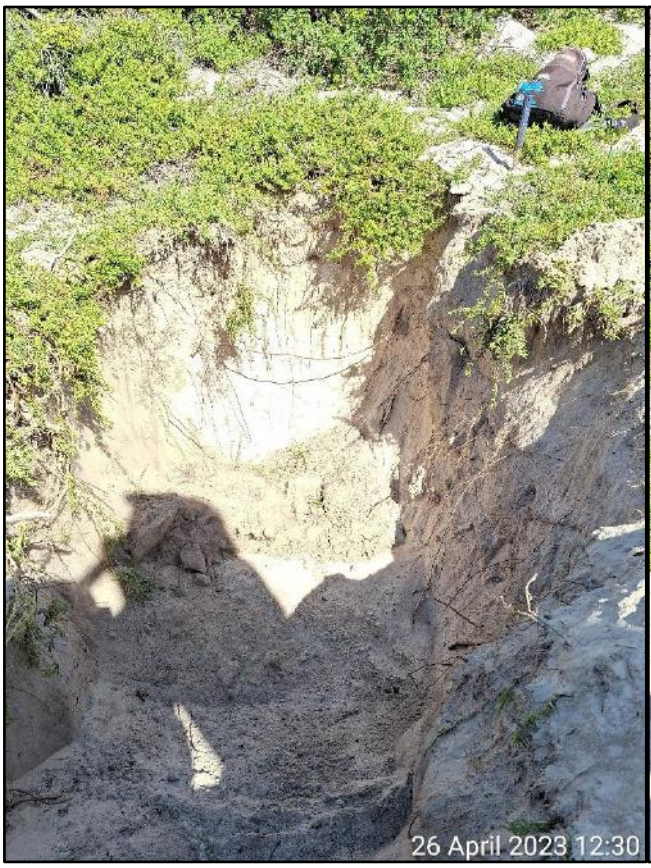
CONTRACTOR : Sylco
MACHINE : TLB SDLG B877
DRILLED BY : -
PROFILED BY : HH (Reviewed by WK PriSciNat)
TYPE SET BY : Hendre Human
SETUP FILE : STANDARD.SET

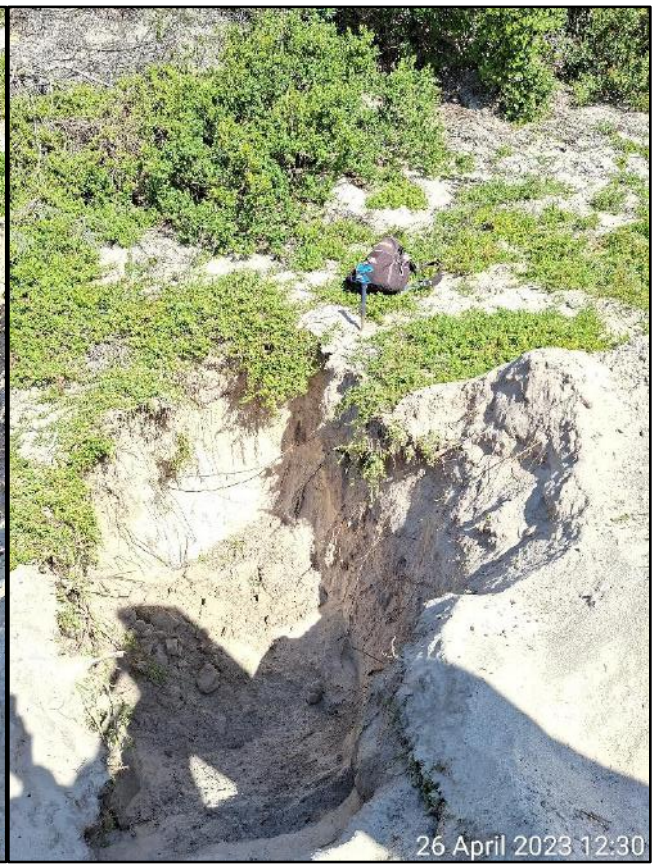
INCLINATION : -
DIAM : N/A
DATE : -
DATE : 27/04/2023
DATE : 07/07/2023 11:56
TEXT : ..2MacassarWWTWDTPLogs.TXT

ELEVATION : 8m
X-COORD : 18´°45'44.00"E
Y-COORD : 34´°04'36.90"S

HOLE No: DTP08

		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP08	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 2.8 m	General Comments: *Test Pit keeping on collapsing (very unstable).* *Very Loose to Loose slightly silty SAND.*	



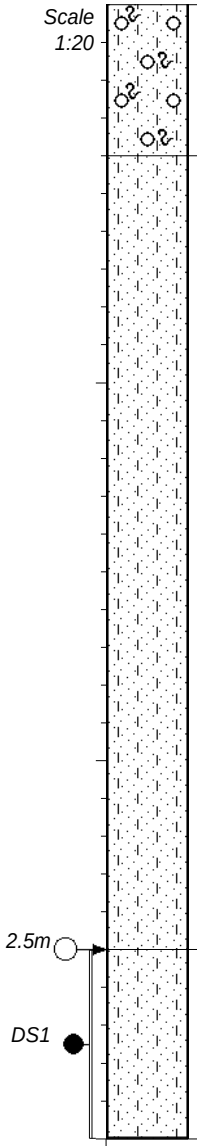


Zutari
Macassar WWTW

HOLE No: DTP12
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00	Moist light brown blotched brown LOOSE pinholed silty gravelly SAND to silty SAND with abundant fine roots. TOPSOIL.
0.40	Moist to very moist yellowish-white to light brown streaked brown VERY LOOSE to LOOSE intact silty SAND. TRANSPORTED AEOLIAN.
2.50	Very moist to wet greyish-brown VERY LOOSE intact silty SAND with shell fragments. TRANSPORTED ESTAURINE.
3.00	

NOTES

1) Slight groundwater seepage at 2.5m.
2) Collapsing sidewalls observed at 2.0-3.0m.
3) Final depth at 3.0m (no refusal).
4) Hole very unstable and kept on collapsing.
5) Mole holes in vicinity of test pit.
6) Samples taken: Disturbed Sample DS1 taken at 2.5--3.0m.

CONTRACTOR : Sylco
MACHINE : TLB SDLG B877
DRILLED BY : -
PROFILED BY : HH (Reviewed by WK PriSciNat)

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 27/04/2023

ELEVATION : 5m
X-COORD : 18´°45'54.80"E
Y-COORD : 34´°04'41.20"S

HOLE No: DTP12

TYPE SET BY : Hendre Human
SETUP FILE : STANDARD.SET

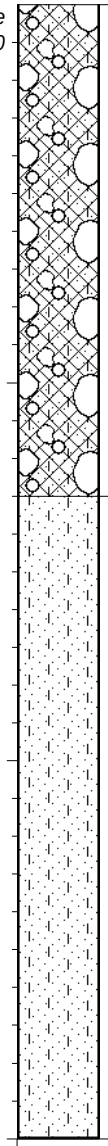
DATE : 07/07/2023 11:56
TEXT : ..2MacassarWWTWDTPLogs.TXT

Zutari
Macassar WWTW

HOLE No: DTP13
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00

Slightly moist to moist dark brown to orange-brown and yellowish-white MEDIUM DENSE becoming LOOSE pinholed to voided silty gravelly SAND with scattered cobbles becoming silty SAND. FILL MATERIAL.

1.30

Moist yellowish-white to light brown MEDIUM DENSE becoming LOOSE intact silty SAND. COMPACTED AEOLIAN.

3.00

NOTES

1) No Groundwater Seepage.
2) Stable sidewalls.
3) Final depth at 3.0m (no refusal).
4) No samples taken.

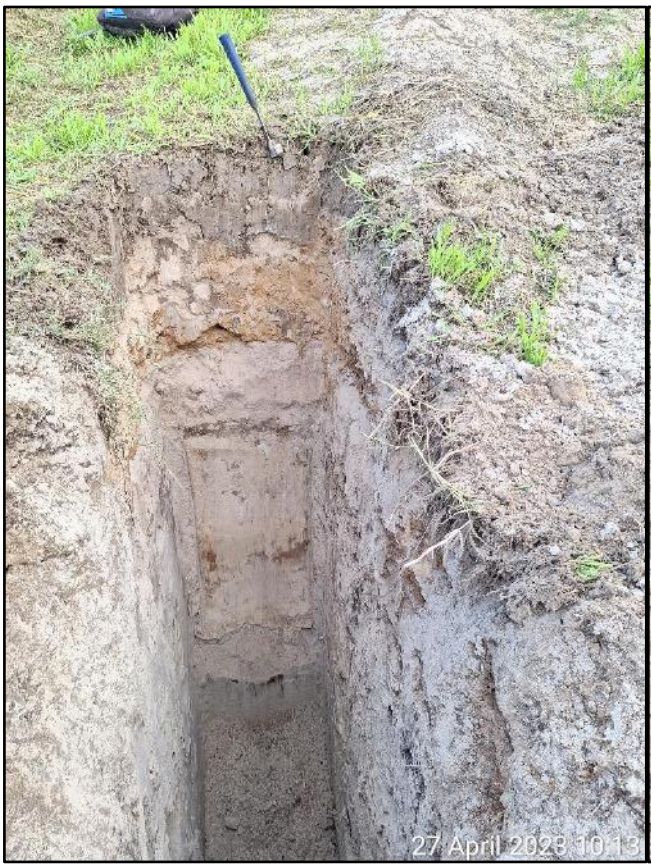
CONTRACTOR : Sylco
MACHINE : TLB SDLG B877
DRILLED BY : -
PROFILED BY : HH (Reviewed by WK PriSciNat)
TYPE SET BY : Hendre Human
SETUP FILE : STANDARD.SET

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 27/04/2023
DATE : 07/07/2023 11:56
TEXT : ..2MacassarWWTWDTPLogs.TXT

ELEVATION : 7m
X-COORD : 18´°45'58.60"E
Y-COORD : 34´°04'37.70"S

HOLE No: DTP13

		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP13	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Fill Material underlain by compacted aeolian material.*	

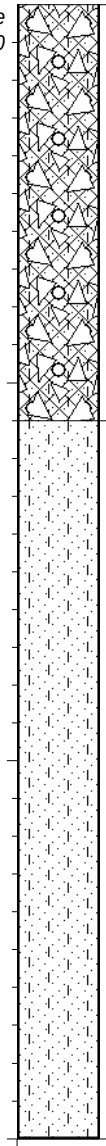


Zutari
Macassar WWTW

HOLE No: DTP14
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00

Slightly moist to moist dark brown to yellowish-brown VERY LOOSE to LOOSE pinholed and voided silty gravelly SAND with abundant builders rubble (concrete and steel). FILL MATERIAL.

1.10

Moist yellowish-white to light brown LOOSE intact silty SAND. TRANSPORTED AEOLIAN.

3.00

NOTES

1) No Groundwater Seepage.
2) Potentially unstable sidewalls observed at 1.5-3.0m.
3) Final depth at 3.0m (no refusal).
4) Mole holes in vicinity of test pit.
5) No samples taken.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 9m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°45'55.40"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'34.30"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 27/04/2023	*HOLE No:* DTP14
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:56	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWDTPLogs.TXT	

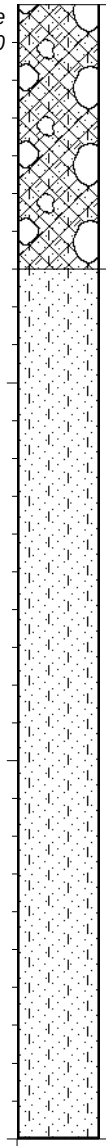
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP14	Date Logged: 27/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Fill material underlain by compacted aeolian material.* *Fill material consiting of rubble (concrete and steel).*	

Zutari
Macassar WWTW

HOLE No: DTP15
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00 Slightly moist to moist dark brown to yellowish-white MEDIUM DENSE becoming LOOSE pinholed clayey silty SAND with scattered cobbles becoming silty SAND. FILL MATERIAL.

0.70 Moist yellowish-white to light brown MEDIUM DENSE to LOOSE intact silty SAND. COMPACTED AEOLIAN.

3.00

NOTES

1) No Groundwater Seepage.
2) Potentially unstable sidewalls observed at 2.5-3.0m.
3) Final depth at 3.0m (no refusal).
4) No samples taken.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 10m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°45'56.40"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'35.00"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 27/04/2023	*HOLE No:* DTP15
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:56	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWDTPLogs.TXT	

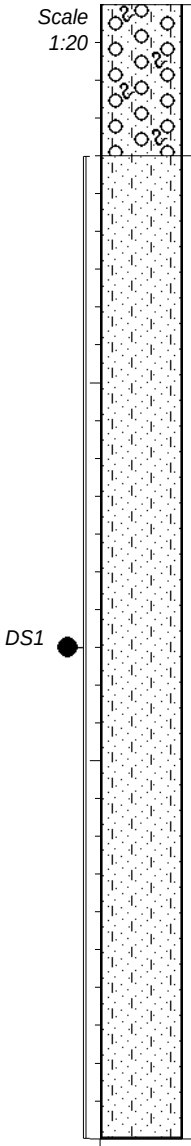
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP15	Date Logged: 27/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Fill material underlain by compacted aeolian material.* *Fill material consiting of loose clayey silty SAND with scattered cobbles.*	

Zutari
Macassar WWTW

HOLE No: DTP16
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00 Moist yellowish-white speckled black LOOSE pinholed silty SAND with fine roots and scattered gravel. TOPSOIL.

0.40 Moist yellowish-white to light brown VERY LOOSE to LOOSE intact silty SAND. TRANSPORTED AEOLIAN.

3.00

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.0-2.0m.
3) Final depth at 3.0m (no refusal).
4) Hole very unstable and kept on collapsing.
5) Mole holes in vicinity of test pit.
6) Samples taken: Disturbed Sample DS1 taken at 0.4--3.0m.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 10m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°45'58.00"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'31.90"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 27/04/2023	*HOLE No:* DTP16
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:56	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWDTPLogs.TXT	

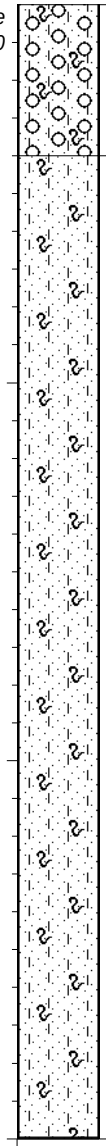
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP16	Date Logged: 27/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Test Pit collapsing.* *Collapsing sidewalls (very unstable).*	

Zutari
Macassar WWTW

HOLE No: DTP18
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00 Moist yellowish-white speckled black VERY LOOSE pinholed silty SAND with abundant roots and scattered gravel. TOPSOIL.

0.40 Moist to very moist yellowish-white to light brown VERY LOOSE to LOOSE intact silty SAND with scattered roots. TRANSPORTED AEOLIAN.

3.00

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.0-2.8m.
3) Final depth at 3.0m (no refusal).
4) Hole very unstable and kept on collapsing.
5) Mole holes in vicinity of test pit.
6) No samples taken.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 10m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°45'57.80"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'30.00"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 27/04/2023	*HOLE No:* DTP18
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:56	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWDTPLogs.TXT	

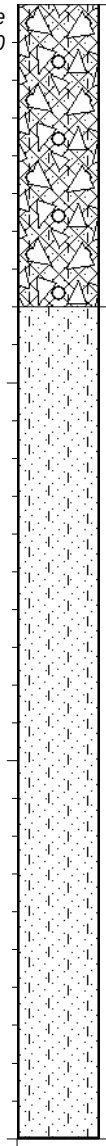
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP18	Date Logged: 26/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Test Pit collapsing (very unstable).* *Slightly silty SAND transported aeolian material.*	

Zutari
Macassar WWTW

HOLE No: DTP19
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00 Moist yellowish-white speckled black MEDIUM DENSE becoming LOOSE pinholed to voided silty gravelly SAND to silty SAND with scattered builders rubble (concrete and steel). FILL MATERIAL.

0.80 Moist yellowish-white to light brown streaked brown MEDIUM DENSE becoming LOOSE intact silty SAND. COMPACTED AEOLIAN.

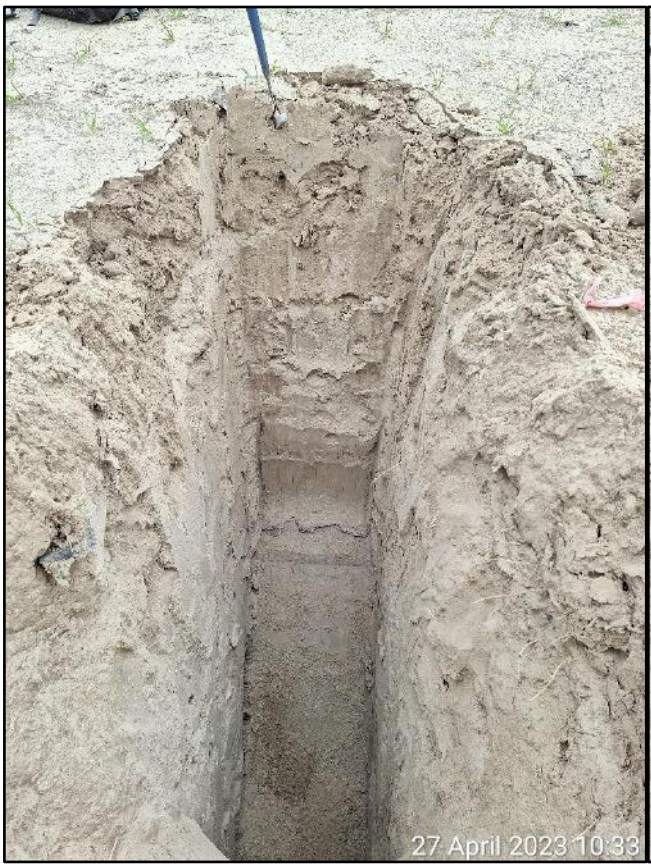
3.00

NOTES

1) No Groundwater Seepage.
2) Stable sidewalls.
3) Final depth at 3.0m (no refusal).
4) Mole holes in vicinity of test pit.
5) No samples taken.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 11m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°45'42.50"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'39.50"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 27/04/2023	*HOLE No:* DTP19
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:56	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWDTPLogs.TXT	

		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP19	Date Logged: 27/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Fill material underlain by compacted aeolian material.*	

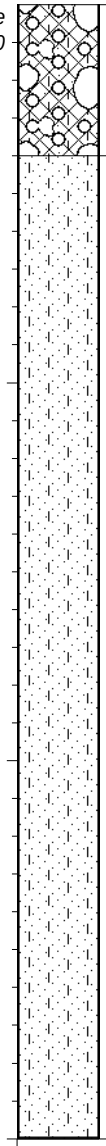


Zutari
Macassar WWTW

HOLE No: DTP20
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00	Slightly moist grey to brown speckled black MEDIUM DENSE to DENSE pinholed to voided silty sandy GRAVEL with scattered cobbles. FILL MATERIAL (ROAD FILL).
0.40	Moist yellowish-white to light brown streaked brown MEDIUM DENSE becoming LOOSE intact silty SAND. COMPACTED AEOLIAN.
3.00	

NOTES

1) No Groundwater Seepage.
2) Stable sidewalls.
3) Final depth at 3.0m (no refusal).
4) No samples taken.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 7m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°46'01.30"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'35.90"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 27/04/2023	*HOLE No:* DTP20
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:56	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWDTPLogs.TXT	

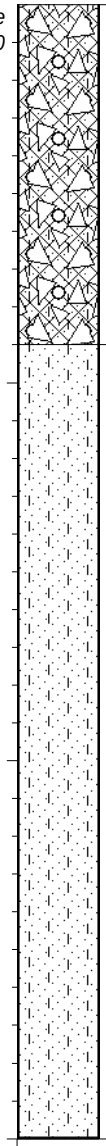
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP20	Date Logged: 27/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Fill material underlain by compacted aeolian material.*	

Zutari
Macassar WWTW

HOLE No: DTP21
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00	Moist yellowish-white speckled black MEDIUM DENSE becoming LOOSE pinholed to voided silty gravelly SAND to silty SAND with scattered builders rubble (concrete and steel). FILL MATERIAL.
0.90	Moist yellowish-white to light brown streaked brown MEDIUM DENSE becoming LOOSE intact silty SAND. COMPACTED AEOLIAN.
3.00	

NOTES

1) No Groundwater Seepage.
2) Potentially unstable sidewalls observed at 1.5-3.0m.
3) Final depth at 3.0m (no refusal).
4) No samples taken.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 8m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°46'02.60"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'33.70"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 27/04/2023	*HOLE No:* DTP21
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:56	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWDTPLogs.TXT	

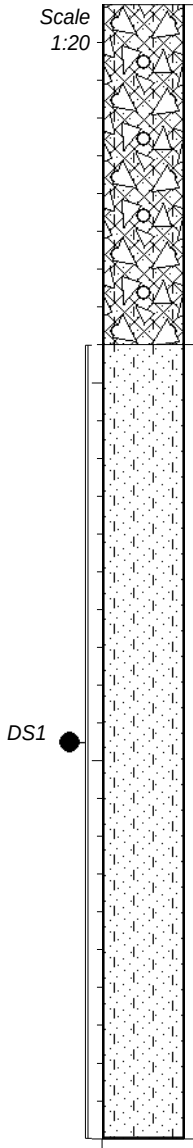
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP21	Date Logged: 27/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Fill material underlain by compacted aeolian material.*	

Zutari
Macassar WWTW

HOLE No: DTP22
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00 Moist yellowish-white speckled black MEDIUM DENSE becoming LOOSE pinholed to voided silty gravelly SAND to silty SAND with scattered builders rubble (concrete and steel). FILL MATERIAL.

0.90 Moist yellowish-white to light brown streaked brown MEDIUM DENSE becoming LOOSE intact silty SAND. COMPACTED AEOLIAN.

3.00

NOTES

1) No Groundwater Seepage.
2) Stable sidewalls.
3) Final depth at 3.0m (no refusal).
4) Mole holes in vicinity of test pit.
5) Samples taken: Disturbed Samples DS1 taken at 0.9--3.0m.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 9m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°46'02.20"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'29.40"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 27/04/2023	*HOLE No:* DTP22
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:56	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWDTPLogs.TXT	

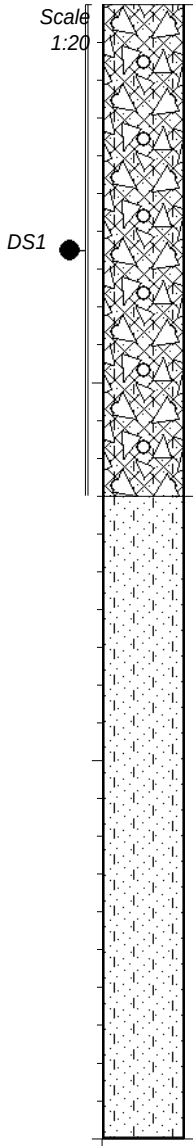
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP22	Date Logged: 27/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Fill material underlain by compacted aeolian material.*	

Zutari
Macassar WWTW

HOLE No: DTP24
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00

Moist yellowish-white to dark brown speckled black MEDIUM DENSE becoming LOOSE pinholed to voided silty gravelly SAND to silty SAND with scattered builders rubble (concrete and steel). FILL MATERIAL.

1.30

Moist yellowish-white to light brown streaked brown MEDIUM DENSE becoming LOOSE intact silty SAND. COMPACTED AEOLIAN.

3.00

NOTES

1) No Groundwater Seepage.
2) Stable sidewalls.
3) Final depth at 3.0m (no refusal).
4) Mole holes in vicinity of test pit.
5) Samples taken: Disturbed Samples DS1 taken at 0.0--1.3m.

CONTRACTOR : Sylco
MACHINE : TLB SDLG B877
DRILLED BY : -
PROFILED BY : HH (Reviewed by WK PriSciNat)
TYPE SET BY : Hendre Human
SETUP FILE : STANDARD.SET

INCLINATION : -
DIAM : N/A
DATE : -
DATE : 27/04/2023
DATE : 07/07/2023 11:56
TEXT : ..2MacassarWWTWDTPLogs.TXT

ELEVATION : 8m
X-COORD : 18´°46'05.20"E
Y-COORD : 34´°04'31.40"S

HOLE No: DTP24

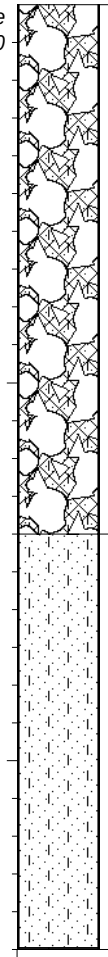
		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP24	Date Logged: 27/04/2023	Project No.: 22-1172
Depth (m): 0 – 3.0 m	General Comments: *Fill material underlain by compacted aeolian material.*	

Zutari
Macassar WWTW

HOLE No: DTP25
Sheet 1 of 1

JOB NUMBER: 22-1172

Scale 1:20



0.00

Moist yellowish-white to dark brown speckled black VERY LOOSE to LOOSE pinholed to voided silty gravelly SAND to silty SAND with scattered builders rubble (concrete) and boulders. FILL MATERIAL.

1.40

Moist yellowish-white to light brown VERY LOOSE to LOOSE intact silty SAND. TRANSPORTED AEOLIAN.

2.50

NOTES

1) No Groundwater Seepage.
2) Collapsing sidewalls observed at 0.5-2.5m.
3) Final depth at 2.5m (no refusal).
4) Mole holes in vicinity of test pit.
5) Hole very unstable and kept on collapsing.
6) No samples taken.

CONTRACTOR : Sylco	*INCLINATION :* -	*ELEVATION :* 8m
MACHINE : TLB SDLG B877	*DIAM :* N/A	*X-COORD :* 18´°46'05.20"E
DRILLED BY : -	*DATE :* -	*Y-COORD :* 34´°04'31.40"S
PROFILED BY : HH (Reviewed by WK PriSciNat)	*DATE :* 27/04/2023	*HOLE No:* DTP25
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 11:56	
SETUP FILE : STANDARD.SET	*TEXT :* ..2MacassarWWTWDTPLogs.TXT	

		PHOTOGRAPHIC LOG
Client Name: Zutari	Site Location: Macassar WWTW	Project Name: Macassar WWTW
Test Pit No.: DTP25	Date Logged: 27/04/2023	Project No.: 22-1172
Depth (m): 0 – 2.5 m	General Comments: *Test pit keeping collapsing.* *Sidewalls very unstable.*	

Zutari
Macassar WWTW

LEGEND
Sheet 1 of 1

JOB NUMBER: 22-1172

	BOULDERS	{SA01}
	GRAVEL	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SANDY	{SA05}
	SILTY	{SA07}
	CLAYEY	{SA09}
	RUBBLE	{SA31}
	FILL	{SA32}
Name	DISTURBED SAMPLE	{SA38}
	ROOTS	{SA40}
11.5	WATER SEEPAGE/water strike	{CH50}
	COBBLES	{SA58}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : Hendre Human
SETUP FILE : STANDARD.SET

DATE : 07/07/2023 11:56
TEXT : ..2MacassarWWTWDTPLogs.TXT

LEGEND
SUMMARY OF SYMBOLS

APPENDIX B1:

Laboratory Test Results (Soil)

WATERLAB (Pty) Ltd

Reg. No.: 1983/009165/07 V.A.T. No.: 4130107891

23B De Havilland Crescent
Persequor Techno Park
Meiring Naudé Drive
Pretoria

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Persequor Park, 0020
Tel: +2712 – 349 – 1066
Fax: +2712 – 349 – 2064
e-mail: admin@waterlab.co.za

T0391

CERTIFICATE OF ANALYSES
BRE TEST

Date received: 2023-05-12
Project number: 1000
Report number: 120368
Date completed: 2023-06-02
Order number: POR01976

Client name: STEYN-WILSON Geotechnical
Address: 11 Gooderson Rd, Blackheath, Cape Town
Telephone: 021 905 0503
Contact person: Frank Coetzee
Email: geotech@steynwilson.co.za
Cell: ---

Analyses	Method Identification	Sample Identification: Macassar			
		DTP02 0.5-3.0		DTP24 0-1.3	
Sample number		**23-6485**		**23-6486**	
Leachate used	**WLAB075**	**Distilled Water**		**Distilled Water**	
Mass Used (g)	---	**500**		**500**	
Volume Used (mℓ)	---	**1000**		**1000**	
Paste pH	WLAB077	8.7		8.4	
Units		**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**
Chloride as Cl	WLAB046	23	46	19	38
Sulphate as SO_4	WLAB046	53	106	<2	<4
Nitrate as N	WLAB046	11	22	5.1	10
Free & Saline Ammonia	WLAB046	0.4	0.8	0.6	1.2
Acid soluble Sulphate as SO_4*	---	80	160	66	132
Total Ammonium Ion as NH_4* (calc)	WLAB068	0.5	1.0	0.7	1.4
Magnesium as Mg	WLAB015	3	6	2	4
Total Sulphur as S (Eltra) %*	---	<0.01		<0.01	

Please note:

- **The blank is subtracted from all leach results, except pH and Electrical Conductivity.**
- *** = Not SANAS Accredited**
- **Tests marked "Not SANAS Accredited" in this report are not included in the SANAS Schedule of Accreditation for this Laboratory.**
- **[o] = Analyses performed by an Outsourced Laboratory**
- **Results marked "Outsourced Test" in this report are not included in the SANAS Schedule of Accreditation for this Laboratory**

S. Laubscher
Technical Signatory

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WATERLAB (Pty) Ltd

Reg. No.: 1983/009165/07 V.A.T. No.: 4130107891

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Pretoria

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Persequor Park, 0020
Tel: +2712 – 349 – 1066
Fax: +2712 – 349 – 2064
e-mail: admin@waterlab.co.za

T0391

CERTIFICATE OF ANALYSES
BRE TEST

Date received: 2023-05-12
Project number: 1000
Report number: 120368
Date completed: 2023-06-02
Order number: POR01976

Client name: STEYN-WILSON Geotechnical
Address: 11 Gooderson Rd, Blackheath, Cape Town
Telephone: 021 905 0503
Contact person: Frank Coetzee
Email: geotech@steynwilson.co.za
Cell: ---

Analyses	Method Identification	Sample Identification: Macassar			
		STP06 0-0.9		STP09 2.0-3.0	
Sample number		23-6487		23-6488	
Leachate used	WLAB075	Distilled Water		Distilled Water	
Mass Used (g)	---	350		500	
Volume Used (mℓ)	---	700		1000	
Paste pH	WLAB077	7.2		9.0	
Units		mg/ℓ	mg/kg	mg/ℓ	mg/kg
Chloride as Cl	WLAB046	134	268	29	58
Sulphate as SO_4	WLAB046	1473	2946	21	42
Nitrate as N	WLAB046	1091	2182	14	28
Free & Saline Ammonia	WLAB046	20	40	0.6	1.2
Acid soluble Sulphate as SO_4*	---	3591	7182	241	482
Total Ammonium Ion as NH_4* (calc)	WLAB068	26	52	0.6	1.2
Magnesium as Mg	WLAB015	97	194	3	6
Total Sulphur as S (Eltra) %*	---	0.49		<0.1	

S. Laubscher
Technical Signatory

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WATERLAB (PTY) Ltd

Reg. No.: 1983/009165/07 V.A.T. No.: 4130107891

23B De Havilland Crescent
Persequor Techno Park,
Meiring Naudé Road, Pretoria
P.O. Box 283, 0020

Telephone: +2712 – 349 – 1066
Facsimile: +2712 – 349 – 2064
Email: accounts@waterlab.co.za

T0391

CERTIFICATE OF ANALYSES
DIN 50 929

Date received: 2023-05-12
Project number: 1000
Report number: 120368
Date completed: 2023-06-02
Order number: POR01976

Client name: STEYN-WILSON Geotechnical
Address: 11 Gooderson Rd, Blackheath, Cape Town
Telephone: 021 905 0503
Contact person: Frank Coetzee
Email: geotech@steynwilson.co.za
Cell: ---

Analyses in mg/ℓ	Method Identification	Sample Identification: Macassar	
		DTP02 0.5-3.0	DTP24 0-1.3
Sample Number		**23-6485**	**23-6486**
Leachate used	WLAB075	**Distilled Water**	**Distilled Water**
Mass Used (g)	---	**500**	**500**
Volume Used (mℓ)	---	**1000**	**1000**
pH Value at 25°C	WLAB001	7.9	8.1
Electrical Conductivity in mS/m at 25°C	WLAB002	34.4	23.3
Resistivity (ohm.cm) (calc)	WLAB068	2 907	4 292
Alkalinity as $CaCO_3$	WLAB007	32	64
Acidity as $CaCO_3$	WLAB022	12	12
Chloride as Cl	WLAB046	23	19
Water Soluble Sulphate as SO_4	WLAB046	53	<2
Acid Soluble Sulphate as SO_4 *	----	80	66
Sulphide as S^{2-} *	WLAB035	0.5	2.0
% Moisture *	WLAB078	5.3	8.1

UTD = Unable to determine due to interferences.

Please note:
- **The blank is subtracted from all leach results, except pH and Electrical Conductivity.**
- *** = Not SANAS Accredited**
- **Tests marked "Not SANAS Accredited" in this report are not included in the SANAS Schedule of Accreditation for this Laboratory.**
- **[o] = Analyses performed by an Outsourced Laboratory**
- **Results marked "Outsourced Test" in this report are not included in the SANAS Schedule of Accreditation for this Laboratory**

S. Laubscher _____
Technical Signatory

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CERTIFICATE OF ANALYSES
DIN 50 929

Date received: 2023-05-12
Project number: 1000
Report number: 120368
Date completed: 2023-06-02
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Address: 11 Gooderson Rd, Blackheath, Cape Town
Telephone: 021 905 0503
Contact person: Frank Coetzee
Email: geotech@steynwilson.co.za
Cell: ---

Analyses in mg/ℓ	Method Identification	Sample Identification: Macassar	
		STP06 0-0.9	STP09 2.0-3.0
Sample Number		**23-6487**	**23-6488**
Leachate used	WLAB075	**Distilled Water**	**Distilled Water**
Mass Used (g)	---	**500**	**500**
Volume Used (mℓ)	---	**1000**	**1000**
pH Value at 25°C	WLAB001	6.7	8.8
Electrical Conductivity in mS/m at 25°C	WLAB002	664	30.4
Resistivity (ohm.cm) (calc)	WLAB068	151	3 289
Alkalinity as $CaCO_3$	WLAB007	108	32
Acidity as $CaCO_3$	WLAB022	84	12
Chloride as Cl	WLAB046	134	29
Water Soluble Sulphate as SO_4	WLAB046	1 473	21
Acid Soluble Sulphate as SO_4 *	----	3 591	241
Sulphide as S^{2-} *	WLAB035	0.7	0.2
% Moisture *	WLAB078	33.9	21.1

S. Laubscher _____
Technical Signatory

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STEYN-WILSON LABORATORIES

CIVIL ENGINEERING TESTING LABORATORIES

sanas Testing Laboratory T0835

11 Gooderson Road Blackheath
PO Box 58 Blackheath 7581
Tel: 021 905 0435
Fax: 086 499 9482
Email: info@steynwilson.co.za
Web: www.steynwilson.co.za

Client: **GCS Geotechnical (Pty) Ltd**

Project: Macassar WWTW

Attention: Hendre Human

Your Ref. No: -

Date Reported 11/05/23

TEST REPORT REFERENCE NUMBER / JOB NUMBER : SWL27781

Dear Sir / Madam

Herewith please find the original reports pertaining to the above mentioned project.

Test Requested

4 x FOUNDATION INDICATOR

3 x PH

3 x CONDUCTIVITY

2 x ORGANIC IMPURITIES

1 x METHYLENE BLUE

FINAL REPORT

Site Sampling and Materials Information

Sampling Method	*Specimens delivered to Steyn Wilson Laboratory.*
Environmental Condition	*Sunny*
Deviation from the prescribed test method	*No deviation from standard test method.*
Responsibility of information disclaimer	*The sample information was received from the customer. Results apply to the sample as received from the Customer.*

We would like to take this opportunity to thank you for your valued support.
Should you have any further enquiries please don't hesitate to contact me.

Yours Faithfully
STEYN-WILSON LABORATORIES (PTY) LTD

Mr. R.Wilson
Technical Signatory

Remarks:

1. Information contained herein is confidential to STEYN-WILSON PTY LTD and the addressee
2. Opinions & Interpretations are not included in our schedule of Accreditation.
3. The samples where subjected and analysed according to ASTM.
4. The results reported relate only to the sample tested, Further use of the attached information is not the responsibility or liability of STEYN-WILSON LABORATORIES (PTY) LTD.
5. This document is the correct record of all measurements made, and may not be reproduced other than with full written approval from a director of STEYN-WILSON LABORATORIES (PTY) LTD.
6. Measuring equipment is traceable to national standards (Where applicable).
7. Should there be any deviation from the prescribed test method comments will be made thereof, pertaining to the test on the relevant materials report.
8. Uncertainty of measurement is calculated and corresponds to a coverage probability of approximately 95%. Available on request.
9. The decision rule states that the measurement of uncertainty can be applied by the customer to the test results, on request. It is not the responsibility or liability of STEYN-WILSON LABORATORIES (PTY) LTD.

DIRECTORS: **Mr. J. Steyn ND-Civil (Managing) | Mr. R. Wilson B-Tech Civil (Operations)**

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Web: www.steynwilson.co.za

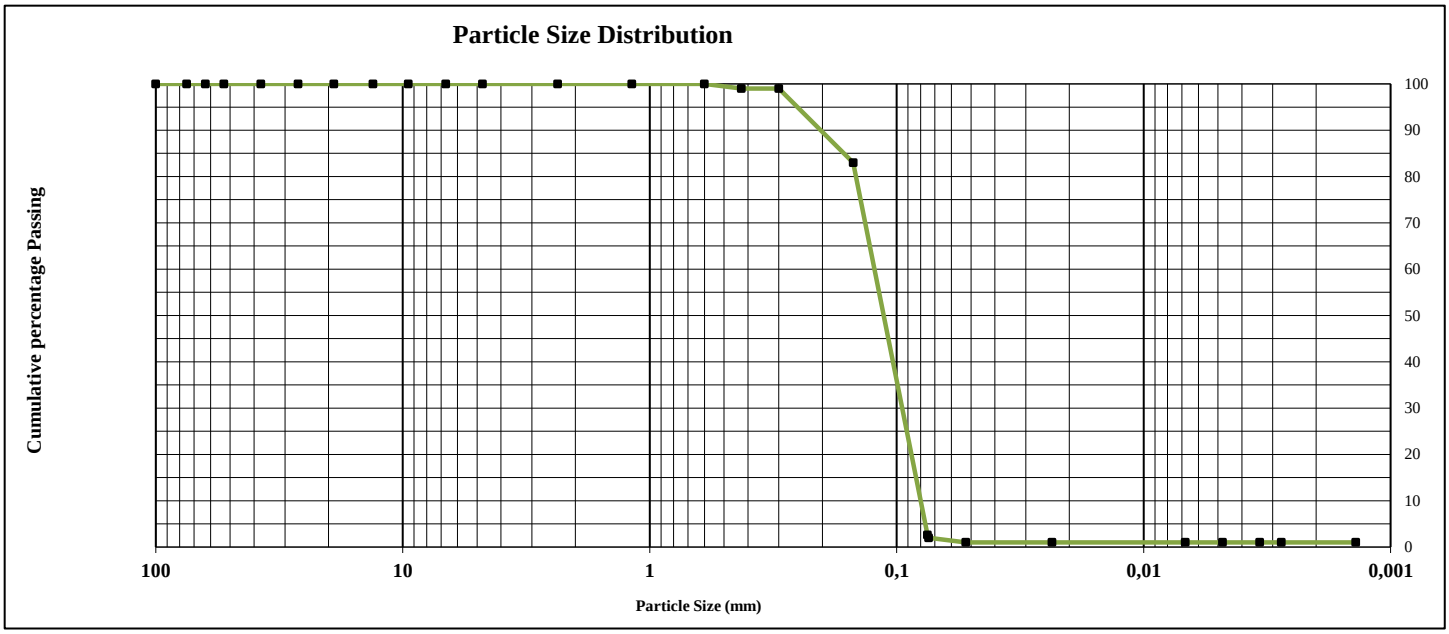
Customer :	**GCS Geotechnical (Pty) Ltd**	Project :	Macassar WWTW
	63 Wessel Road	Date Received :	28/04/23
	Rivonia	Date Reported :	11/05/23
	2128	Req. Number :	-
Attention :	Hendre Human	Date Sampled:	28/04/23

FOUNDATION INDICATOR ASTM D422

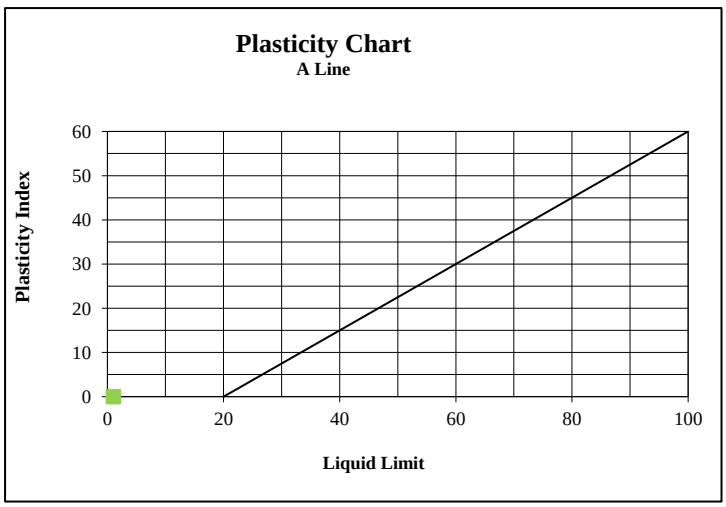
Material Description:	Yellow-White Speckled Black Silty SAND. TOPSOIL	Sample Number:		27781 / 1		
Position:	STP01 - 1S	Liquid Limit	Cassgranda SANS 3001 GR12	**NP**	Linear Shrinkage	**0,0**
Depth:	0-0.8m	Plasticity Index		**NP**	Insitu M/C%	**7,1**

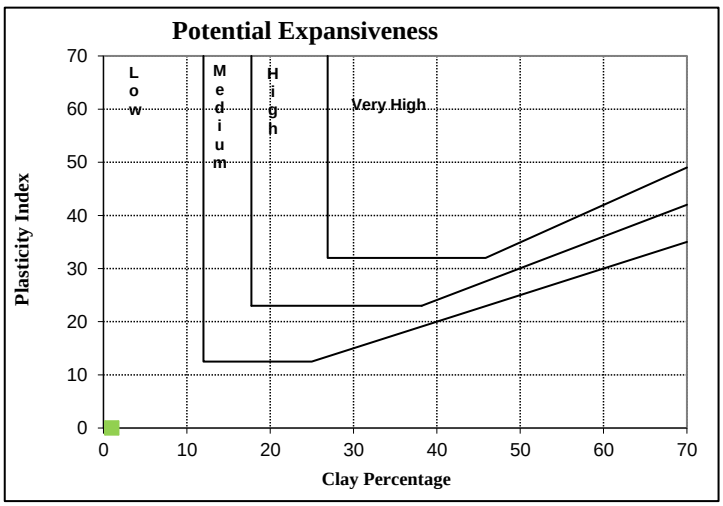
PH		EC		Methylene Blue		Organic Impurities		SG	2,615

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	0,074	0,052	0,023	0,007	0,005	0,003	0,003	0,001
100	100	100	100	100	100	100	100	100	100	100	100	100	100	99	99	83	2,6	2	1	1	1	1	1	1	1
% Passing																									



% Gravel		% Sand	98	% Silt	1	% Clay	1





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Web: www.steynwilson.co.za

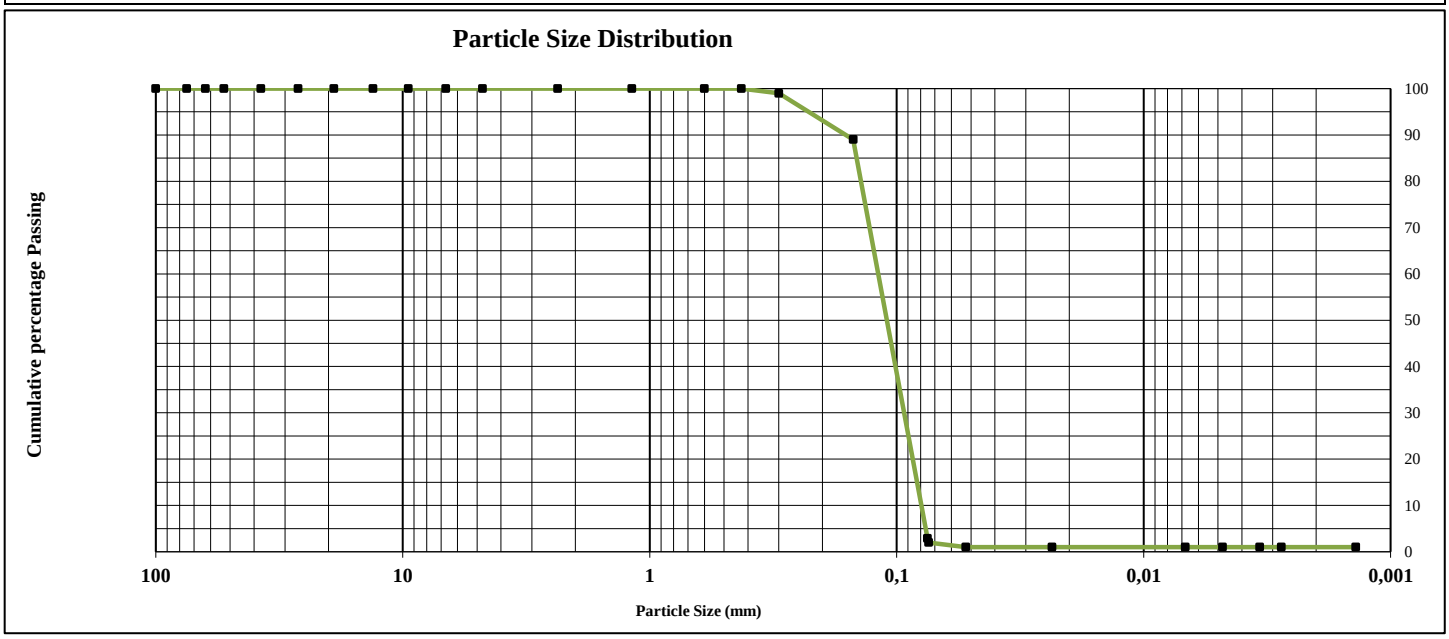
Customer :	**GCS Geotechnical (Pty) Ltd**	Project :	Macassar WWTW
	63 Wessel Road	Date Received :	28/04/23
	Rivonia	Date Reported :	11/05/23
	2128	Req. Number :	-
Attention :	Hendre Human		

FOUNDATION INDICATOR ASTM D422

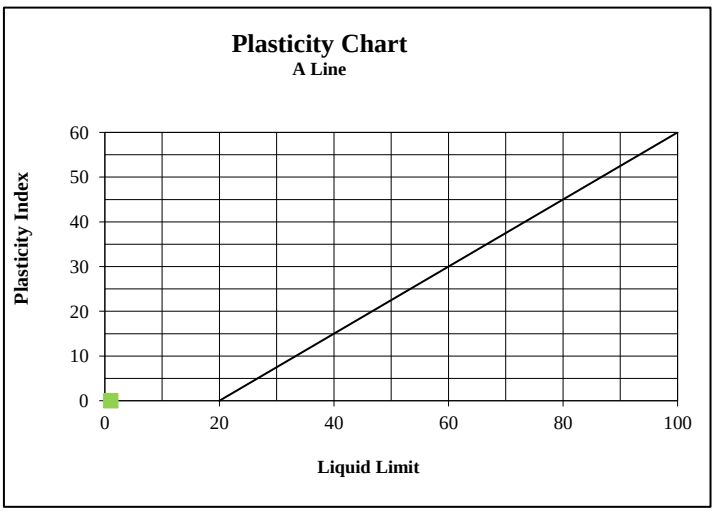
Material Description:	Yellow- White to Light Brown Silty SAND. TRANSPORTED AEOLIAN	Sample Number:	27781 / 3		
Position:	STP03 - 1S	Liquid Limit (Cassgranda SANS 3001 GR12)	**NP**	Linear Shrinkage	**0,0**
Depth:	0.6 - 3.0m	Plasticity Index	**NP**	Insitu M/C%	**4,5**

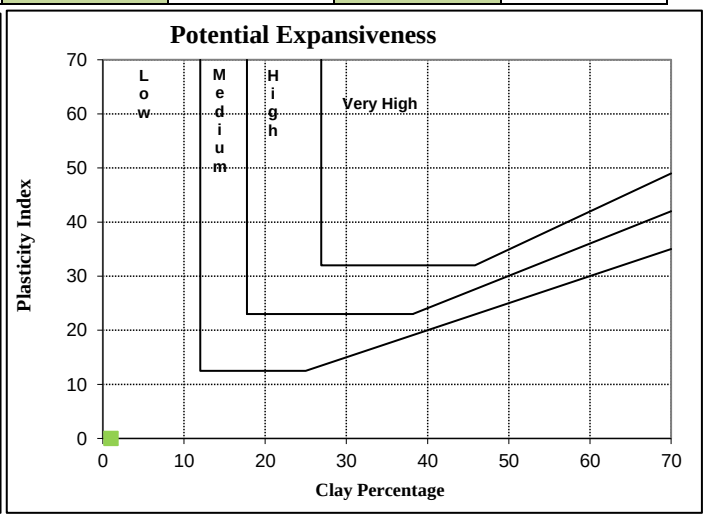
PH	EC	Methylene Blue	Organic Impurities	SG
8,0	0.013	0.2		2,604

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	0,074	0,052	0,023	0,007	0,005	0,003	0,003	0,001
100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	99	89	2,9	2	1	1	1	1	1	1	1
% Passing																									



% Gravel		% Sand	97	% Silt	2	% Clay	1





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Web: www.steynwilson.co.za

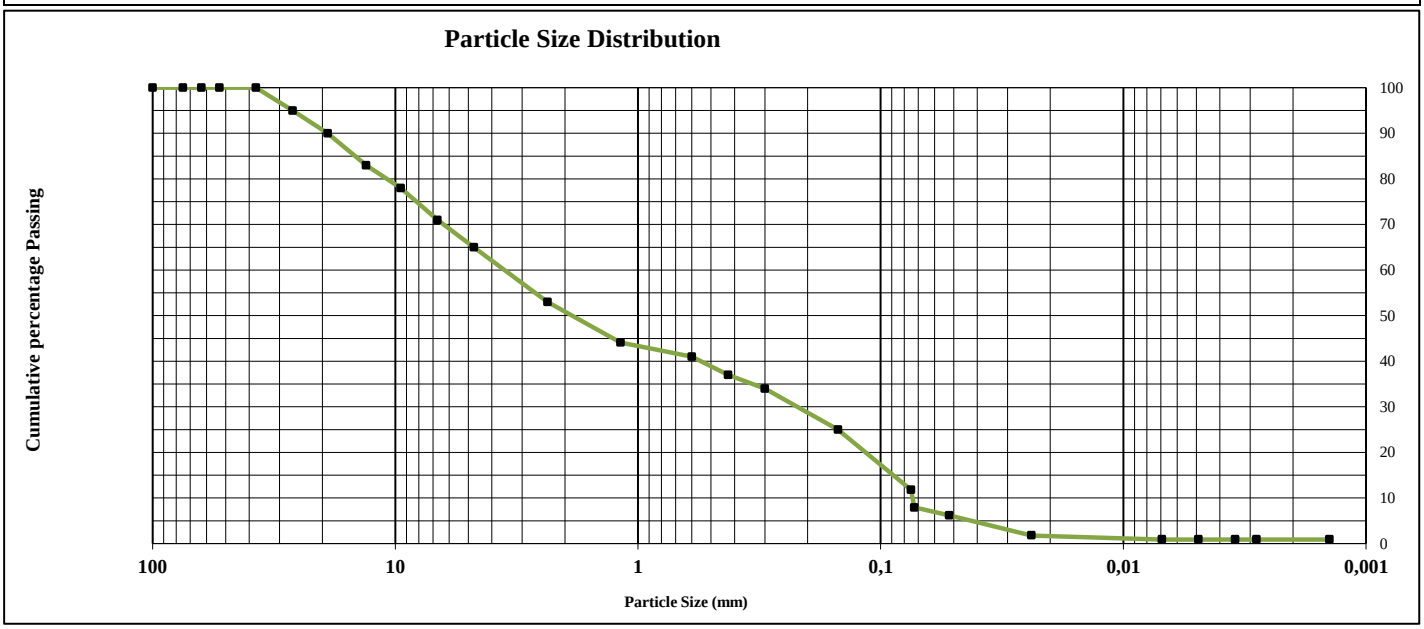
Customer :	**GCS Geotechnical (Pty) Ltd**	Project :	Macassar WWTW
	63 Wessel Road	Date Received :	28/04/23
	Rivonia	Date Reported :	11/05/23
	2128	Req. Number :	-
Attention :	Hendre Human		

FOUNDATION INDICATOR ASTM D422

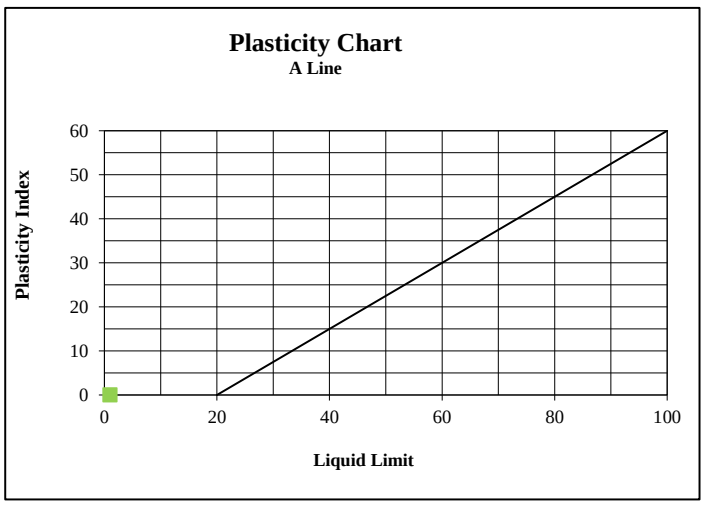
Material Description:	Dark Brown to Brown Clayey Silty SAND. DOMESCTIC FILL	Sample Number:	27781 / 4		
Position:	STP06 - 1S	Liquid Limit (Cassgranda SANS 3001 GR12)	**NP**	Linear Shrinkage	**0,0**
Depth:	0-0.9m	Plasticity Index	**NP**	Insitu M/C%	**25,6**

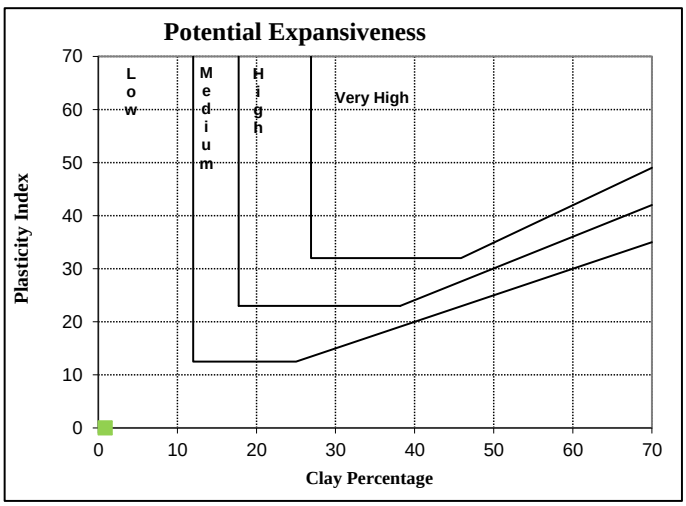
PH	6,2	EC	0.043	Methylene Blue		Organic Impurities	Equal to Standard Solution	SG	2,64

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	0,073	0,052	0,024	0,007	0,005	0,003	0,003	0,001
100	100	100	100	100	95	90	83	78	71	65	53	44,1	41	37	34	25	11,8	7,938	6,174	1,764	0,882	0,882	0,882	0,882	0,882
% Passing																									



% Gravel	35	% Sand	55	% Silt	9	% Clay	1





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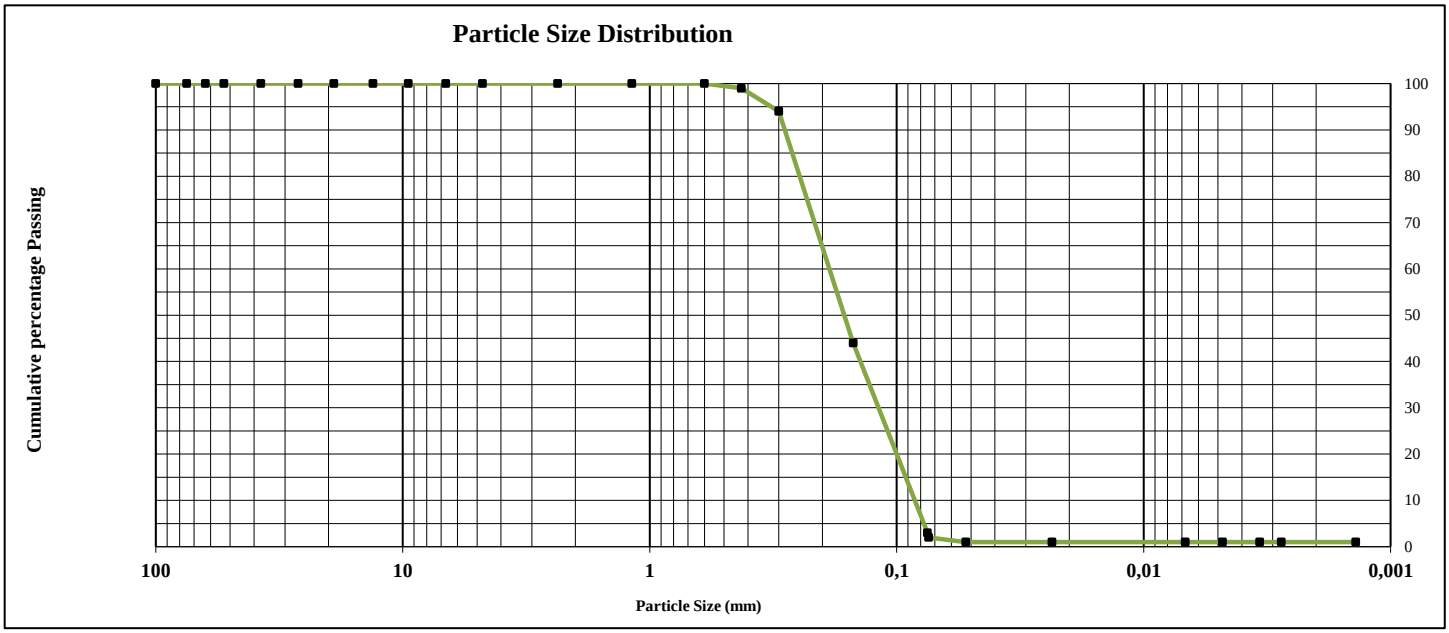
Customer :	**GCS Geotechnical (Pty) Ltd**	Project :	Macassar WWTW
	63 Wessel Road	Date Received :	28/04/23
	Rivonia	Date Reported :	11/05/23
	2128	Req. Number :	-
Attention :	Hendre Human		

FOUNDATION INDICATOR ASTM D422

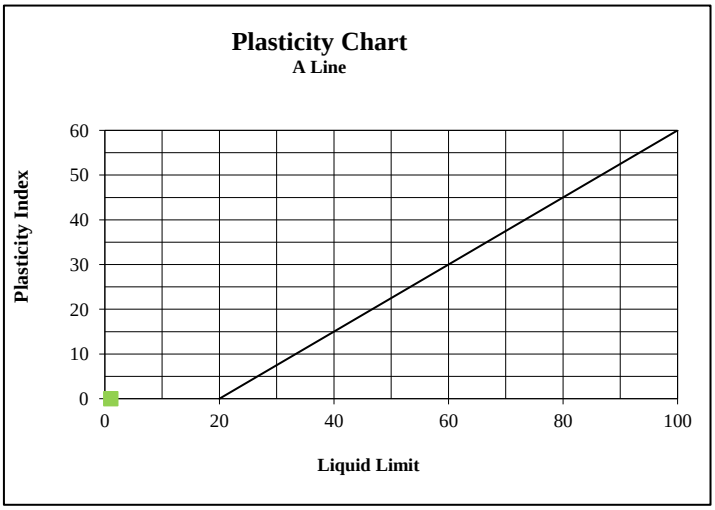
Material Description:	STP09 - 1S	Sample Number:		27781 / 5		
Position:	Greyish-Brown Silty SAND. TRANSPORTED ESTUARINE	Liquid Limit	Cassgranda SANS 3001 GR12	**NP**	Linear Shrinkage	**0,0**
Depth:	2.0-3.0m	Plasticity Index		**NP**	Insitu M/C%	**21,6**

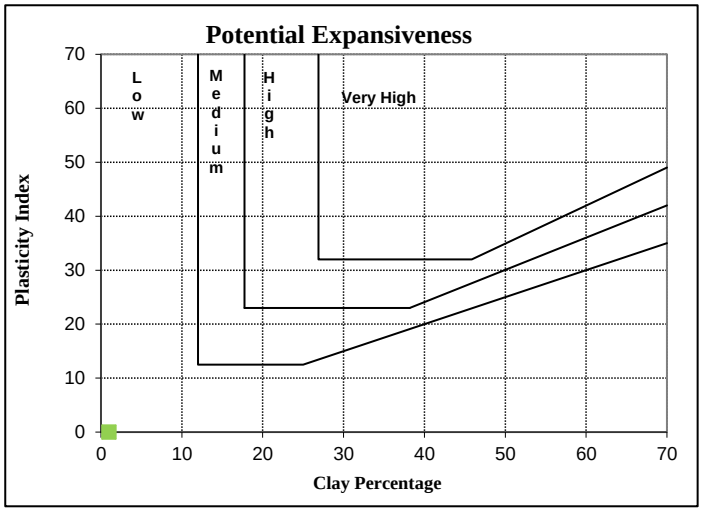
PH	7,5	EC	0.026	Methylene Blue		Organic Impurities	Lighter Than Standard Solution	SG	2,626

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	0,074	0,052	0,023	0,007	0,005	0,003	0,003	0,001
100	100	100	100	100	100	100	100	100	100	100	100	100	100	99	94	44	3	2	1	1	1	1	1	1	1
% Passing																									



% Gravel		% Sand	97	% Silt	2	% Clay	1





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Email: info@steynwilson.co.za
Web: www.steynwilson.co.za

Client: **GCS Geotechnical (Pty) Ltd**

Project: Macassar WWTW

Attention: Hendre Human

Your Ref. No: -

Date Reported 11/05/23

TEST REPORT REFERENCE NUMBER / JOB NUMBER : SWL27781

Dear Sir / Madam

Herewith please find the original reports pertaining to the above mentioned project.

Test Requested

4 x FOUNDATION INDICATOR

3 x PH

3 x CONDUCTIVITY

2 x ORGANIC IMPURITIES

1 x METHYLENE BLUE

FINAL REPORT

Site Sampling and Materials Information

Sampling Method	*Specimens delivered to Steyn Wilson Laboratory.*
Environmental Condition	*Sunny*
Deviation from the prescribed test method	*No deviation from standard test method.*
Responsibility of information disclaimer	*The sample information was received from the customer. Results apply to the sample as received from the Customer.*

We would like to take this opportunity to thank you for your valued support.
Should you have any further enquiries please don't hesitate to contact me.

Yours Faithfully
STEYN-WILSON LABORATORIES (PTY) LTD

Mr. R.Wilson
Technical Signatory

Remarks:

1. Information contained herein is confidential to STEYN-WILSON PTY LTD and the addressee
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9. The decision rule states that the measurement of uncertainty can be applied by the customer to the test results, on request. It is not the responsibility or liability of STEYN-WILSON LABORATORIES (PTY) LTD.

DIRECTORS: **Mr. J. Steyn ND-Civil (Managing) | Mr. R. Wilson B-Tech Civil (Operations)**

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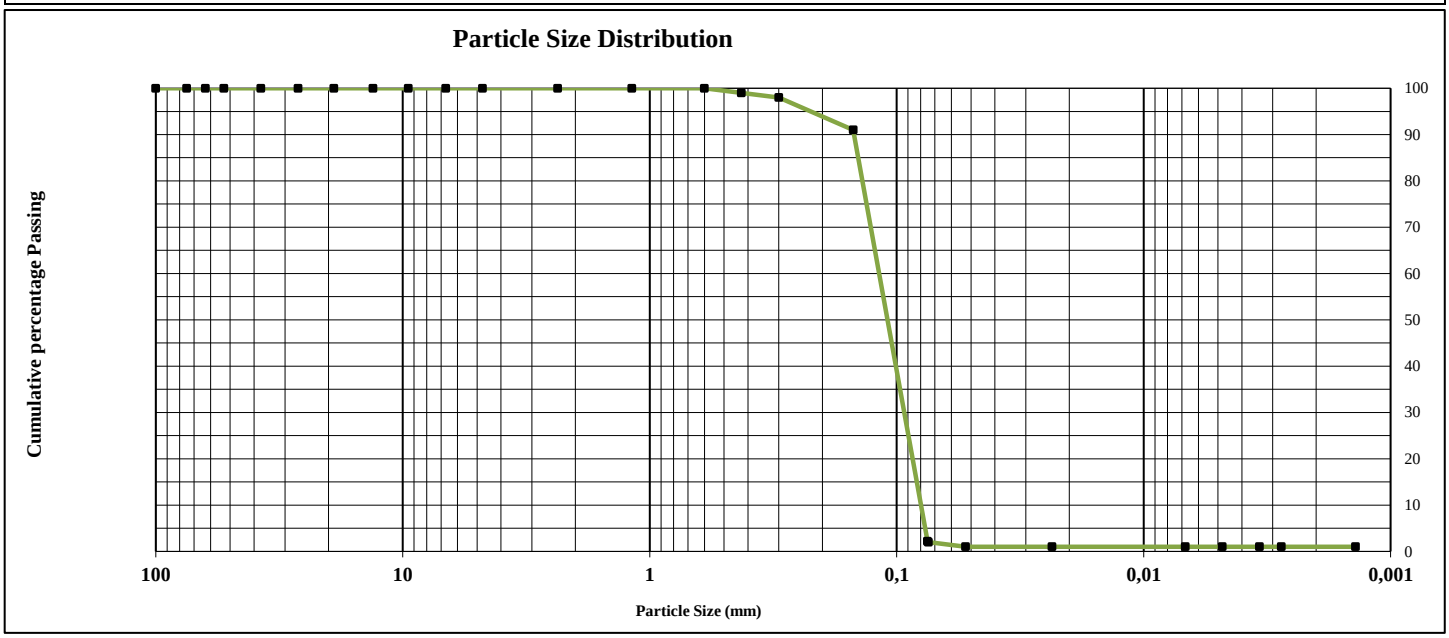
Customer :	**GCS Geotechnical (Pty) Ltd**	Project :	Macassar WWTW
	63 Wessel Road	Date Received :	28/04/23
	Rivonia	Date Reported :	11/05/23
	2128	Req. Number :	-
Attention :	Hendre Human	Date Sampled:	28/04/23

FOUNDATION INDICATOR ASTM D422

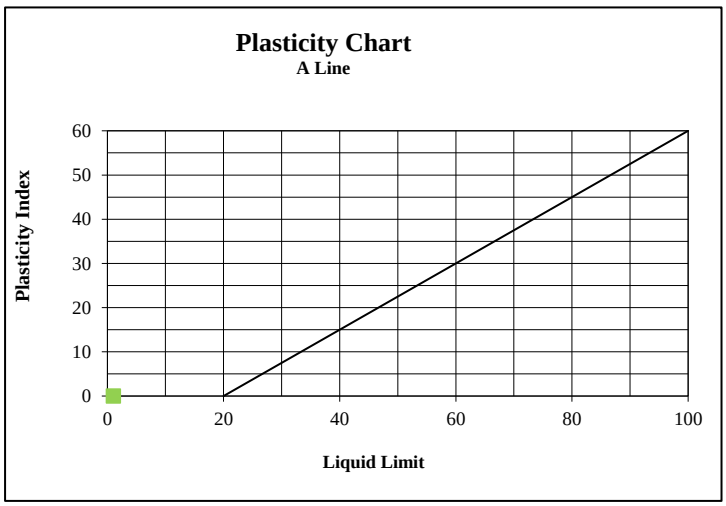
Material Description:	Yellow-White to Light Brown Silty SAND. TRANSPORTED AEOLIAN	Sample Number:		27781 / 6		
Position:	DTP01 - 1S	Liquid Limit	Cassgranda SANS 3001 GR12	**NP**	Linear Shrinkage	**0,0**
Depth:	0.6-3.0m	Plasticity Index		**NP**	Insitu M/C%	**6**

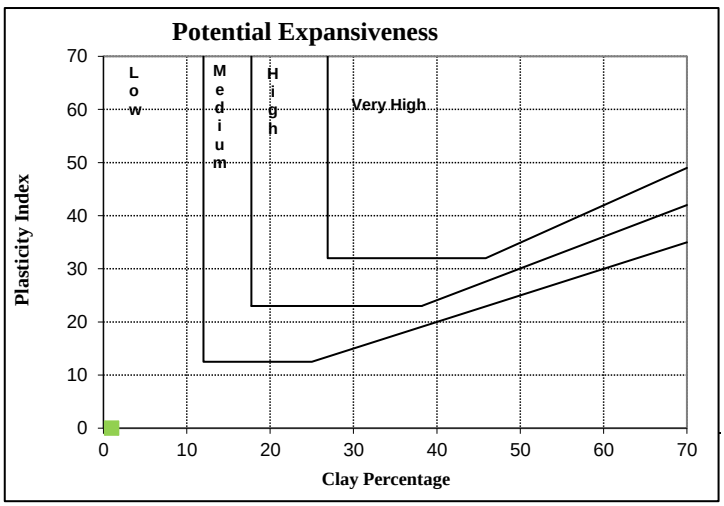
PH		EC		Methylene Blue		Organic Impurities		SG	2,615

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	0,074	0,053	0,023	0,007	0,005	0,003	0,003	0,001
100	100	100	100	100	100	100	100	100	100	100	100	100	100	99	98	91	2,2	2	1	1	1	1	1	1	1
% Passing																									



% Gravel		% Sand	98	% Silt	1	% Clay	1





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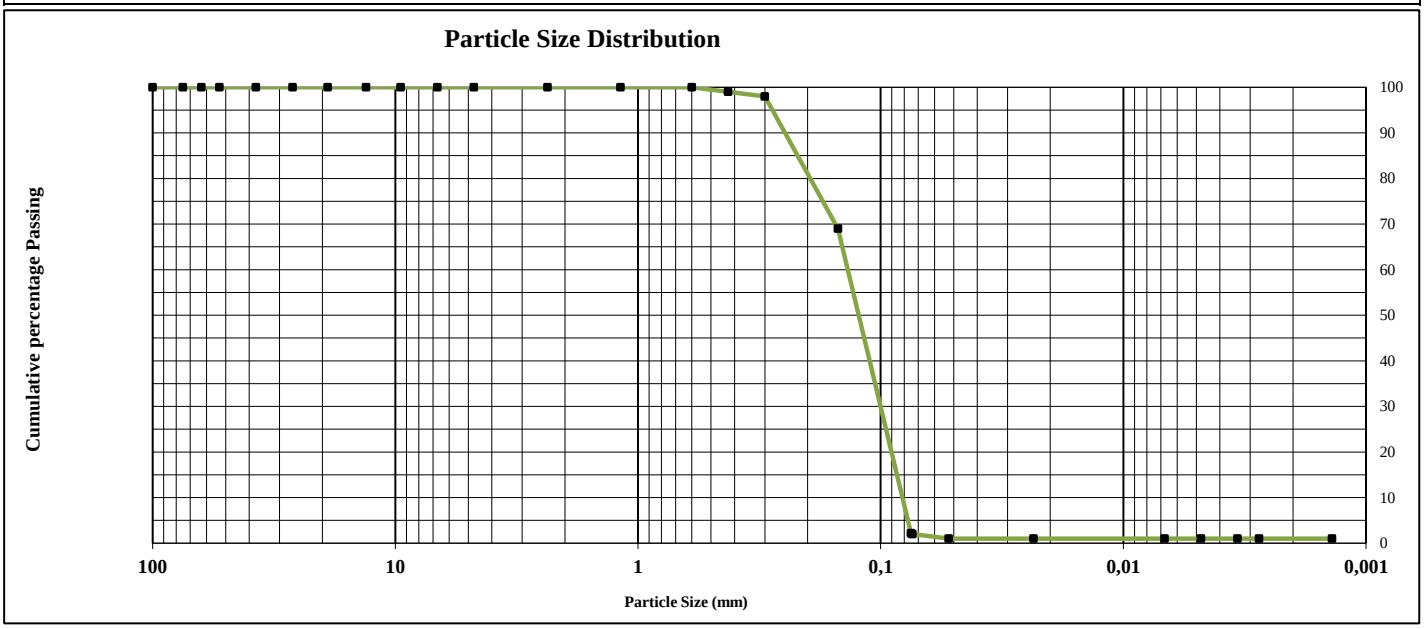
Customer :	**GCS Geotechnical (Pty) Ltd**	Project :	Macassar WWTW
	63 Wessel Road	Date Received :	28/04/23
	Rivonia	Date Reported :	11/05/23
	2128	Req. Number :	-
Attention :	Hendre Human		

FOUNDATION INDICATOR ASTM D422

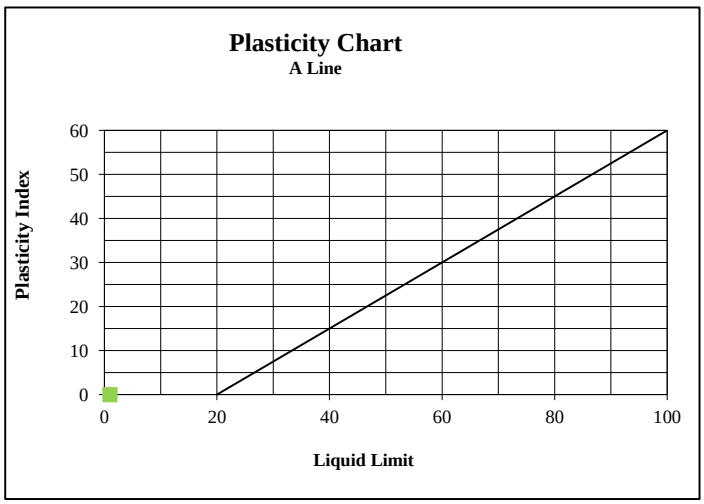
Material Description:	Yellow- White to Light Brown Silty SAND. TRANSPORTED AEOLIAN	Sample Number:	27781 / 8			
Position:	DTP02 - 1S	Liquid Limit Cassgranda SANS 3001 GR12	**NP**	Linear Shrinkage	**0,0**	
Depth:	0.5 - 3.0m	Plasticity Index	**NP**	Insitu M/C%	**4,5**	

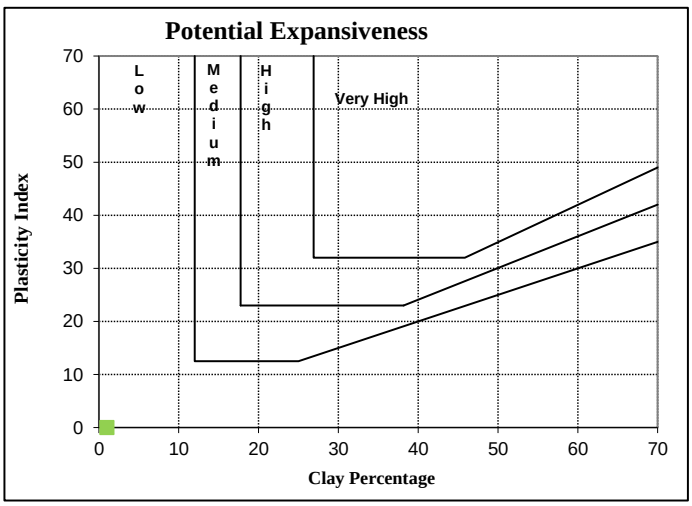
PH	7,3	EC	0,049	Methylene Blue		Organic Impurities	Lighter Than Standard Solution	SG	2,706

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	0,074	0,052	0,023	0,007	0,005	0,003	0,003	0,001
100	100	100	100	100	100	100	100	100	100	100	100	100	100	99	98	69	2,2	2	1	1	1	1	1	1	1
% Passing																									



% Gravel		% Sand	98	% Silt	1	% Clay	1





NOTE: All tests marked with (*) means that those test methods are not accredited.

STEYN-WILSON LABORATORIES
CIVIL ENGINEERING TESTING LABORATORIES

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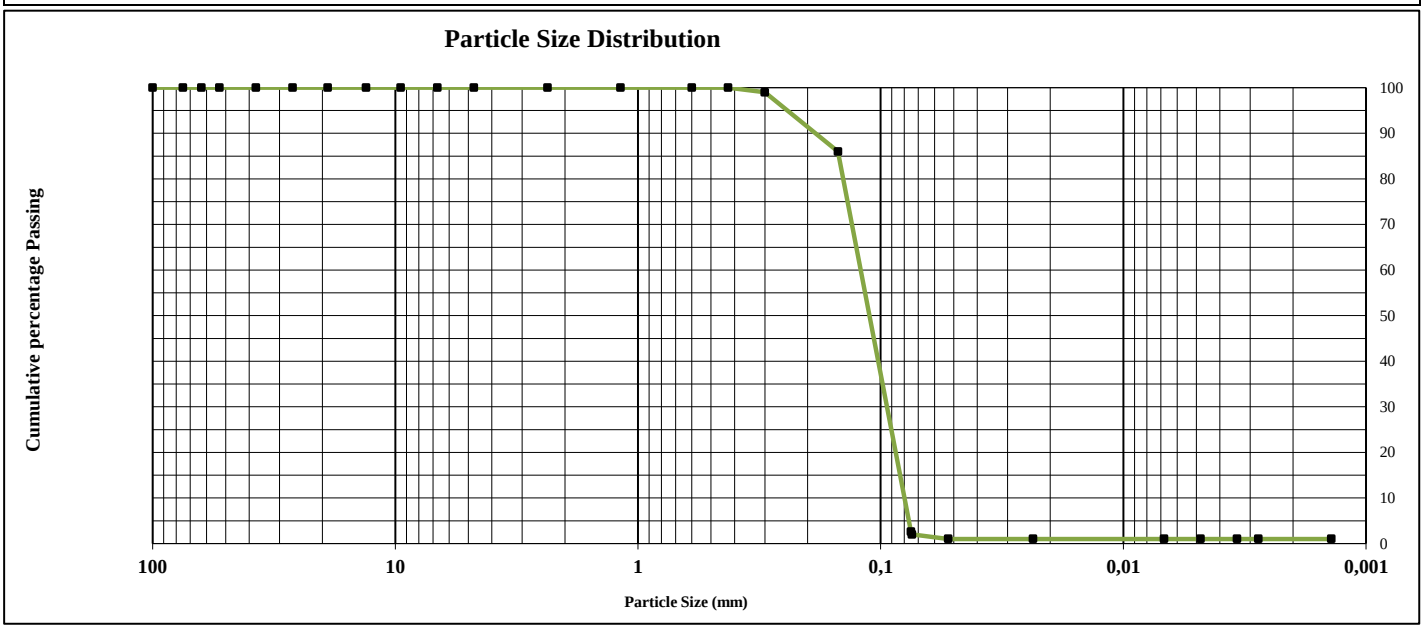
Customer :	**GCS Geotechnical (Pty) Ltd**	Project :	Macassar WWTW
	63 Wessel Road	Date Received :	28/04/23
	Rivonia	Date Reported :	11/05/23
	2128	Req. Number :	-
Attention :	Hendre Human		

FOUNDATION INDICATOR ASTM D422

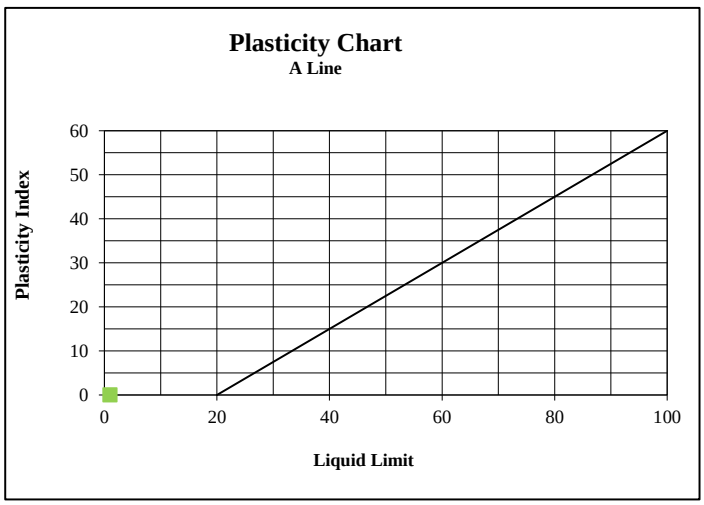
Material Description:	Yellow- White to Light Brown Silty SAND. TRANSPORTED AEOLIAN	Sample Number:	27781 / 9		
Position:	DTP06 - 1S	Liquid Limit (Cassgranda SANS 3001 GR12)	**NP**	Linear Shrinkage	**0,0**
Depth:	0.5-3.0m	Plasticity Index	**NP**	Insitu M/C%	**6,1**

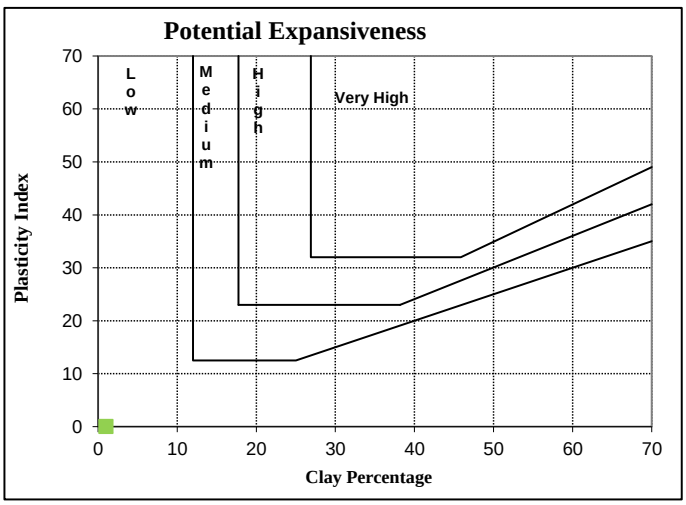
PH	EC	Methylene Blue	Organic Impurities	SG
7,7	0.012	0.2		2,612

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	0,074	0,053	0,024	0,007	0,005	0,003	0,003	0,001
100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	99	86	2,6	2	1	1	1	1	1	1	1
% Passing																									



% Gravel		% Sand	98	% Silt	1	% Clay	1





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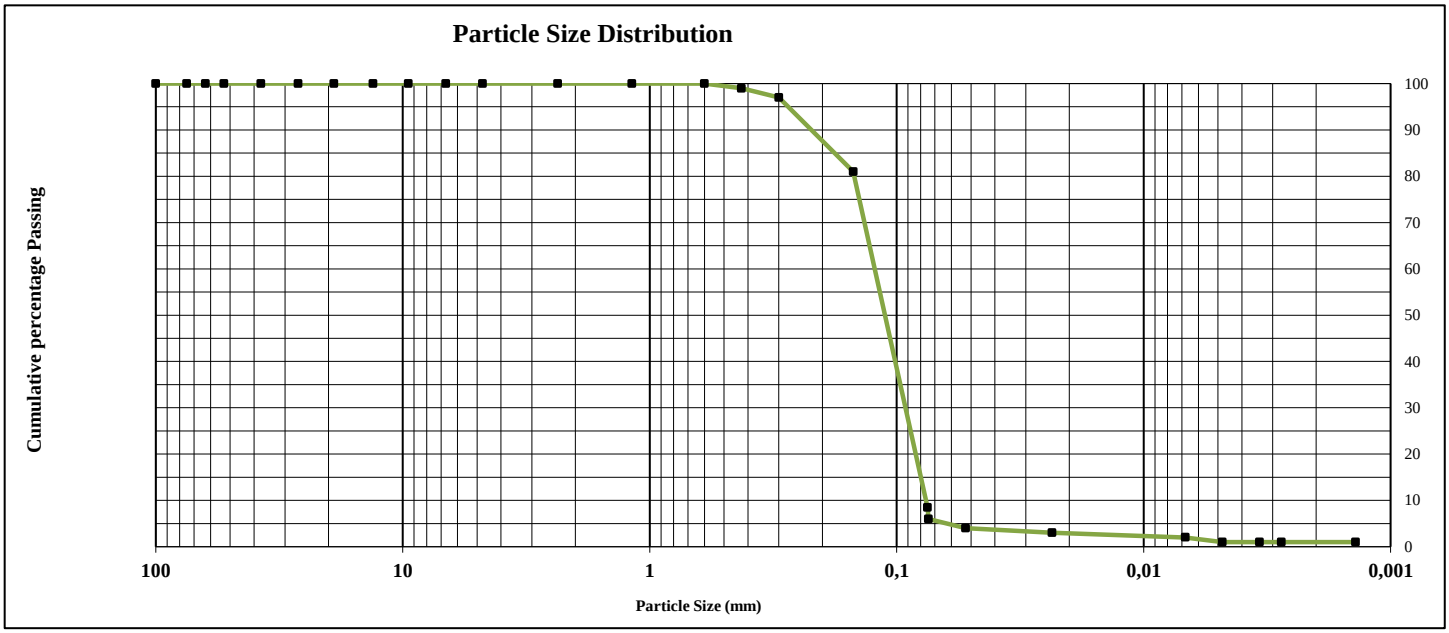
Customer :	**GCS Geotechnical (Pty) Ltd**	Project :	Macassar WWTW
	63 Wessel Road	Date Received :	28/04/23
	Rivonia	Date Reported :	11/05/23
	2128	Req. Number :	-
Attention :	Hendre Human		

FOUNDATION INDICATOR ASTM D422

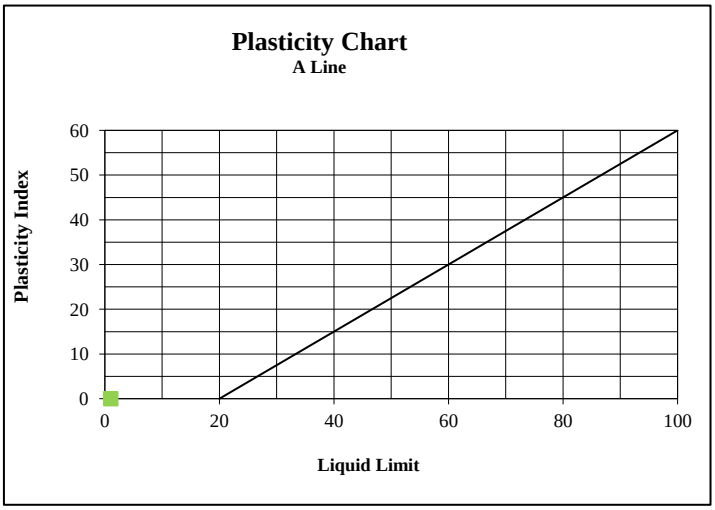
Material Description:	Yellow-White Silty Gravelly SAND. FILL MATERIAL	Sample Number:		27781 / 13		
Position:	DTP24 - 1S	Liquid Limit	Cassgranda SANS 3001 GR12	**NP**	Linear Shrinkage	**0,0**
Depth:	0-1.3m	Plasticity Index		**NP**	Insitu M/C%	**21,6**

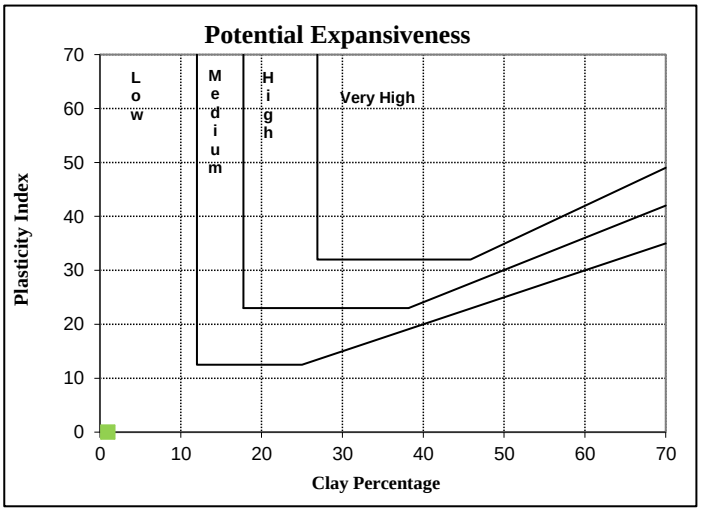
PH	EC	Methylene Blue	Organic Impurities	SG
7,4	0.019		Equal Than Standard Solution	2,564

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	0,074	0,053	0,023	0,007	0,005	0,003	0,003	0,001
100	100	100	100	100	100	100	100	100	100	100	100	100	100	99	97	81	8,5	6	4	3	2	1	1	1	1
% Passing																									



% Gravel		% Sand	93	% Silt	6	% Clay	1





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Email: info@steynwilson.co.za
Web: www.steynwilson.co.za

Client:	**GCS Geotechnical (Pty) Ltd**
Project:	Macassar WWTW
Attention:	Hendre Human
Your Ref. No:	-
Date Reported	11/05/23

TEST REPORT REFERENCE NUMBER / JOB NUMBER : SWL27781

Dear Sir / Madam

Herewith please find the original reports pertaining to the above mentioned project.

Test Requested

1 x MDD / CBR

1 x COMPACTIBILITY

Site Sampling and Materials Information

Sampling Method	*Sampled by CLIENT*
Enviromental Condition	*Sunny*
Deviation from the prescribed test method	*No deviation from standard test method.*
Responsibility of information disclaimer	*The sample information was received from the customer. Results apply to the sample as received from the Customer.*

FINAL REPORT

We would like to take this opportunity to thank you for your valued support.
Should you have any further enquiries please don't hesitate to contact me.

Yours Faithfully
STEYN-WILSON LABORATORIES (PTY) LTD

Mr. R.Wilson
Technical Signatory

Remarks:

1. Information contained herein is confidential to STEYN-WILSON PTY LTD and the addressee
2. Opinions & Interpretations are not included in our schedule of Accreditation.
3. The samples where subjected and analysed according to SANS 3001.
4. The results reported relate only to the sample tested, Further use of the attached information is not the responsibility or liability of STEYN-WILSON LABORATORIES (PTY) LTD.
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6. Measuring equipment is traceable to national standards (Where applicable).
7. Should there be any deviation from the prescribed test method comments will be made thereof, pertaining to the test on the relevant materials report.
8. Uncertainty of measurement is calculated and corresponds to a coverage probability of approximately 95%. Available on request.
9. The decision rule states that the measurement of uncertainty can be applied by the customer to the test results, on request. It is not the responsibility or liability of STEYN-WILSON LABORATORIES (PTY) LTD.

DIRECTORS: **Mr. J. Steyn ND-Civil (Managing) | Mr. R. Wilson B-Tech Civil (Operations)**

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CIVIL ENGINEERING TESTING LABORATORIES

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Web: www.steynwilson.co.za

JOB NO:	SWL27781	Your Ref	-	Date	11/05/23

CLIENT: GCS Geotechnical (Pty) Ltd
63 Wessel Road
Rivonia
2128

ATTENTION: Hendre Human

PROJECT: Macassar WWTW
BALANCE: AC1/0004
OVEN: AB1/0001
AUTO COMPACTOR: AD1/0005
CBR PRESS: AA1/0001

CBR REPORT - TMH5 MD1, MD2 / SANS 3001 GR1, PR5, GR10, GR12, GR20, GR30, GR40, AG10, AG4, AG14, TMH1 A20, TMH1 A21T, *COTO, SANS 3001 AG20/21

The unambiguous description of the sample/s as received are as follows :

SAMPLE No.			27781 / 2	SPEC				
HOLE No. / SV. / CHAINAGE			STP01 - 2B					
ROAD No. OR NAME			-					
LAYER TESTED / SAMPLED FROM			0.8-3.0m					
DATE RECEIVED			28/04/23					
CLIENTS MARKING			-					
DESCRIPTION OF SAMPLE (COLOUR & TYPE)			Yellow-White to Light Brown Silty SAND. TRANSPORTED AEOLIAN					
REDUCTION FACTOR / RF CHECK				< 1%				
SIEVE ANALYSIS (mm) SANS 3001 GR1	100,0							
	75,0							
	63,0							
	53,0							
	37,5							
	28,0							
	20,0							
	14,0							
	5,00							
	2,00							
	0,425							
	0,075							
ACV	SANS AG10	%						
10 % FACT		kN						
10 % FACT Wet / Dry ratio		%						
FLAKINESS INDEX	SANS AG4	%						
FRACTURED FACES	*COTO	%						
ATTERBERG LIMITS SANS 3001 GR10, GR12	LL% - 0,425mm							
	P.I. - 0,425mm							
	LS% - 0,425mm							
	P.I. - 0,075mm							
	GM							
SOIL-MORTAR PERCENTAGES SANS 3001 PR5	Coarse sand							
	Fine sand							
	Coarse fine sand							
	Medium fine sand							
	Fine fine sand							
	Silt and clay							
	Coarse sand ratio							
MOD AASHTO SANS 3001 GR30	OMC	%	14,2					
	MDD	(kg/m³)	1523					
APPARENT & BULK DENSITY / WATER ABSORPTION SANS 3001 AG20/21	AD	(kg/m³)						
	BD	(kg/m³)						
	WA	%						
C.B.R. SANS 3001 GR40	COMP MC	%	14,1					
	SWELL	%	0,0					
	100%		22					
	98%		19					
	97%		17					
	95%		15					
	93%		13					
	90%		11					
pH	TMH1 A20	%						
Conductivity	TMH1 A21T	(S/m)						
Water Soluble Sulfates	*SANS 5850-1	%						
Compactibility	*SABS 0120		0,429					
Durability Mill Index (max)	SANS AG16	-						
% passing 0,425mm sieve after Test		%						

***NOTE** : All tests marked with (*) means that those test methods are not accredited.*

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Web: www.steynwilson.co.za

Client:	**GCS Geotechnical (Pty) Ltd**
Project:	Macassar WWTW
Attention:	Hendre Human
Your Ref. No:	-
Date Reported	11/05/23

TEST REPORT REFERENCE NUMBER / JOB NUMBER : SWL27781

Dear Sir / Madam

Herewith please find the original reports pertaining to the above mentioned project.

Test Requested

3 x MDD / CBR

3 x COMPACTIBILITY

2 x METHYLENE BLUE ABSORPTION

Site Sampling and Materials Information

Sampling Method	*Sampled by CLIENT*
Enviromental Condition	*Sunny*
Deviation from the prescribed test method	*No deviation from standard test method.*
Responsibility of information disclaimer	*The sample information was received from the customer. Results apply to the sample as received from the Customer.*

FINAL REPORT

We would like to take this opportunity to thank you for your valued support.
Should you have any further enquiries please don't hesitate to contact me.

Yours Faithfully
STEYN-WILSON LABORATORIES (PTY) LTD

Mr. R.Wilson
Technical Signatory

Remarks:

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8. Uncertainty of measurement is calculated and corresponds to a coverage probability of approximately 95%. Available on request.
9. The decision rule states that the measurement of uncertainty can be applied by the customer to the test results, on request. It is not the responsibility or liability of STEYN-WILSON LABORATORIES (PTY) LTD.

DIRECTORS: **Mr. J. Steyn ND-Civil (Managing) | Mr. R. Wilson B-Tech Civil (Operations)**

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JOB NO:	SWL27781	Your Ref	-	Date	11/05/23

CLIENT: GCS Geotechnical (Pty) Ltd
63 Wessel Road
Rivonia
2128

ATTENTION: Hendre Human

PROJECT: Macassar WWTW
BALANCE: AC1/0004
OVEN: AB1/0001
AUTO COMPACTOR: AD1/0005
CBR PRESS: AA1/0001

CBR REPORT - TMH5 MD1, MD2 / SANS 3001 GR1, PR5, GR10, GR12, GR20, GR30, GR40, AG10, AG4, AG14, TMH1 A20, TMH1 A21T, *COTO, SANS 3001 AG20/21

The unambiguous description of the sample/s as received are as follows :

SAMPLE No.			27781 / 7	SPEC	27781 / 10	SPEC	27781 / 11	SPEC
HOLE No. / SV. / CHAINAGE			DTP01 - 2B		DTP12 - 2B		DTP16 - 2B	
ROAD No. OR NAME			-		-		-	
LAYER TESTED / SAMPLED FROM			0.6-3.0m		2.5 - 3.0m		0.4 - 3.0m	
DATE RECEIVED			28/04/23		28/04/23		28/04/23	
CLIENTS MARKING			-		-		-	
DESCRIPTION OF SAMPLE (COLOUR & TYPE)			Yellow-White to Light Brown Silty SAND. TRANSPORTED AEOLIAN		Greyish-Brown Silty SAND. TRANSPORTED ESRUARINE		Yellow-White to Light Brown Silty SAND. TRANSPORTED AEOLIAN	
REDUCTION FACTOR / RF CHECK				< 1%		< 1%		< 1%
SIEVE ANALYSIS (mm) SANS 3001 GR1	100,0							
	75,0							
	63,0							
	53,0							
	37,5							
	28,0							
	20,0							
	14,0							
	5,00							
	2,00							
	0,425							
	0,075							
ACV	SANS AG10	%						
10 % FACT		kN						
10 % FACT Wet / Dry ratio		%						
FLAKINESS INDEX	SANS AG4	%						
FRACTURED FACES	*COTO	%						
ATTERBERG LIMITS SANS 3001 GR10, GR12	LL% - 0,425mm							
	P.I. - 0,425mm							
	LS% - 0,425mm							
	P.I. - 0,075mm							
	GM							
SOIL-MORTAR PERCENTAGES SANS 3001 PR5	Coarse sand							
	Fine sand							
	Coarse fine sand							
	Medium fine sand							
	Fine fine sand							
	Silt and clay							
	Coarse sand ratio							
MOD AASHTO SANS 3001 GR30	OMC	%	14,4		14,5		12,3	
	MDD	(kg/m³)	1505		1541		1537	
APPARENT & BULK DENSITY / WATER ABSORPTION SANS 3001 AG20/21	AD	(kg/m³)						
	BD	(kg/m³)						
	WA	%						
C.B.R. SANS 3001 GR40	COMP MC	%	14,2		14,4		12,2	
	SWELL	%	0,0		0,0		0,0	
	100%		22		18		24	
	98%		18		16		19	
	97%		16		15		17	
	95%		14		13		14	
	93%		11		11		11	
	90%		8		9		7	
pH	TMH1 A20	%						
Conductivity	TMH1 A21T	(S/m)						
Methylene Blue Absorption	SANS 6243	%	0,2		0,2			
Compactibility	*SABS 0120		0,410		0,379		0,400	
Durability Mill Index (max)	SANS AG16	-						
% passing 0,425mm sieve after Test		%						

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Web: www.steynwilson.co.za

Client:	**GCS Geotechnical (Pty) Ltd**
Project:	Macassar WWTW
Attention:	Hendre Human
Your Ref. No:	-
Date Reported	11/05/23

TEST REPORT REFERENCE NUMBER / JOB NUMBER : SWL27781

Dear Sir / Madam

Herewith please find the original reports pertaining to the above mentioned project.

Test Requested

1 x MDD / CBR

Site Sampling and Materials Information

Sampling Method	*Sampled by CLIENT*
Enviromental Condition	*Sunny*
Deviation from the prescribed test method	*No deviation from standard test method.*
Responsibility of information disclaimer	*The sample information was received from the customer. Results apply to the sample as received from the Customer.*

FINAL REPORT

We would like to take this opportunity to thank you for your valued support.
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Mr. R.Wilson
Technical Signatory

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DIRECTORS: **Mr. J. Steyn ND-Civil (Managing) | Mr. R. Wilson B-Tech Civil (Operations)**

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JOB NO:	SWL27781	Your Ref	-	Date	11/05/23

CLIENT: GCS Geotechnical (Pty) Ltd
63 Wessel Road
Rivonia
2128

ATTENTION: Hendre Human

PROJECT: Macassar WWTW
BALANCE: AC1/0004
OVEN: AB1/0001
AUTO COMPACTOR: AD1/0005
CBR PRESS: AA1/0001

CBR REPORT - TMH5 MD1, MD2 / SANS 3001 GR1, PR5, GR10, GR12, GR20, GR30, GR40, AG10, AG4, AG14, TMH1 A20, TMH1 A21T, *COTO, SANS 3001 AG20/21

The unambiguous description of the sample/s as received are as follows :

SAMPLE No.			27781 / 12	SPEC				
HOLE No. / SV. / CHAINAGE			DTP22 - 2B					
ROAD No. OR NAME			-					
LAYER TESTED / SAMPLED FROM			0.9-3.0m					
DATE RECEIVED			28/04/23					
CLIENTS MARKING			-					
DESCRIPTION OF SAMPLE (COLOUR & TYPE)			Yellow-White Blotched Brown Silty SAND. AEOLIAN MATERIAL					
REDUCTION FACTOR / RF CHECK				< 1%				
SIEVE ANALYSIS (mm) SANS 3001 GR1	100,0							
	75,0							
	63,0							
	53,0							
	37,5							
	28,0							
	20,0							
	14,0							
	5,00							
	2,00							
	0,425							
	0,075							
ACV	SANS AG10	%						
10 % FACT		kN						
10 % FACT Wet / Dry ratio		%						
FLAKINESS INDEX	SANS AG4	%						
FRACTURED FACES	*COTO	%						
ATTERBERG LIMITS SANS 3001 GR10, GR12	LL% - 0,425mm							
	P.I. - 0,425mm							
	LS% - 0,425mm							
	P.I. - 0,075mm							
	GM							
SOIL-MORTAR PERCENTAGES SANS 3001 PR5	Coarse sand							
	Fine sand							
	Coarse fine sand							
	Medium fine sand							
	Fine fine sand							
	Silt and clay							
	Coarse sand ratio							
MOD AASHTO SANS 3001 GR30	OMC	%	12,3					
	MDD	(kg/m³)	1543					
APPARENT & BULK DENSITY / WATER ABSORPTION SANS 3001 AG20/21	AD	(kg/m³)						
	BD	(kg/m³)						
	WA	%						
C.B.R. SANS 3001 GR40	COMP MC	%	12,2					
	SWELL	%	0,0					
	100%		24					
	98%		20					
	97%		18					
	95%		14					
	93%		12					
	90%		8					
pH	TMH1 A20	%						
Conductivity	TMH1 A21T	(S/m)						
Water Soluble Sulfates	*SANS 5850-1	%						
Acid Soluble Sulfates	*SANS 5850-2	%						
Durability Mill Index (max)	SANS AG16	-						
% passing 0,425mm sieve after Test		%						

***NOTE** : All tests marked with (*) means that those test methods are not accredited.*

APPENDIX B2

Laboratory Test Results (Rock)

ROCKLAB REPORT **CONFIDENTIAL**
2023-GCS-02

Issued by:

ROCKLAB
(ROCK MECHANICS & EXCAVATION LABORATORIES)
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LA MONTAGNE 0184
PRETORIA
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TEL: +27 12 813 4910
E-MAIL: CHENJ@ROCKLAB.CO.ZA

RESULTS OF ROCK PROPERTIES TESTS

Sampling Site: Macassar WWTW

BY

DR J. F. CHEN

Submitted to:

GCS Geotechnical Engineering

24 MAY 2023

C O N T E N T S

TABLE 1 - RESULTS OF UNIAXIAL COMPRESSIVE STRENGTH TESTS WITH ELASTIC MODULUS & POISSON RATIO MEASUREMENTS BY MEANS OF STRAIN GAUGES

TABLE 2 - RESULTS OF ROCK POINT LOAD STRENGTH TESTS

APPENDIX 1 DIAGRAM OF STRESS VIA STRAIN FOR UCM TESTS

APPENDIX 2 FAILURE CODES OF ROCK COMPRESSION TESTS

TABLE 1 RESULTS OF UNIAXIAL COMPRESSION TESTS WITH ELASTIC MODULUS & POISSON RATIO MEASUREMENTS BY MEANS OF STRAIN GAUGES

ROCKLAB
Tel: 0027 12 813 4910
E-mail: Cherij@rocklab.co.za

Client: GCS Geotechnical Engineering

Sampling site: Macassar WWTW

24-05-2023

SPECIMEN PARTICULARS				SPECIMEN DIMENSIONS					SPECIMEN TEST RESULTS								
Rocklab Specimen No 9293-	Test No	Sample depth m	Rock Type	Diameter mm	Height mm	Ratio of Height to diameter	Mass g	Density g/cm³	Failure Load kN	Strength (UCS) MPa	Tangent Elastic Modulus @ 50% UCS GPa	Secant Elastic Modulus @ 50% UCS GPa	Poisson's Ratio Tangent @ 50% UCS	Poisson's Ratio Secant @ 50% UCS	Linear Axial Strain at Failure mm/mm	Failure Code	Note
UCM-02	BH02	7.79 - 8.13	Light grey to grey-green slightly weathered soft rock	60.39	157.86	2.6	1227.79	2.72	68.8	24.0	83.9	88.9	0.21	0.22	0.000278	0B	
UCM-03	BH03	17.71 - 17.92	Dark grey streaked light grey slightly weathered soft rock	60.78	144.88	2.4	1105.57	2.63	90.9	31.3	79.4	78.1	0.29	0.26	0.000398	0B	
UCM-05	BH06	13.20 - 13.51	Light grey to grey-green sligthly weathered very soft rock	59.98	155.34	2.6	1122.82	2.56	126.4	44.7	28.5	33.3	0.21	0.18	0.001539	0B	
UCM-06	BH09	14.57 - 18.81	Dark grey to grey streaked light grey slightly weathered soft rock	60.80	159.06	2.6	1265.72	2.74	212.8	73.3	73.5	78.5	0.29	0.30	0.000972	0B	

Note: All tests were conducted according to the ISRM's Specification.

Failure codes shown in Appendix 2

TABLE 2 RESULTS OF POINT LOAD STRENGTH INDEX TESTS

ROCKLAB
Tel: 0027 12 813 4910
E-mail: Chenj@rocklab.co.za

Client: GCS Geotechnical Engineering

Sampling Site: Macassar WWTW - 22-1172

17-05-2023

SPECIMEN PARTICULARS				SPECIMEN TEST RESULTS							
ROCKLAB Specimen No 9293-	Test No	Sample Depth m	Rock Type	Core Diameter D (mm)	Core Height (mm)	Failue Load P (kN)	Equivalent Core Diameter (mm)	Point Load Strength I_S (MPa)	Corrected $I_{S(50)}$ (MPa)	Test Code	Note
PLT-01	BH01	14.06 - 14.39	Dark grey stained brown slightly weathered soft rock	61.09		2.15	61.09	0.58	0.63	1	A
				61.09		10.65	61.09	2.85	3.12	1	A
PLT-02	BH02	7.79 - 8.13	Light grey to grey-green slightly weathered soft rock	60.32		6.45	60.32	1.77	1.93	1	A
PLT-04	BH05	15.01 - 15.13	Light grey to grey stained red brown slightly weathered soft rock	60.33		3.40	60.33	0.93	1.02	1	A
PLT-05	BH06	13.20 - 13.51	Light grey to grey-green sligthly weathered very soft rock	60.33		6.40	60.33	1.76	1.91	1	A
				60.33	28.16	0.80	46.51	0.37	0.36	2	A
				60.33	35.57	1.95	52.27	0.71	0.73	2	A

Note: the tests were conducted accoding to the ISRM suggested method.

A - specimen was failed on existing crack /joints.

B - specimen was failed on intact rock

APPENDIX 1

STRESS VIA STRAIN CURVES FOR UCM TESTS

UNIAXIAL COMPRESSION TEST

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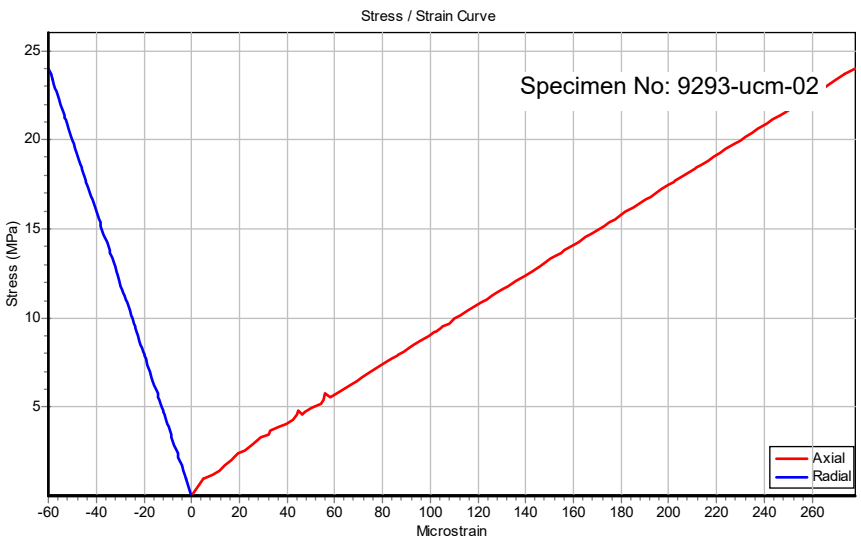
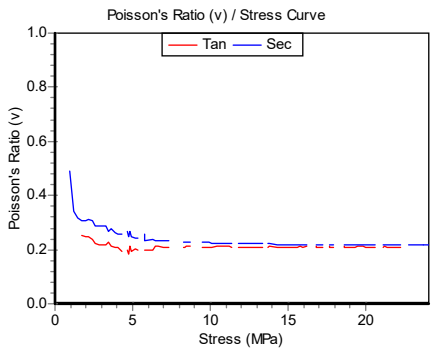
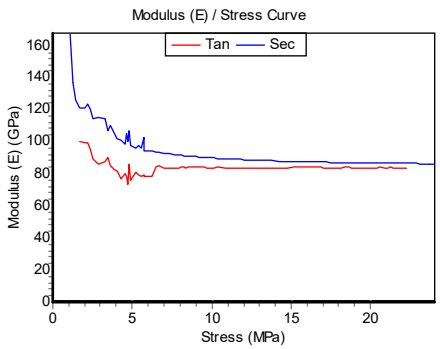
WITH ELASTIC MODULUS AND POISSON'S RATIO MEASUREMENTS BY MEANS OF STRAIN GAUGES







Failure Load: 68.84 kN Peak Strength: 24.03 MPa Axial Strain at Failure: 278 microstrain

% Strength	Strength (MPa)	E Tan (GPa)	E Sec (GPa)	v Tan	v Sec
10	2.4	89.4	115	0.223	0.287
20	4.81	76.1	97.8	0.192	0.246
30	7.21	83.9	92.5	0.210	0.232
40	9.61	83.9	90.2	0.210	0.226
50	12	83.9	88.9	0.208	0.223
60	14.4	83.8	88	0.209	0.220
70	16.8	84.3	87.5	0.211	0.219
80	19.2	83.9	87	0.210	0.218
90	21.6	83.9	86.6	0.210	0.217

ROCKLAB

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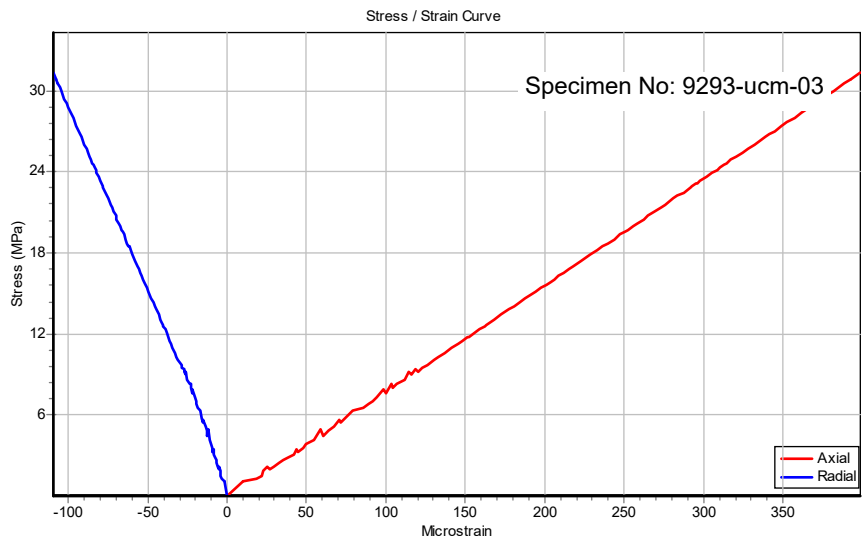
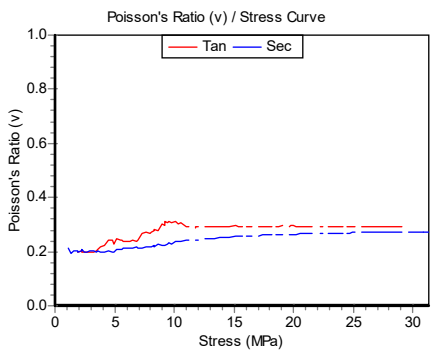
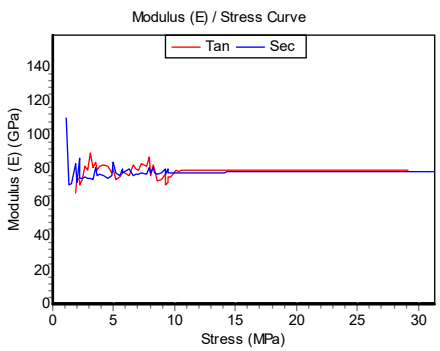
UNIAXIAL COMPRESSION TEST

2023/05/24 11:48:54

WITH ELASTIC MODULUS AND POISSON'S RATIO MEASUREMENTS BY MEANS OF STRAIN GAUGES







Failure Load: 90.92 kN Peak Strength: 31.34 MPa Axial Strain at Failure: 398 microstrain

% Strength	Strength (MPa)	E Tan (GPa)	E Sec (GPa)	v Tan	v Sec
10	3.13	83.5	81	0.201	0.198
20	6.27	76	80.2	0.237	0.215
30	9.4	72	80	0.306	0.229
40	12.5	79.3	77.8	0.291	0.247
50	15.7	79.4	78.1	0.294	0.257
60	18.8	79.3	78.3	0.295	0.262
70	21.9	79.3	78.4	0.291	0.267
80	25.1	79.3	78.5	0.293	0.270
90	28.2	79.3	78.6	0.292	0.272

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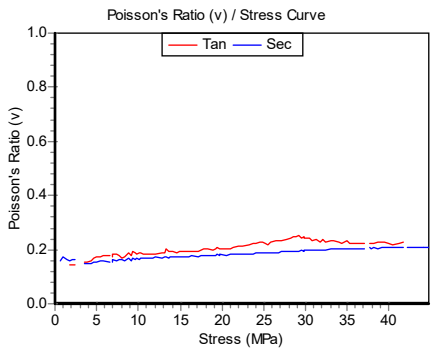
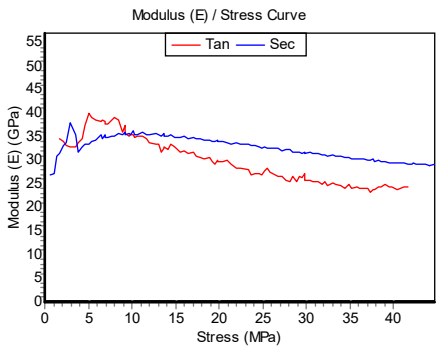
UNIAXIAL COMPRESSION TEST

2023/05/24 11:40:48

WITH ELASTIC MODULUS AND POISSON'S RATIO MEASUREMENTS BY MEANS OF STRAIN GAUGES





Failure Load: 126.4 kN Peak Strength: 44.75 MPa Axial Strain at Failure: 1539 microstrain

% Strength	Strength (MPa)	E Tan (GPa)	E Sec (GPa)	v Tan	v Sec
10	4.48	37.5	33.5	0.167	0.152
20	8.95	37.5	36.1	0.179	0.159
30	13.4	32.5	35.7	0.193	0.169
40	17.9	30.4	34.3	0.201	0.179
50	22.4	28.5	33.3	0.214	0.184
60	26.9	26.7	32.2	0.232	0.191
70	31.3	25.5	31.5	0.236	0.200
80	35.8	24.3	30.4	0.224	0.205
90	40.3	23.7	29.6	0.219	0.207

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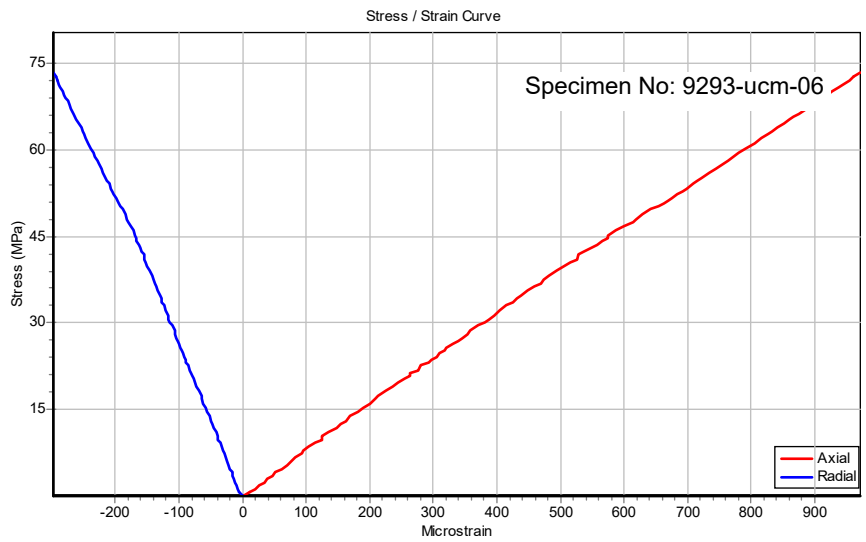
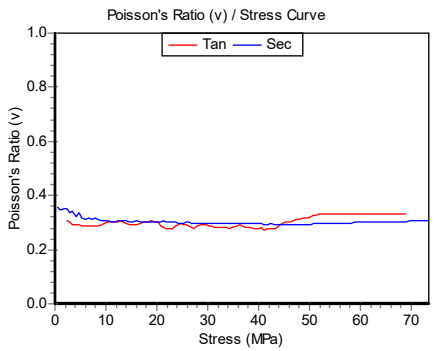
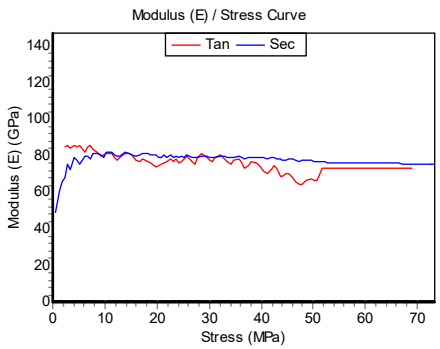
UNIAXIAL COMPRESSION TEST

2023/05/24 11:40:17

WITH ELASTIC MODULUS AND POISSON'S RATIO MEASUREMENTS BY MEANS OF STRAIN GAUGES







Failure Load: 212.8 kN Peak Strength: 73.29 MPa Axial Strain at Failure: 972 microstrain

% Strength	Strength (MPa)	E Tan (GPa)	E Sec (GPa)	v Tan	v Sec
10	7.33	83.1	81.5	0.287	0.316
20	14.7	81	81.2	0.294	0.303
30	22	78	80.5	0.276	0.302
40	29.3	78.8	79.8	0.293	0.298
50	36.6	73.5	78.5	0.286	0.296
60	44	68.8	77.9	0.291	0.294
70	51.3	73.1	76.5	0.330	0.295
80	58.6	73.1	76	0.331	0.300
90	66	73.1	75.7	0.331	0.303

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APPENDIX 2

CLASSIFICATION OF ROCK SPECIMEN FAILURE MODE INFLUENCED / NOT INFLUENCED BY DISCONTINUITIES DURING COMPRESSION TESTING

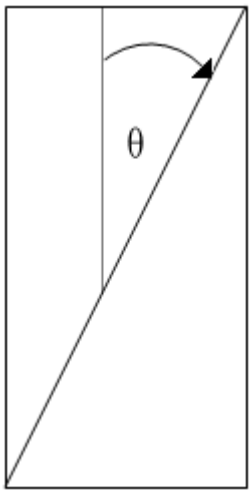
FAILURE NOT INFLUENCED BY DISCONTINUITIES (INTACT)

TYPE CODE	DESCRIPTION OF SUB CODES	
	A	B
X	SINGLE SLIDING SHEAR FAILURE	COMPLETE CONE DEVELOPMENT
Y	SPLITTING	

FAILURE INFLUENCED BY DISCONTINUITIES

TYPE CODE	DESCRIPTION OF SUB CODES	
	A	B
	PARTIAL FAILURE ON DISCONTINUITY	FAILURE COMPLETELY ON DISCONTINUITY
1	AT 0-10° TO AXIS	AT 0-10° TO AXIS
2	AT 11-20° TO AXIS	AT 11-20° TO AXIS
3	AT 21-30° TO AXIS	AT 21-30° TO AXIS
4	AT 31-40° TO AXIS	AT 31-40° TO AXIS
5	AT 41-50° TO AXIS	AT 41-50° TO AXIS
6	AT 51-70° TO AXIS	AT 51-70° TO AXIS
7	AT 71-90° TO AXIS	AT 71-90° TO AXIS
0	Multiple Discontinuities	Multiple Discontinuities

Example: Failure Type3B: Failure completely on a discontinuity with an orientation of between 21° and 30° to the specimen axis.



APPENDIX C

DCP Test Results

- Geology
- Geotechnics
- Groundwater
- Wetland Delineations
- Mining Rights
- Environmental
- Geophysics

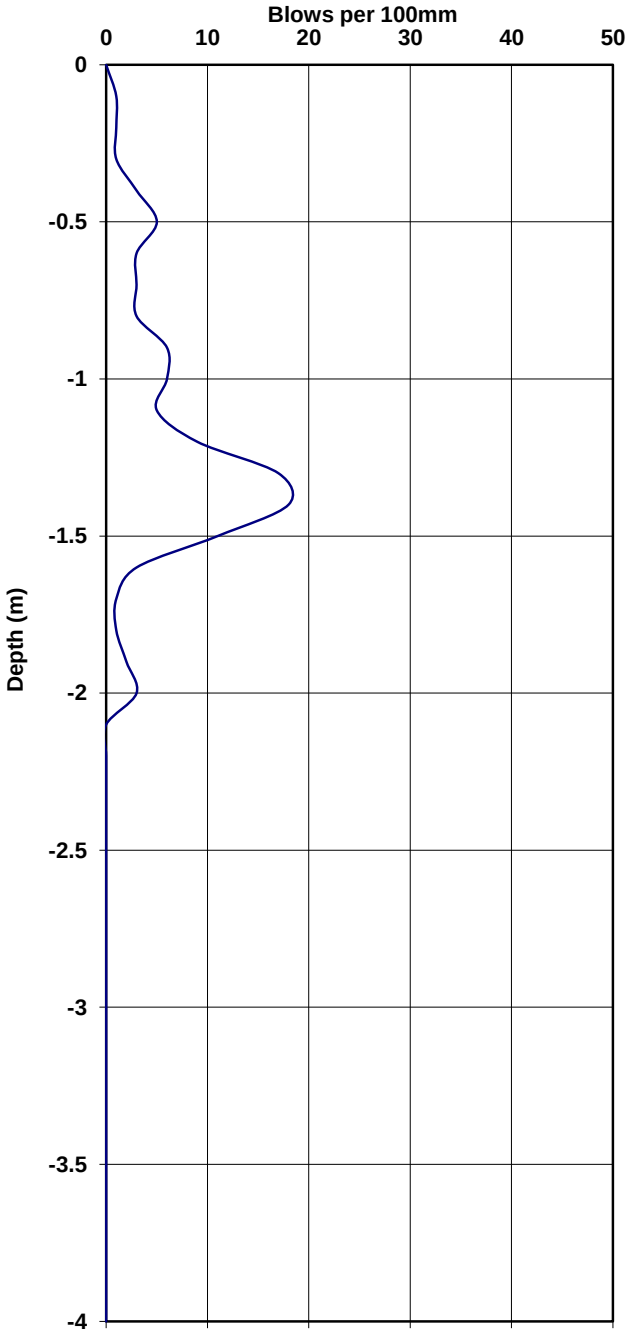
Tel: (082) 567 1561 Fax: (086) 672 4258 Email: ninow@gcg-sa.biz www.gcs-sa.biz

Client:	Zutari	22-1172
Project:	Macassar WWTW	HH
Section:	Proposed Road - Next to DTP20	

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No DCP 1***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	1	Very Loose	<29	2
0.2	1	Very Loose	<29	2
0.3	1	Very Loose	<29	2
0.4	3	Loose	<30	5
0.5	5	Med.Dense	32	8
0.6	3	Loose	<30	5
0.7	3	Loose	<30	5
0.8	3	Loose	<30	5
0.9	6	Med.Dense	33	10
1	6	Med.Dense	33	10
1.1	5	Med.Dense	32	8
1.2	9	Med.Dense	35	15
1.3	17	Dense	37	31
1.4	18	Dense	37	33
1.5	11	Dense	36	19
1.6	3	Loose	<30	5
1.7	1	Very Loose	<29	2
1.8	1	Very Loose	<29	2
1.9	2	Loose	<30	3
2	3	Loose	<30	5
2.1				
2.2				
2.3				
2.4				
2.5				
2.6				
2.7				
2.8				
2.9				
3				
3.1				
3.2				
3.3				
3.4				
3.5				
3.6				
3.7				
3.8				
3.9				
4				



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- Geology
- Geotechnics
- Groundwater
- Wetland Delineations
- Mining Rights
- Environmental
- Geophysics

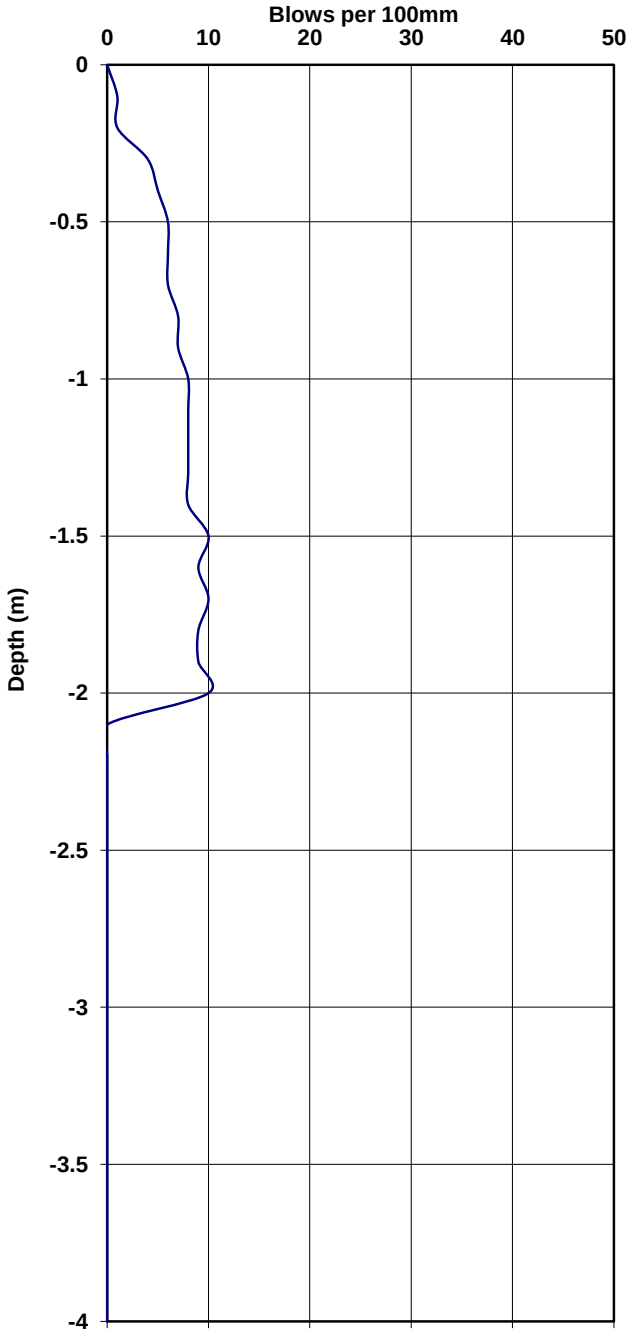
Tel: (082) 567 1561 Fax: (086) 672 4258 Email: ninow@gcg-sa.biz www.gcs-sa.biz

Client:	Zutari	22-1172
Project:	Macassar WWTW	HH
Section:	Proposed Road - Next to STP01	

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No DCP 2***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	1	Very Loose	<29	2
0.2	1	Very Loose	<29	2
0.3	4	Med.Dense	30	7
0.4	5	Med.Dense	32	8
0.5	6	Med.Dense	33	10
0.6	6	Med.Dense	33	10
0.7	6	Med.Dense	33	10
0.8	7	Med.Dense	34	12
0.9	7	Med.Dense	34	12
1	8	Med.Dense	35	14
1.1	8	Med.Dense	35	14
1.2	8	Med.Dense	35	14
1.3	8	Med.Dense	35	14
1.4	8	Med.Dense	35	14
1.5	10	Med.Dense	36	17
1.6	9	Med.Dense	35	15
1.7	10	Med.Dense	36	17
1.8	9	Med.Dense	35	15
1.9	9	Med.Dense	35	15
2	10	Med.Dense	36	17
2.1				
2.2				
2.3				
2.4				
2.5				
2.6				
2.7				
2.8				
2.9				
3				
3.1				
3.2				
3.3				
3.4				
3.5				
3.6				
3.7				
3.8				
3.9				
4				



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- Geology
- Geotechnics
- Groundwater
- Wetland Delineations
- Mining Rights
- Environmental
- Geophysics

Tel: (082) 567 1561 Fax: (086) 672 4258 Email: ninow@gcg-sa.biz www.gcs-sa.biz

Client:	Zutari	22-1172
Project:	Macassar WWTW	HH
Section:	Proposed Road - Next to STP03	

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No DCP 3***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	2	Loose	<30	3
0.2	5	Med.Dense	32	8
0.3	4	Med.Dense	30	7
0.4	2	Loose	<30	3
0.5	1	Very Loose	<29	2
0.6	1	Very Loose	<29	2
0.7	1	Very Loose	<29	2
0.8	1	Very Loose	<29	2
0.9	7	Med.Dense	34	12
1	4	Med.Dense	30	7
1.1	5	Med.Dense	32	8
1.2	6	Med.Dense	33	10
1.3	6	Med.Dense	33	10
1.4	6	Med.Dense	33	10
1.5	8	Med.Dense	35	14
1.6	7	Med.Dense	34	12
1.7	13	Dense	37	23
1.8	14	Dense	37	25
1.9	14	Dense	37	25
2	15	Dense	37	27
2.1				
2.2				
2.3				
2.4				
2.5				
2.6				
2.7				
2.8				
2.9				
3				
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3.3				
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3.9				
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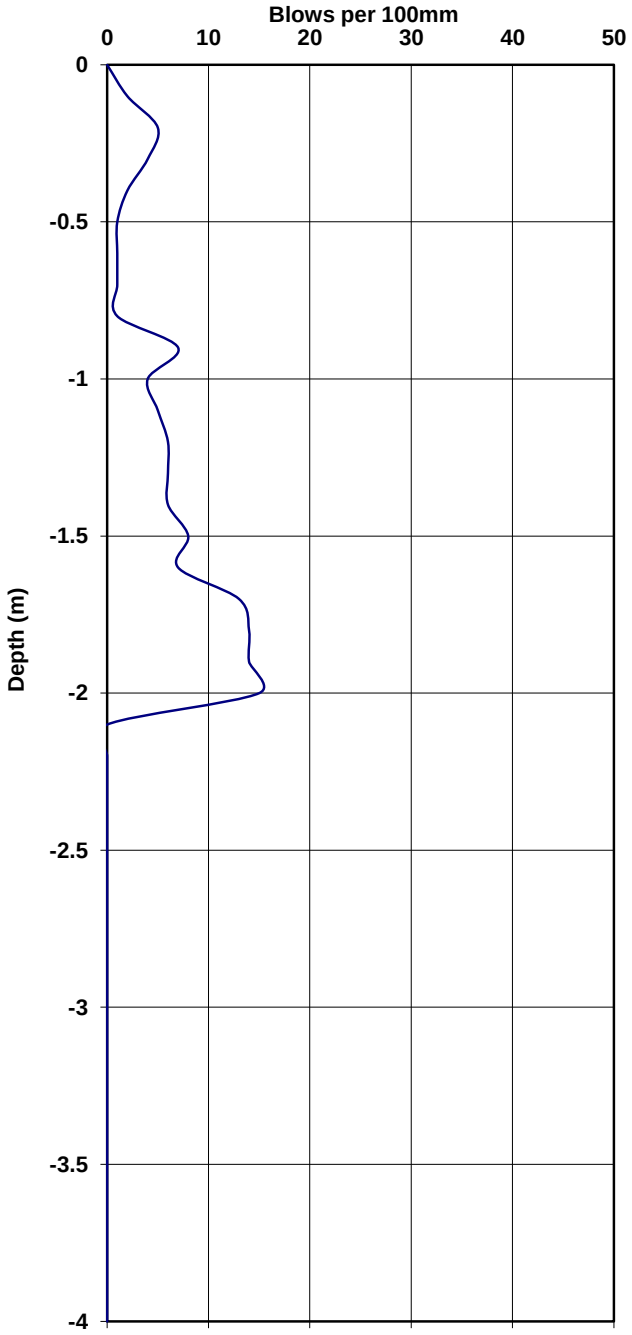

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GCS Geotechnical Engineering

- Geology
- Geotechnics
- Groundwater
- Wetland Delineations
- Mining Rights
- Environmental
- Geophysics

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Client:	Zutari	22-1172
Project:	Macassar WWTW	HH
Section:	Proposed Road - Next to STP04	

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No DCP 4***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	3	Loose	<30	5
0.2	6	Med.Dense	33	10
0.3	5	Med.Dense	32	8
0.4	4	Med.Dense	30	7
0.5	4	Med.Dense	30	7
0.6	3	Loose	<30	5
0.7	4	Med.Dense	30	7
0.8	4	Med.Dense	30	7
0.9	4	Med.Dense	30	7
1	4	Med.Dense	30	7
1.1	4	Med.Dense	30	7
1.2	4	Med.Dense	30	7
1.3	4	Med.Dense	30	7
1.4	5	Med.Dense	32	8
1.5	4	Med.Dense	30	7
1.6	4	Med.Dense	30	7
1.7	4	Med.Dense	30	7
1.8	5	Med.Dense	32	8
1.9	5	Med.Dense	32	8
2	5	Med.Dense	32	8
2.1				
2.2				
2.3				
2.4				
2.5				
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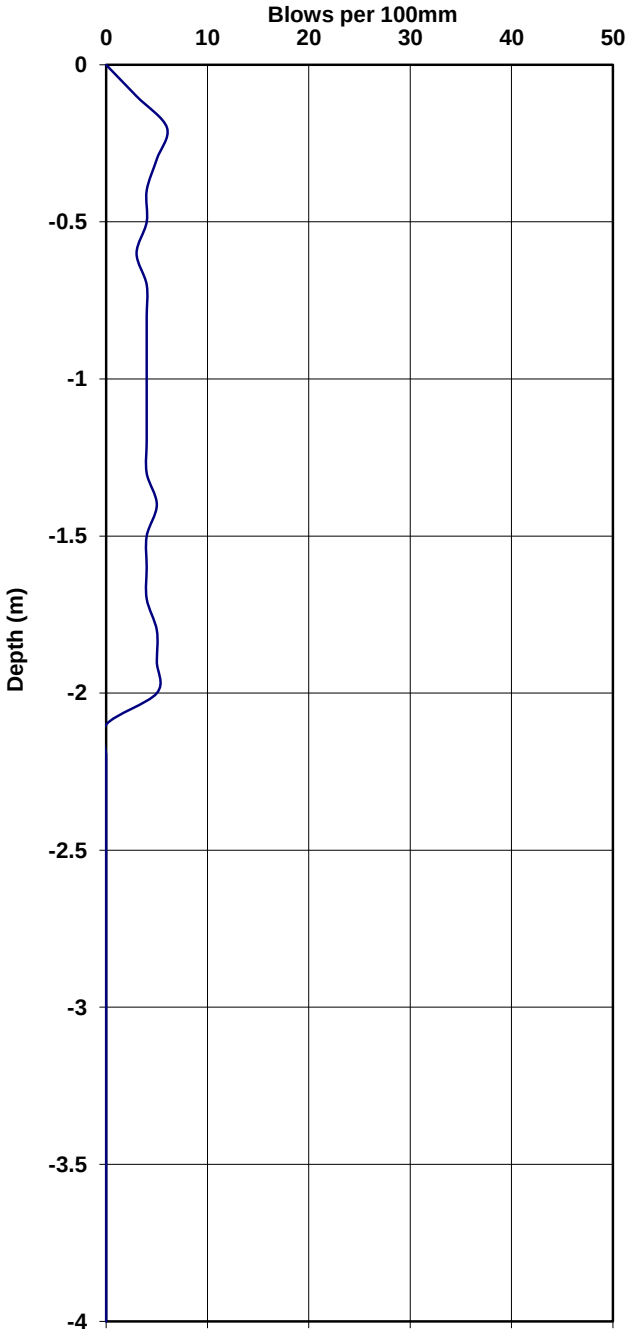

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Phi=0

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Client:	Zutari	22-1172
Project:	Macassar WWTW	HH
Section:	Proposed Road - Next to STP05	

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No DCP 5***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	1	Very Loose	<29	2
0.2	4	Med.Dense	30	7
0.3	2	Loose	<30	3
0.4	4	Med.Dense	30	7
0.5	5	Med.Dense	32	8
0.6	6	Med.Dense	33	10
0.7	6	Med.Dense	33	10
0.8	6	Med.Dense	33	10
0.9	7	Med.Dense	34	12
1	5	Med.Dense	32	8
1.1	5	Med.Dense	32	8
1.2	6	Med.Dense	33	10
1.3	6	Med.Dense	33	10
1.4	7	Med.Dense	34	12
1.5	8	Med.Dense	35	14
1.6	6	Med.Dense	33	10
1.7	6	Med.Dense	33	10
1.8	7	Med.Dense	34	12
1.9	6	Med.Dense	33	10
2	6	Med.Dense	33	10
2.1				
2.2				
2.3				
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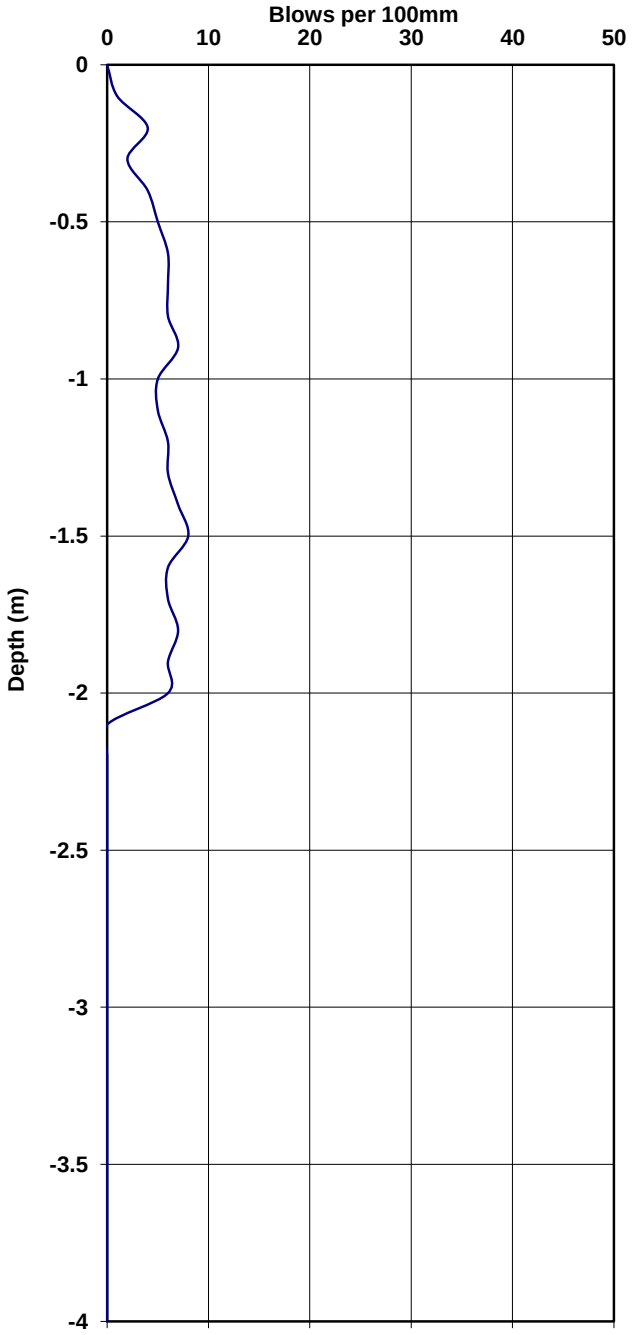

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Client:	Zutari	22-1172
Project:	Macassar WWTW	HH
Section:	Proposed Road - Next to STP02	

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No DCP 6***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	2	Loose	<30	3
0.2	2	Loose	<30	3
0.3	3	Loose	<30	5
0.4	2	Loose	<30	3
0.5	3	Loose	<30	5
0.6	2	Loose	<30	3
0.7	4	Med.Dense	30	7
0.8	4	Med.Dense	30	7
0.9	3	Loose	<30	5
1	3	Loose	<30	5
1.1	3	Loose	<30	5
1.2	4	Med.Dense	30	7
1.3	3	Loose	<30	5
1.4	7	Med.Dense	34	12
1.5	9	Med.Dense	35	15
1.6	11	Dense	36	19
1.7	7	Med.Dense	34	12
1.8	7	Med.Dense	34	12
1.9	7	Med.Dense	34	12
2	8	Med.Dense	35	14
2.1				
2.2				
2.3				
2.4				
2.5				
2.6				
2.7				
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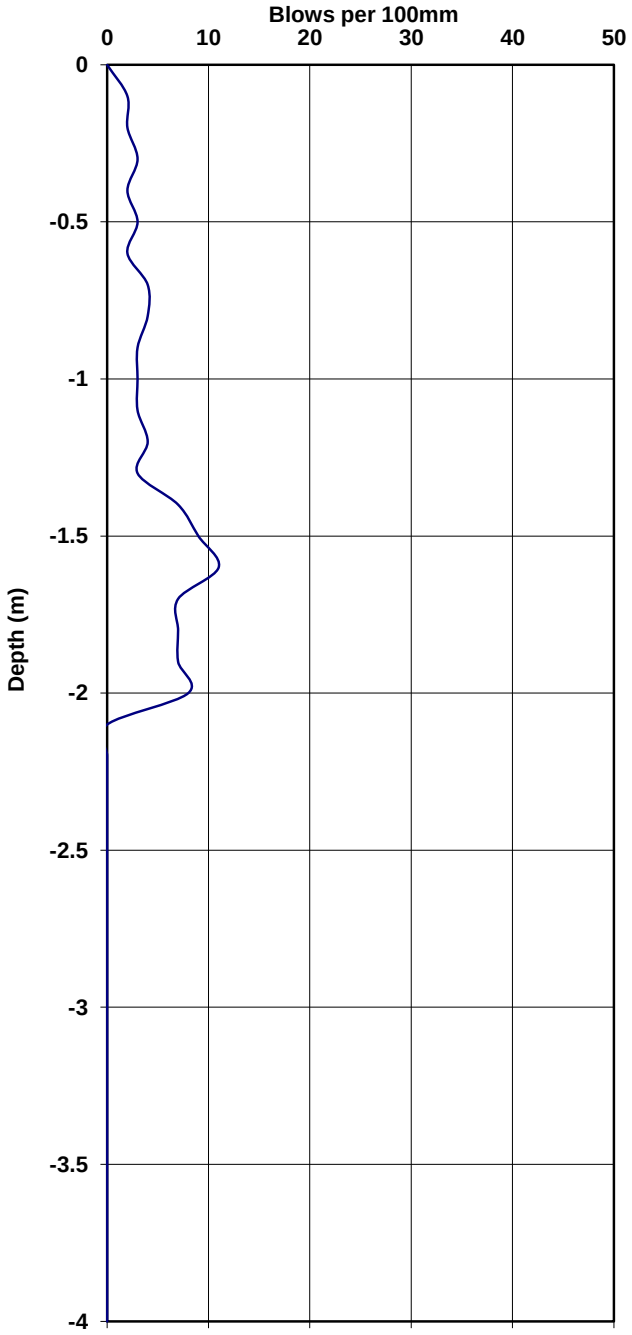

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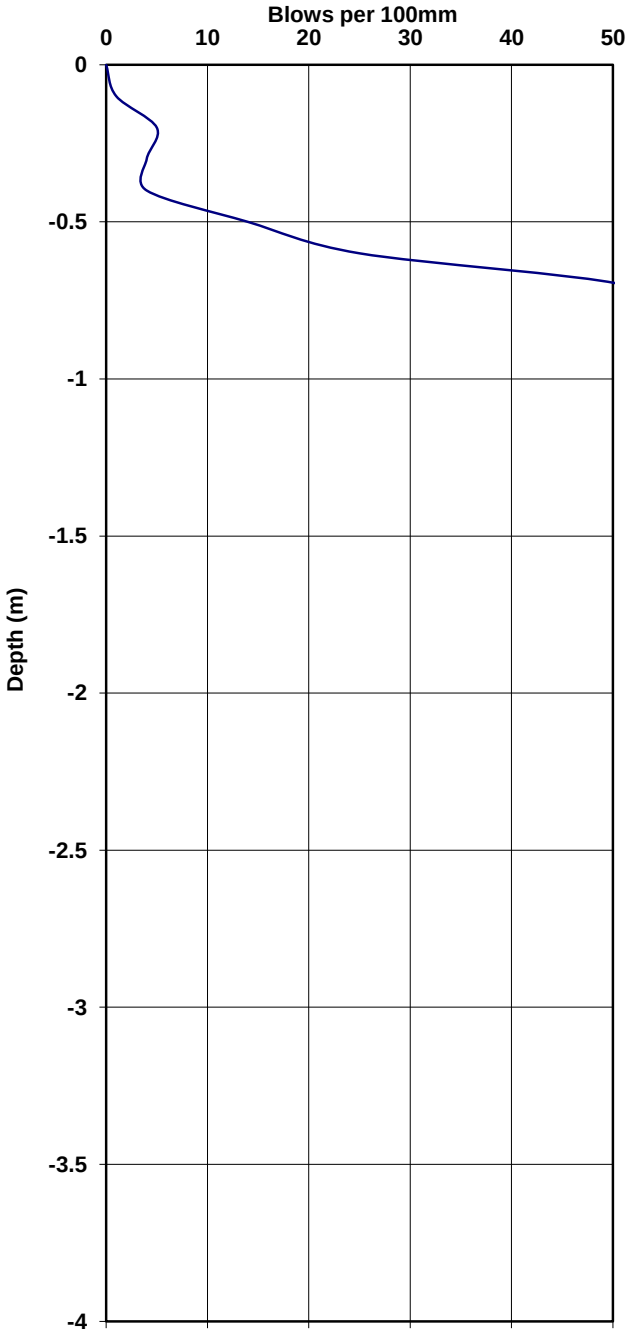
Client:	Zutari	22-1172
Project:	Macassar WWTW	HH
Section:	Proposed Road - Next to DTP12	

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No DCP 7***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	1	Very Loose	<29	2
0.2	5	Med.Dense	32	8
0.3	4	Med.Dense	30	7
0.4	4	Med.Dense	30	7
0.5	14	Dense	37	25
0.6	25	Very Dense	38	49
	Ref			



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Client:	Zutari	22-1172
Project:	Macassar WWTW	HH
Section:	Proposed Road - Next to STP09	

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No DCP 8***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	3	Loose	<30	5
0.2	3	Loose	<30	5
0.3	2	Loose	<30	3
0.4	3	Loose	<30	5
0.5	4	Med.Dense	30	7
0.6	6	Med.Dense	33	10
0.7	7	Med.Dense	34	12
0.8	9	Med.Dense	35	15
0.9	12	Dense	36	21
1	12	Dense	36	21
1.1	15	Dense	37	27
1.2	13	Dense	37	23
1.3	10	Med.Dense	36	17
1.4	5	Med.Dense	32	8
1.5	4	Med.Dense	30	7
1.6	5	Med.Dense	32	8
1.7	7	Med.Dense	34	12
1.8	11	Dense	36	19
1.9	5	Med.Dense	32	8
2	6	Med.Dense	33	10
2.1				
2.2				
2.3				
2.4				
2.5				
2.6				
2.7				
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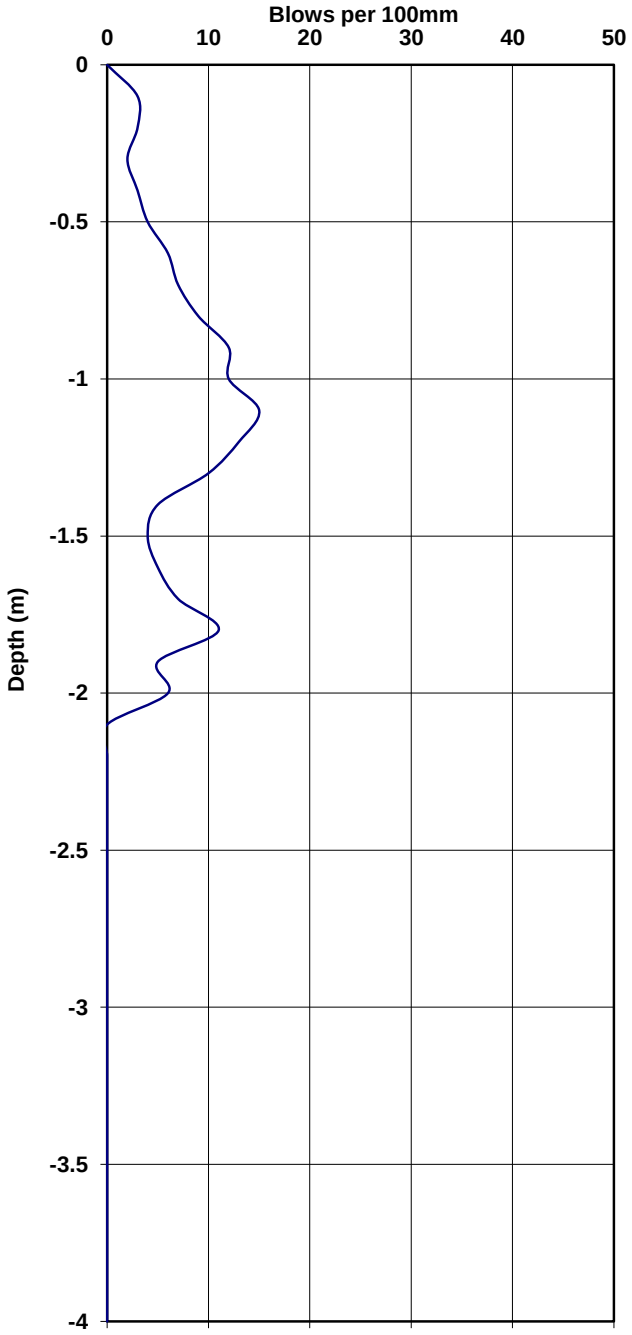

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Client:	Zutari	22-1172
Project:	Macassar WWTW	HH
Section:	Proposed Road - Next to STP06	

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No DCP 9***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	1	Very Loose	<29	2
0.2	1	Very Loose	<29	2
0.3	1	Very Loose	<29	2
0.4	2	Loose	<30	3
0.5	2	Loose	<30	3
0.6	2	Loose	<30	3
0.7	1	Very Loose	<29	2
0.8	2	Loose	<30	3
0.9	2	Loose	<30	3
1	2	Loose	<30	3
1.1	3	Loose	<30	5
1.2	3	Loose	<30	5
1.3	6	Med.Dense	33	10
1.4	7	Med.Dense	34	12
1.5	12	Dense	36	21
1.6	15	Dense	37	27
1.7	9	Med.Dense	35	15
1.8	5	Med.Dense	32	8
1.9	5	Med.Dense	32	8
2	5	Med.Dense	32	8
2.1				
2.2				
2.3				
2.4				
2.5				
2.6				
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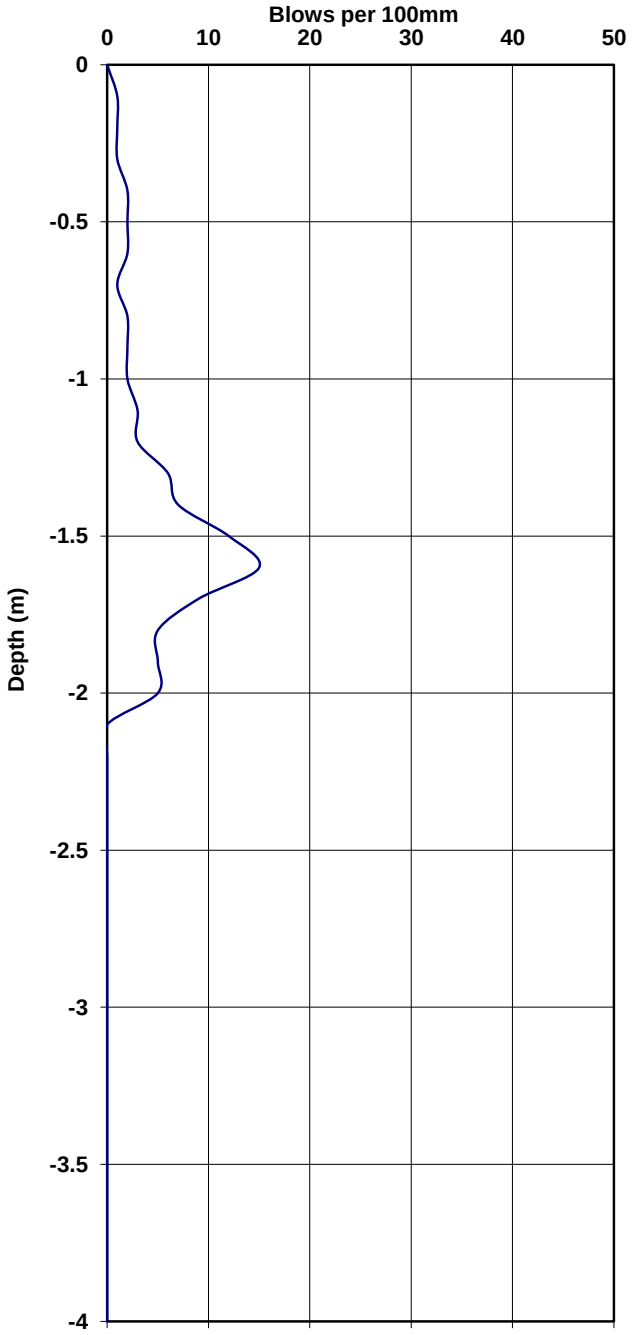

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Client:	Zutari	22-1172
Project:	Macassar WWTW	HH
Section:	Proposed Road - Next to STP07	

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No DCP 10***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	4	Med.Dense	30	7
0.2	5	Med.Dense	32	8
0.3	10	Med.Dense	36	17
0.4	13	Dense	37	23
0.5	15	Dense	37	27
0.6	16	Dense	37	29
0.7	13	Dense	37	23
0.8	11	Dense	36	19
0.9	8	Med.Dense	35	14
1	9	Med.Dense	35	15
1.1	6	Med.Dense	33	10
1.2	6	Med.Dense	33	10
1.3	7	Med.Dense	34	12
1.4	10	Med.Dense	36	17
1.5	11	Dense	36	19
1.6	8	Med.Dense	35	14
1.7	7	Med.Dense	34	12
1.8	11	Dense	36	19
1.9	11	Dense	36	19
2	11	Dense	36	19
2.1				
2.2				
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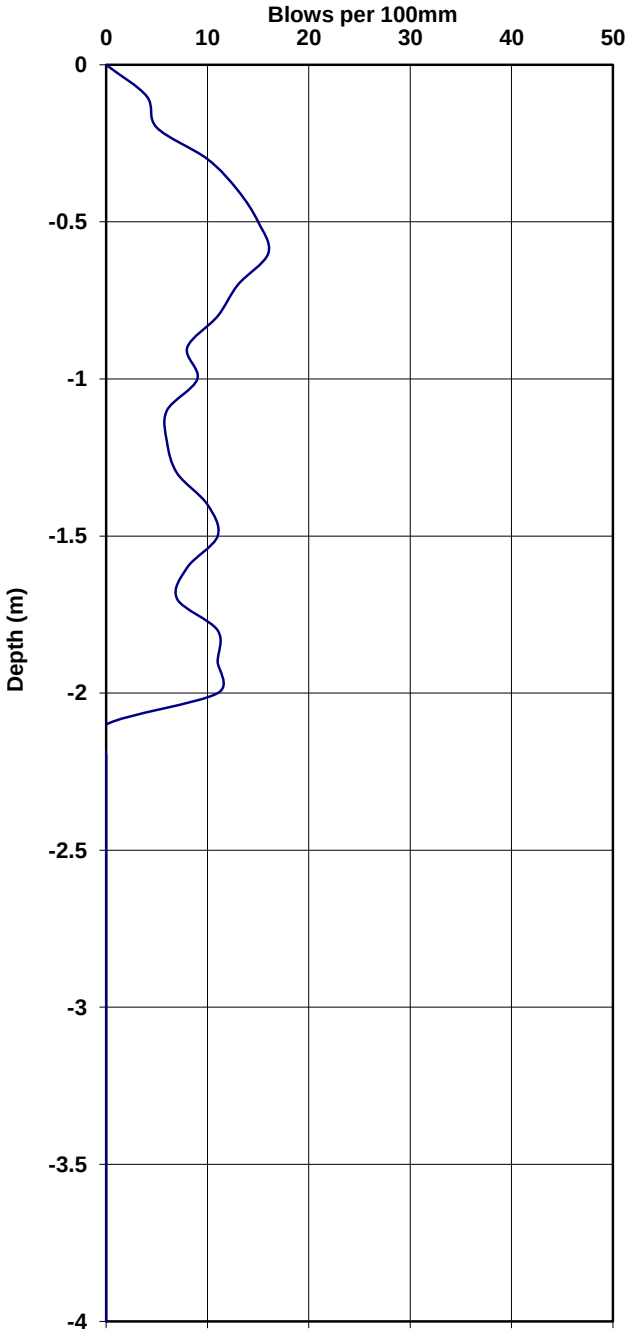

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Client:	Zutari	22-1172
Project:	Macassar WWTW	HH
Section:	Proposed Road - Next to STP10	

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No DCP 11***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	6	Med.Dense	33	10
0.2	4	Med.Dense	30	7
0.3	3	Loose	<30	5
0.4	3	Loose	<30	5
0.5	3	Loose	<30	5
0.6	2	Loose	<30	3
0.7	3	Loose	<30	5
0.8	3	Loose	<30	5
0.9	3	Loose	<30	5
1	2	Loose	<30	3
1.1	2	Loose	<30	3
1.2	3	Loose	<30	5
1.3	2	Loose	<30	3
1.4	3	Loose	<30	5
1.5	2	Loose	<30	3
1.6	3	Loose	<30	5
1.7	4	Med.Dense	30	7
1.8	3	Loose	<30	5
1.9	4	Med.Dense	30	7
2	3	Loose	<30	5
2.1				
2.2				
2.3				
2.4				
2.5				
2.6				
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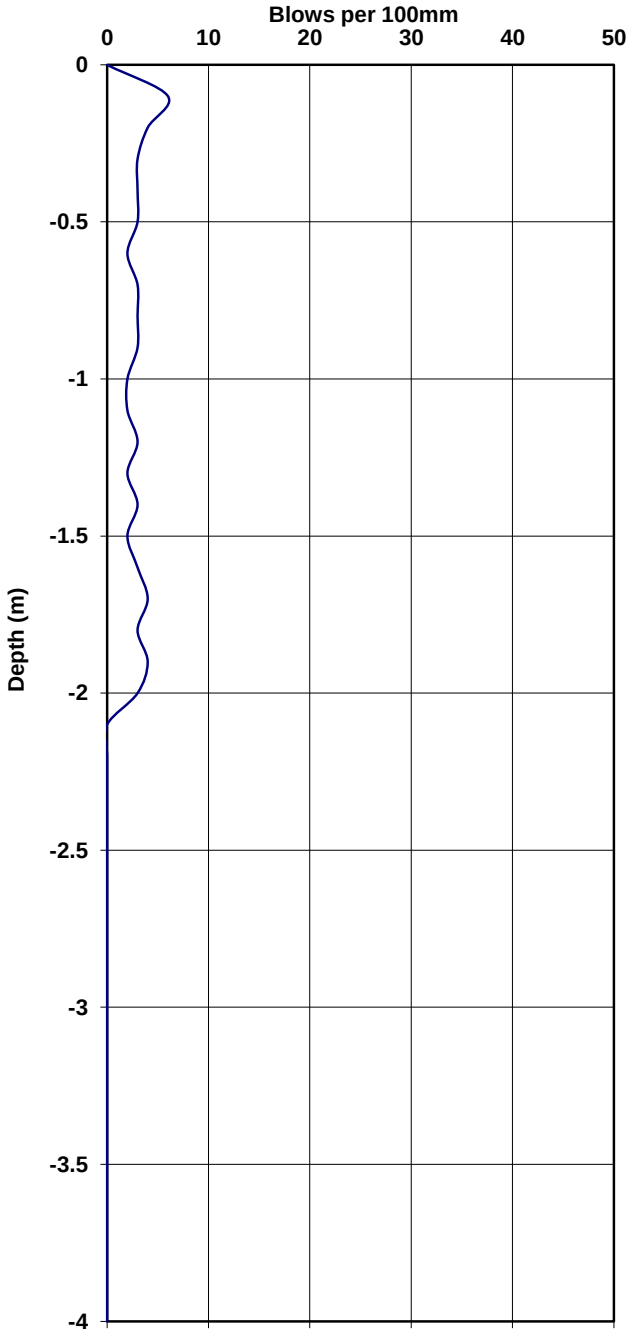

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Client:	Zutari	22-1172
Project:	Macassar WWTW	HH
Section:	Proposed Road - Next to STP11	

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No DCP 12***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	1	Very Loose	<29	2
0.2	1	Very Loose	<29	2
0.3	2	Loose	<30	3
0.4	1	Very Loose	<29	2
0.5	2	Loose	<30	3
0.6	2	Loose	<30	3
0.7	5	Med.Dense	32	8
0.8	4	Med.Dense	30	7
0.9	5	Med.Dense	32	8
1	8	Med.Dense	35	14
1.1	6	Med.Dense	33	10
1.2	4	Med.Dense	30	7
1.3	5	Med.Dense	32	8
1.4	5	Med.Dense	32	8
1.5	6	Med.Dense	33	10
1.6	6	Med.Dense	33	10
1.7	4	Med.Dense	30	7
1.8	4	Med.Dense	30	7
1.9	4	Med.Dense	30	7
2	4	Med.Dense	30	7
2.1				
2.2				
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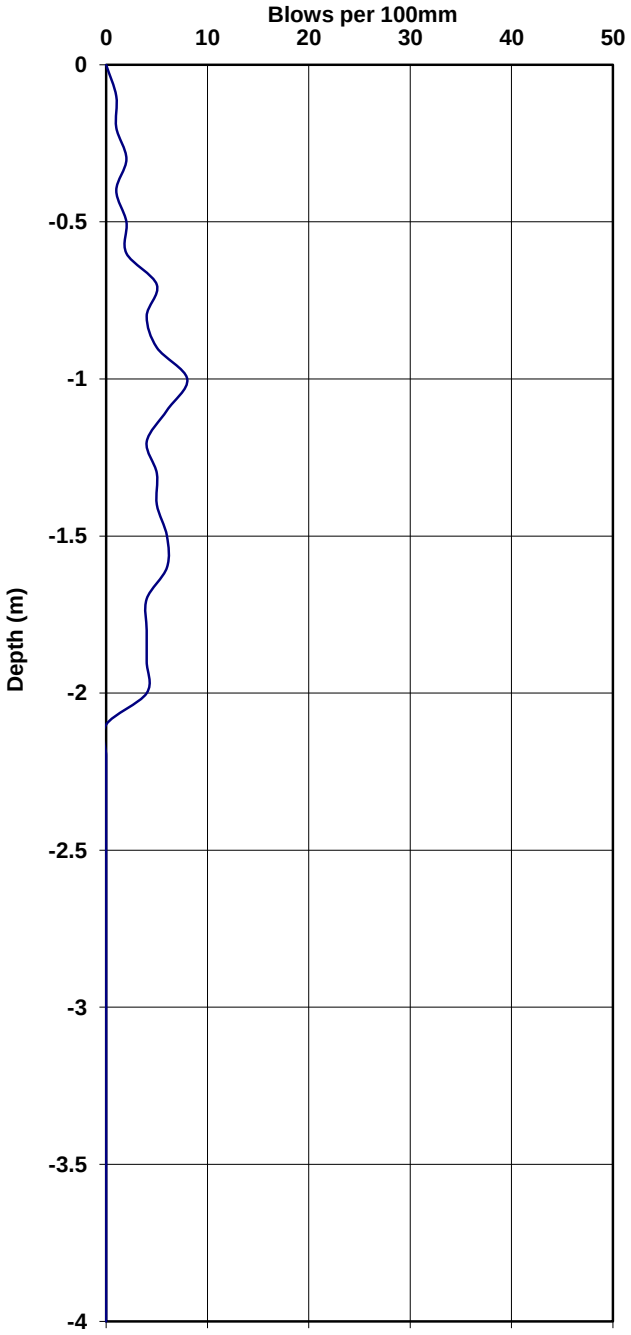

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Client:	Zutari	22-1172
Project:	Macassar WWTW	HH
Section:	Proposed Road - Next to STP8	

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No DCP 13***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	1	Very Loose	<29	2
0.2	1	Very Loose	<29	2
0.3	3	Loose	<30	5
0.4	3	Loose	<30	5
0.5	4	Med.Dense	30	7
0.6	4	Med.Dense	30	7
0.7	4	Med.Dense	30	7
0.8	6	Med.Dense	33	10
0.9	4	Med.Dense	30	7
1	5	Med.Dense	32	8
1.1	5	Med.Dense	32	8
1.2	4	Med.Dense	30	7
1.3	4	Med.Dense	30	7
1.4	3	Loose	<30	5
1.5	4	Med.Dense	30	7
1.6	3	Loose	<30	5
1.7	6	Med.Dense	33	10
1.8	4	Med.Dense	30	7
1.9	3	Loose	<30	5
2	3	Loose	<30	5
2.1				
2.2				
2.3				
2.4				
2.5				
2.6				
2.7				
2.8				
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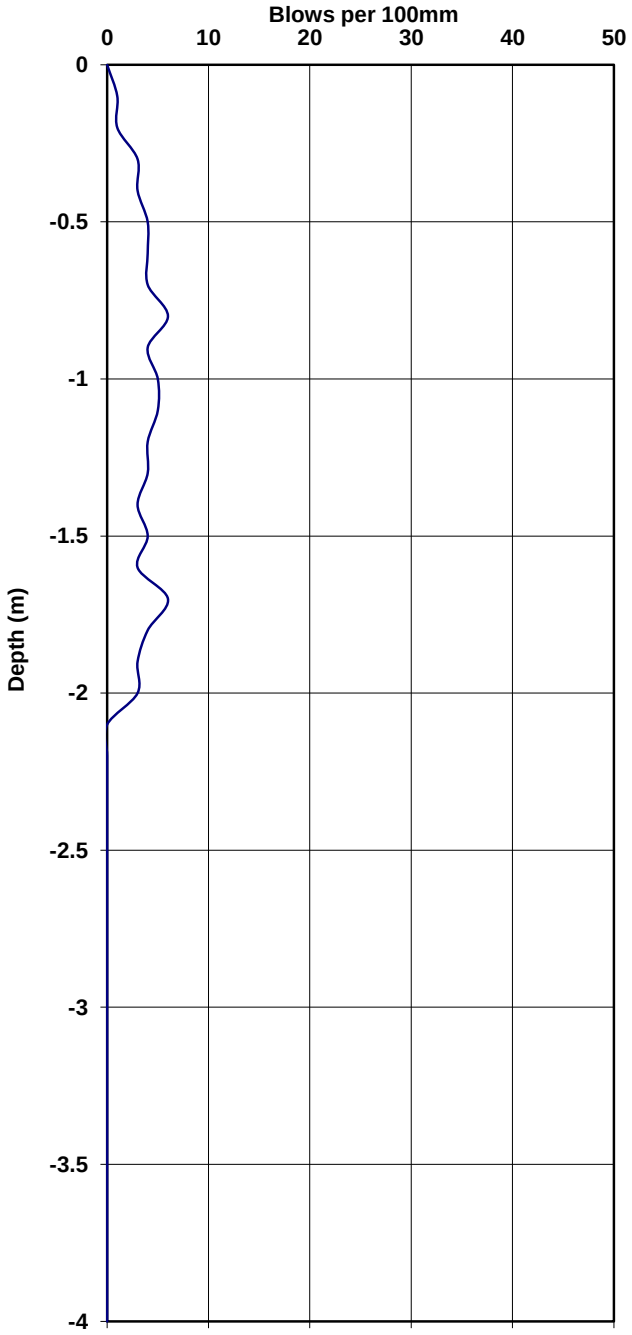

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Client:	Zutari	22-1172
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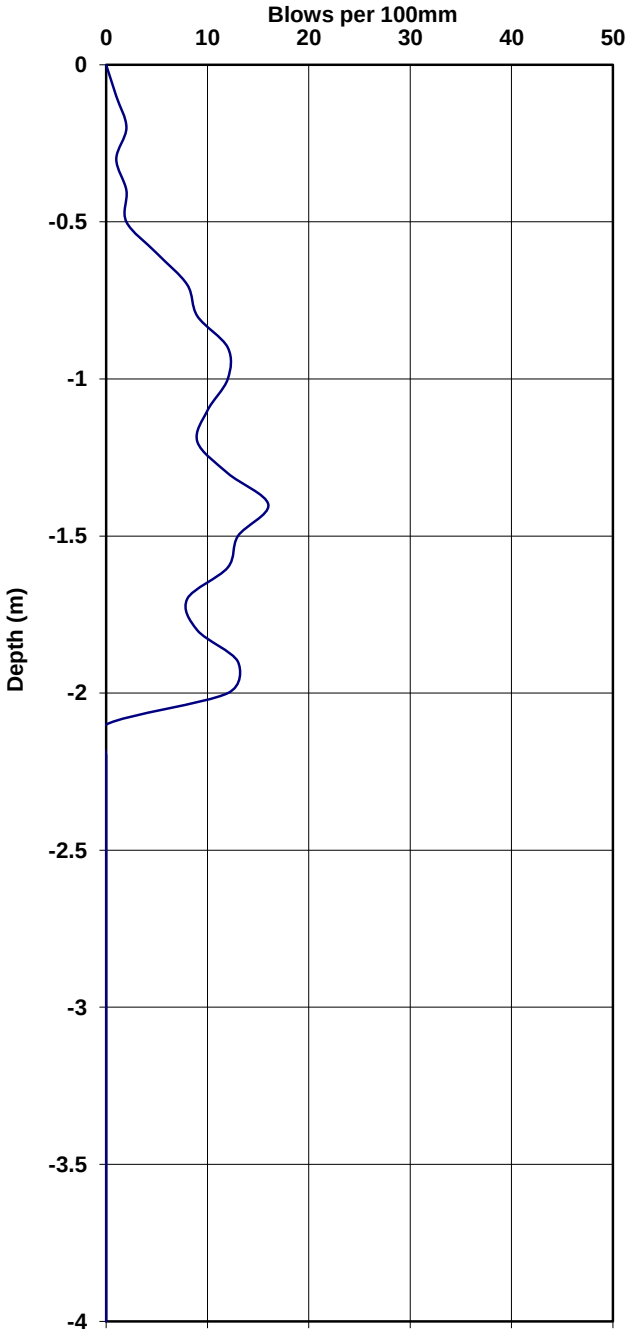
Section:	Proposed Road - Next to STP12	

CBR DYNAMIC CONE PENETROMETER PROBE — ***TEST No DCP 14***

THE STRENGTH AND CBR VALUES ARE EMPIRICAL AND DEPEND ON FACTORS SUCH AS MOISTURE CONTENT WHICH HAVE NOT BEEN DETERMINED. THEY ARE THEREFORE INDICATIVE AND SHOULD BE VERIFIED BY TEST OR OBSERVATION.

Depth (m)	Blows/ 100mm	Inferred Consistency	Shear Strength	CBR %
0				
0.1	1	Very Loose	<29	2
0.2	2	Loose	<30	3
0.3	1	Very Loose	<29	2
0.4	2	Loose	<30	3
0.5	2	Loose	<30	3
0.6	5	Med.Dense	32	8
0.7	8	Med.Dense	35	14
0.8	9	Med.Dense	35	15
0.9	12	Dense	36	21
1	12	Dense	36	21
1.1	10	Med.Dense	36	17
1.2	9	Med.Dense	35	15
1.3	12	Dense	36	21
1.4	16	Dense	37	29
1.5	13	Dense	37	23
1.6	12	Dense	36	21
1.7	8	Med.Dense	35	14
1.8	9	Med.Dense	35	15
1.9	13	Dense	37	23
2	12	Dense	36	21
2.1				
2.2				
2.3				
2.4				
2.5				
2.6				
2.7				
2.8				
2.9				
3				
3.1				
3.2				
3.3				
3.4				
3.5				
3.6				
3.7				
3.8				
3.9				
4				



C=1
Phi=0

APPENDIX D

DPSH Test Results

DYNAMIC PROBE SUPER HEAVY (DPSH)

PROJECT NAME: MACASSAR WWTW
PROJECT NUMBER: GM/CT/1480
DATE OF TEST: 2023/05/06

TEST NUMBER: #01
OPERATOR: Michael Mohajane

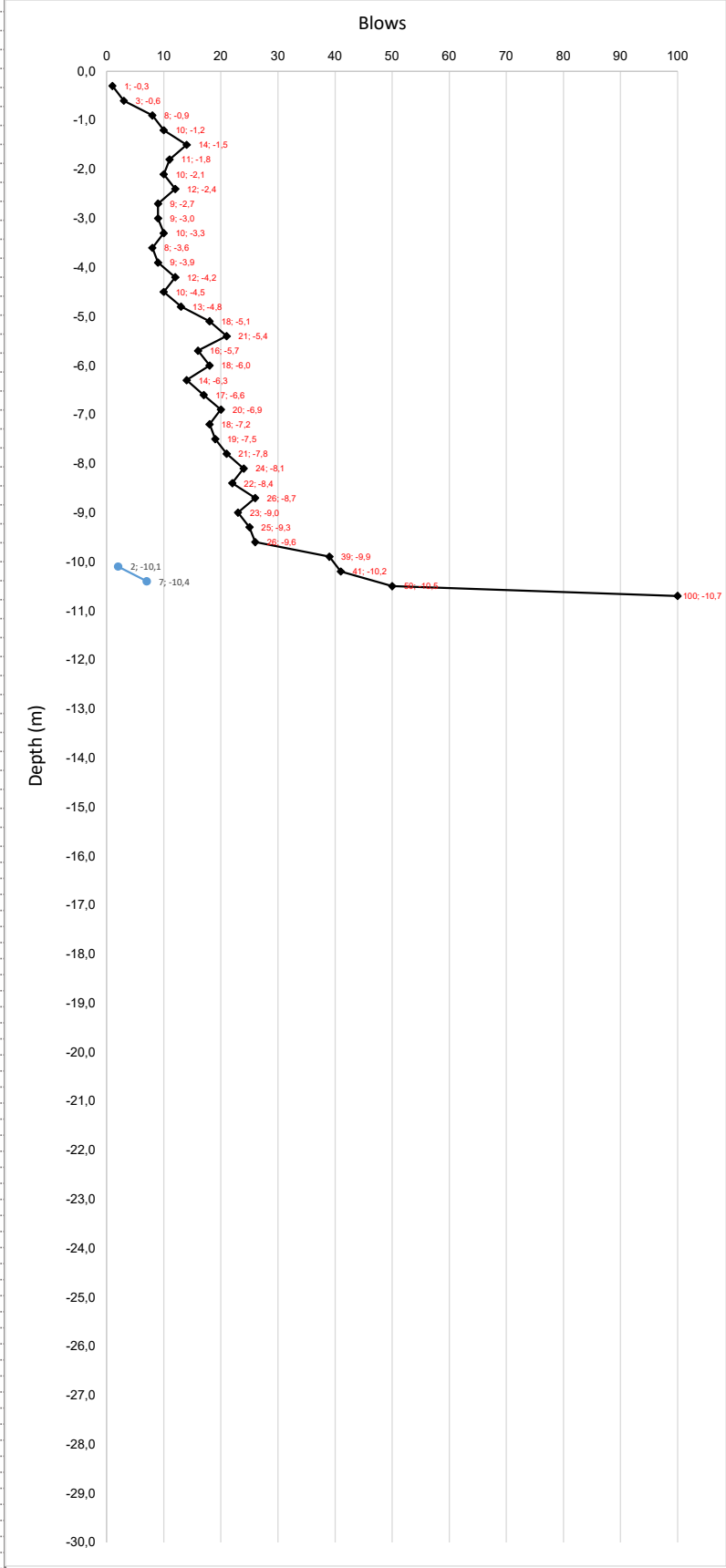
TEST RESULT

Depth (m)	Number of Blows	Redrive Depth (m)	Redrive Number of Blows
0,0			
-0,3	1		
-0,6	3		
-0,9	8		
-1,2	10		
-1,5	14		
-1,8	11		
-2,1	10		
-2,4	12		
-2,7	9		
-3,0	9		
-3,3	10		
-3,6	8		
-3,9	9		
-4,2	12		
-4,5	10		
-4,8	13		
-5,1	18		
-5,4	21		
-5,7	16		
-6,0	18		
-6,3	14		
-6,6	17		
-6,9	20		
-7,2	18		
-7,5	19		
-7,8	21		
-8,1	24		
-8,4	22		
-8,7	26		
-9,0	23		
-9,3	25		
-9,6	26		
-9,9	39		
-10,2	41	-10,1	2
-10,5	50	-10,4	7
-10,7	100		
-11,0			
-11,3			
-11,6			
-11,9			
-12,2			
-12,5			
-12,8			
-13,1			
-13,4			
-13,7			
-14,0			
-14,3			
-14,6			
-14,9			
-15,2			
-15,5			
-15,8			
-16,1			
-16,4			
-16,7			
-17,0			
-17,3			
-17,6			
-17,9			
-18,2			
-18,5			
-18,8			
-19,1			
-19,4			
-19,7			
-20,0			
-20,3			
-20,6			
-20,9			
-21,2			
-21,5			
-21,8			
-22,1			
-22,4			
-22,7			
-23,0			
-23,3			
-23,6			
-23,9			
-24,2			
-24,5			
-24,8			
-25,1			
-25,4			
-25,7			
-26,0			
-26,3			
-26,6			
-26,9			
-27,2			
-27,5			
-27,8			
-28,1			
-28,4			
-28,7			
-29,0			
-29,3			
-29,6			
-29,9			

ADDITIONAL INFORMATION

TERMINATION DEPTH: 10,70m
REDIVE **FROM:** 10,10m **BLOWS:** 2
FROM: 10,40m **BLOWS:** 7

COMMENTS:



The Blue line represents the 600mm re-drive to check rod friction

DYNAMIC PROBE SUPER HEAVY (DPSH)

PROJECT NAME: MACASSAR WWTW
PROJECT NUMBER: GM/CT/1480
DATE OF TEST: 2023/05/05

TEST NUMBER: #02
OPERATOR: Michael Mohajane

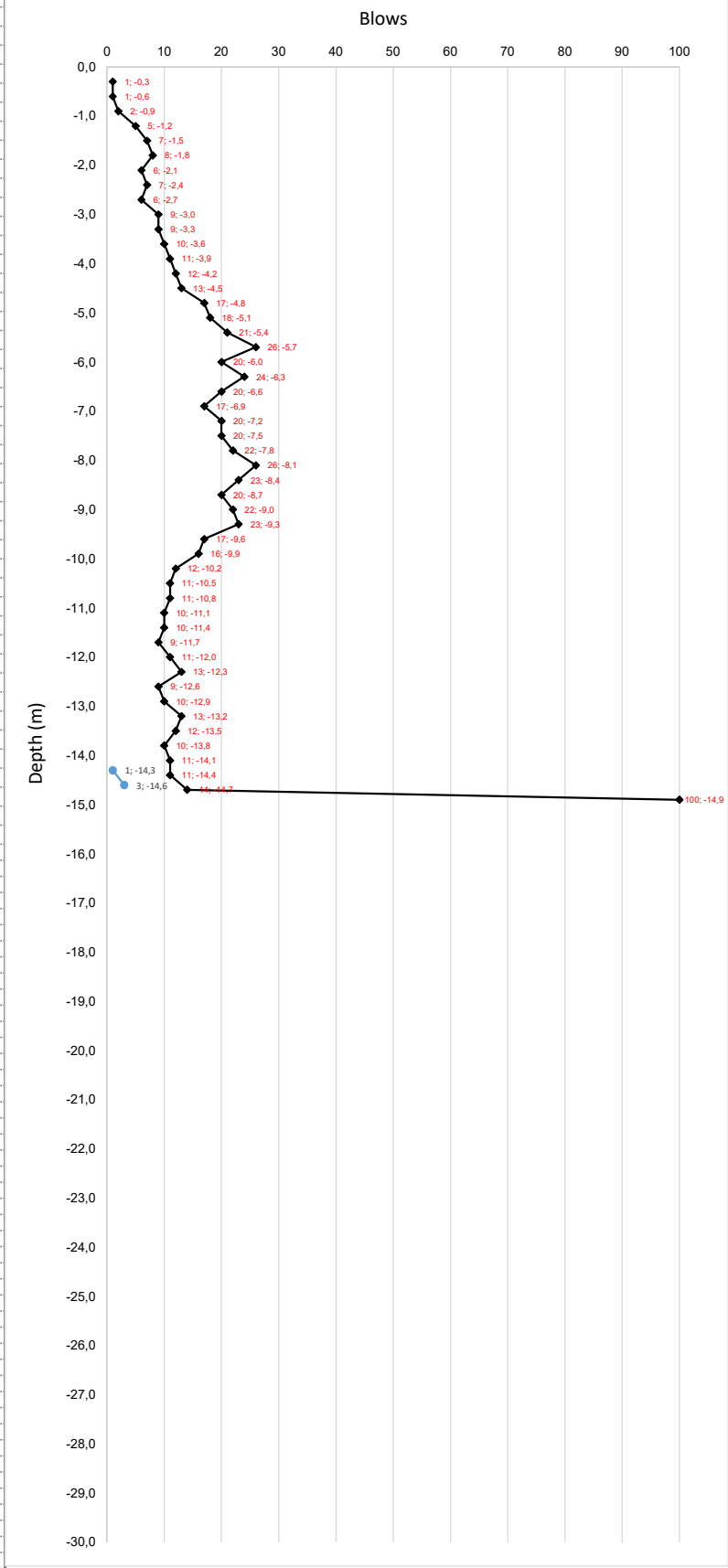
TEST RESULT

Depth (m)	Number of Blows	Redrive Depth (m)	Redrive Number of Blows
0,0			
-0,3	1		
-0,6	1		
-0,9	2		
-1,2	5		
-1,5	7		
-1,8	8		
-2,1	6		
-2,4	7		
-2,7	6		
-3,0	9		
-3,3	9		
-3,6	10		
-3,9	11		
-4,2	12		
-4,5	13		
-4,8	17		
-5,1	18		
-5,4	21		
-5,7	26		
-6,0	20		
-6,3	24		
-6,6	20		
-6,9	17		
-7,2	20		
-7,5	20		
-7,8	22		
-8,1	26		
-8,4	23		
-8,7	20		
-9,0	22		
-9,3	23		
-9,6	17		
-9,9	16		
-10,2	12		
-10,5	11		
-10,8	11		
-11,1	10		
-11,4	10		
-11,7	9		
-12,0	11		
-12,3	13		
-12,6	9		
-12,9	10		
-13,2	13		
-13,5	12		
-13,8	10		
-14,1	11		
-14,4	11	-14,3	1
-14,7	14	-14,6	3
-14,9	100		
-15,2			
-15,5			
-15,8			
-16,1			
-16,4			
-16,7			
-17,0			
-17,3			
-17,6			
-17,9			
-18,2			
-18,5			
-18,8			
-19,1			
-19,4			
-19,7			
-20,0			
-20,3			
-20,6			
-20,9			
-21,2			
-21,5			
-21,8			
-22,1			
-22,4			
-22,7			
-23,0			
-23,3			
-23,6			
-23,9			
-24,2			
-24,5			
-24,8			
-25,1			
-25,4			
-25,7			
-26,0			
-26,3			
-26,6			
-26,9			
-27,2			
-27,5			
-27,8			
-28,1			
-28,4			
-28,7			
-29,0			
-29,3			
-29,6			
-29,9			

ADDITIONAL INFORMATION

TERMINATION DEPTH: 14,90m
REDIVE **FROM:** 14,30m **BLOWS:** 1
FROM: 14,60m **BLOWS:** 3

COMMENTS:



The Blue line represents the 600mm re-drive to check rod friction

DYNAMIC PROBE SUPER HEAVY (DPSH)

PROJECT NAME: MACASSAR WWTW
PROJECT NUMBER: GM/CT/1480
DATE OF TEST: 2023/05/06

TEST NUMBER: #05
OPERATOR: Michael Mohajane

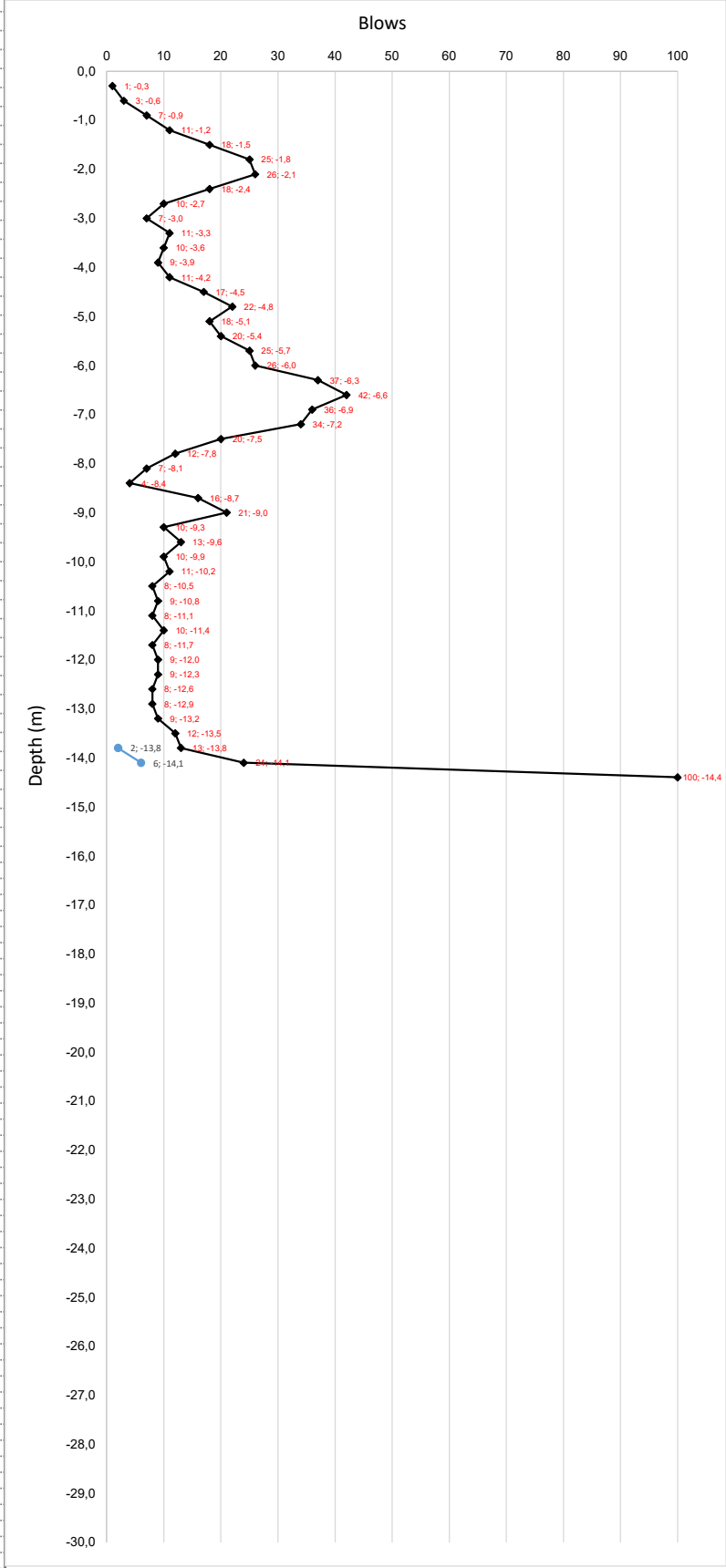
TEST RESULT

Depth (m)	Number of Blows	Redrive Depth (m)	Redrive Number of Blows
0,0			
-0,3	1		
-0,6	3		
-0,9	7		
-1,2	11		
-1,5	18		
-1,8	25		
-2,1	26		
-2,4	18		
-2,7	10		
-3,0	7		
-3,3	11		
-3,6	10		
-3,9	9		
-4,2	11		
-4,5	17		
-4,8	22		
-5,1	18		
-5,4	20		
-5,7	25		
-6,0	26		
-6,3	37		
-6,6	42		
-6,9	36		
-7,2	34		
-7,5	20		
-7,8	12		
-8,1	7		
-8,4	4		
-8,7	16		
-9,0	21		
-9,3	10		
-9,6	13		
-9,9	10		
-10,2	11		
-10,5	8		
-10,8	9		
-11,1	8		
-11,4	10		
-11,7	8		
-12,0	9		
-12,3	9		
-12,6	8		
-12,9	8		
-13,2	9		
-13,5	12		
-13,8	13	-13,8	2
-14,1	24	-14,1	6
-14,4	100		
-14,7			
-15,0			
-15,3			
-15,6			
-15,9			
-16,2			
-16,5			
-16,8			
-17,1			
-17,4			
-17,7			
-18,0			
-18,3			
-18,6			
-18,9			
-19,2			
-19,5			
-19,8			
-20,1			
-20,4			
-20,7			
-21,0			
-21,3			
-21,6			
-21,9			
-22,2			
-22,5			
-22,8			
-23,1			
-23,4			
-23,7			
-24,0			
-24,3			
-24,6			
-24,9			
-25,2			
-25,5			
-25,8			
-26,1			
-26,4			
-26,7			
-27,0			
-27,3			
-27,6			
-27,9			
-28,2			
-28,5			
-28,8			
-29,1			
-29,4			
-29,7			
-30,0			

ADDITIONAL INFORMATION

TERMINATION DEPTH: 14,40m
REDIVE **FROM:** 13,80m **BLOWS:** 2
FROM: 14,10m **BLOWS:** 6

COMMENTS:



The Blue line represents the 600mm re-drive to check rod friction

DYNAMIC PROBE SUPER HEAVY (DPSH)

PROJECT NAME: MACASSAR WWTW
PROJECT NUMBER: GM/CT/1480
DATE OF TEST: 2023/05/06

TEST NUMBER: #08
OPERATOR: Michael Mohajane

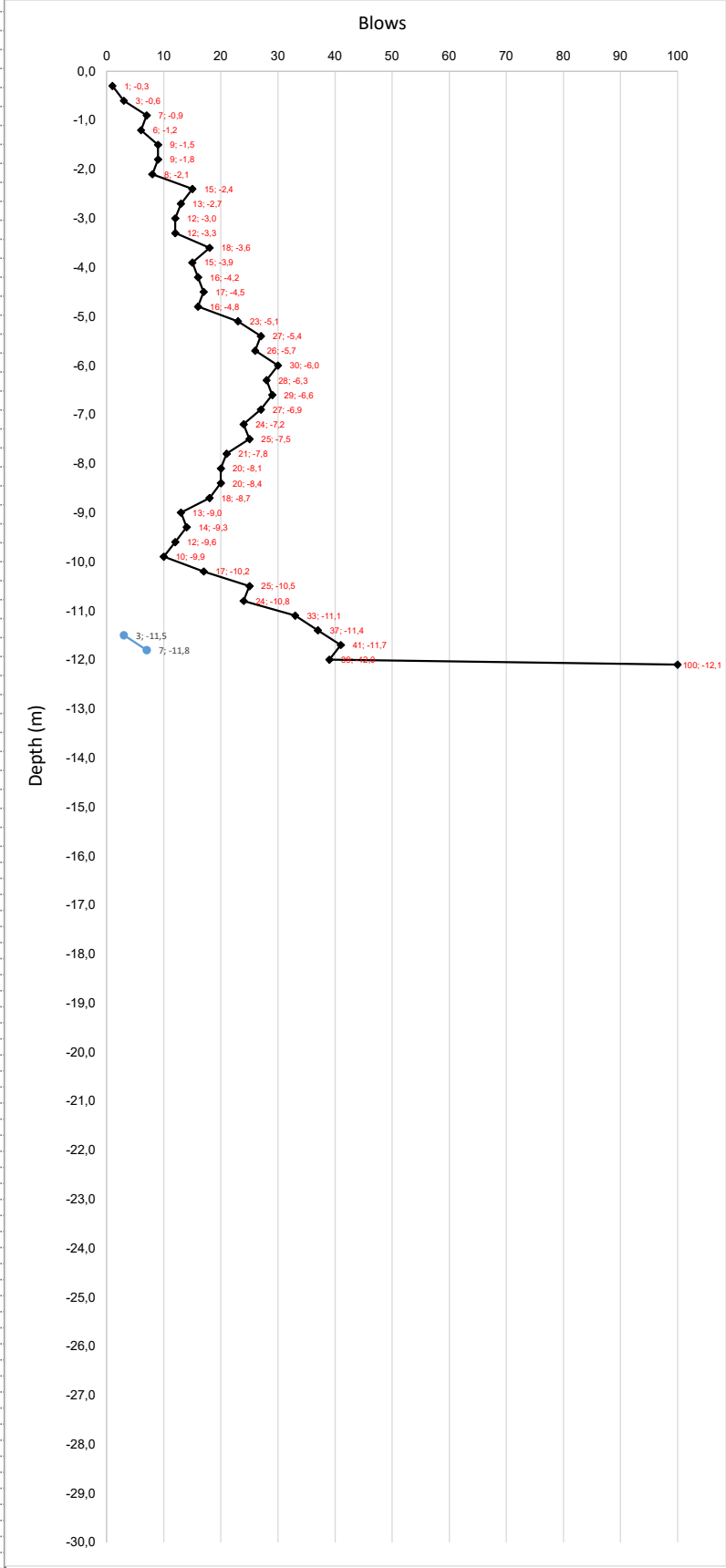
TEST RESULT

Depth (m)	Number of Blows	Redrive Depth (m)	Redrive Number of Blows
0,0			
-0,3	1		
-0,6	3		
-0,9	7		
-1,2	6		
-1,5	9		
-1,8	9		
-2,1	8		
-2,4	15		
-2,7	13		
-3,0	12		
-3,3	12		
-3,6	18		
-3,9	15		
-4,2	16		
-4,5	17		
-4,8	16		
-5,1	23		
-5,4	27		
-5,7	26		
-6,0	30		
-6,3	28		
-6,6	29		
-6,9	27		
-7,2	24		
-7,5	25		
-7,8	21		
-8,1	20		
-8,4	20		
-8,7	18		
-9,0	13		
-9,3	14		
-9,6	12		
-9,9	10		
-10,2	17		
-10,5	25		
-10,8	24		
-11,1	33		
-11,4	37	-11,5	3
-11,7	41	-11,8	7
-12,0	39		
-12,1	100		
-12,4			
-12,7			
-13,0			
-13,3			
-13,6			
-13,9			
-14,2			
-14,5			
-14,8			
-15,1			
-15,4			
-15,7			
-16,0			
-16,3			
-16,6			
-16,9			
-17,2			
-17,5			
-17,8			
-18,1			
-18,4			
-18,7			
-19,0			
-19,3			
-19,6			
-19,9			
-20,2			
-20,5			
-20,8			
-21,1			
-21,4			
-21,7			
-22,0			
-22,3			
-22,6			
-22,9			
-23,2			
-23,5			
-23,8			
-24,1			
-24,4			
-24,7			
-25,0			
-25,3			
-25,6			
-25,9			
-26,2			
-26,5			
-26,8			
-27,1			
-27,4			
-27,7			
-28,0			
-28,3			
-28,6			
-28,9			
-29,2			
-29,5			
-29,8			

ADDITIONAL INFORMATION

TERMINATION DEPTH: 12,20m
REDIVE **FROM:** 11,50m **BLOWS:** 2
FROM: 11,8 **BLOWS:** 7

COMMENTS:



The Blue line represents the 600mm re-drive to check rod friction

DYNAMIC PROBE SUPER HEAVY (DPSH)

PROJECT NAME: MACASSAR WWTW
PROJECT NUMBER: GM/CT/1480
DATE OF TEST: 2023/04/29

TEST NUMBER: #13
OPERATOR: Michael Mohajane

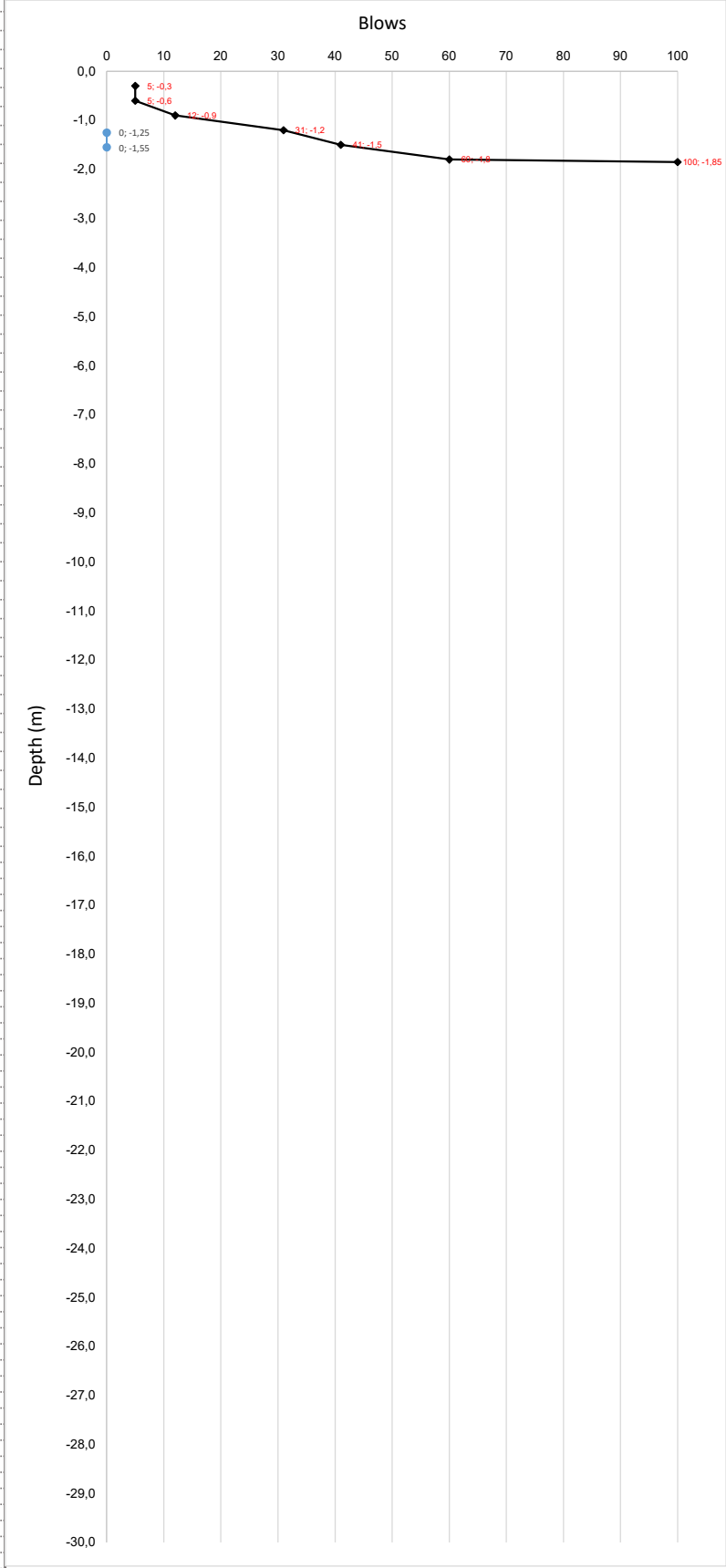
TEST RESULT

Depth (m)	Number of Blows	Redrive Depth (m)	Redrive Number of Blows
0,0			
-0,3	5		
-0,6	5		
-0,9	12		
-1,2	31	-1,25	0
-1,5	41	-1,55	0
-1,8	60		
-1,85	100		
-2,2			
-2,5			
-2,8			
-3,1			
-3,4			
-3,7			
-4,0			
-4,3			
-4,6			
-4,9			
-5,2			
-5,5			
-5,8			
-6,1			
-6,4			
-6,7			
-7,0			
-7,3			
-7,6			
-7,9			
-8,2			
-8,5			
-8,8			
-9,1			
-9,4			
-9,7			
-10,0			
-10,3			
-10,6			
-10,9			
-11,2			
-11,5			
-11,8			
-12,1			
-12,4			
-12,7			
-13,0			
-13,3			
-13,6			
-13,9			
-14,2			
-14,5			
-14,8			
-15,1			
-15,4			
-15,7			
-16,0			
-16,3			
-16,6			
-16,9			
-17,2			
-17,5			
-17,8			
-18,1			
-18,4			
-18,7			
-19,0			
-19,3			
-19,6			
-19,9			
-20,2			
-20,5			
-20,8			
-21,1			
-21,4			
-21,7			
-22,0			
-22,3			
-22,6			
-22,9			
-23,2			
-23,5			
-23,8			
-24,1			
-24,4			
-24,7			
-25,0			
-25,3			
-25,6			
-25,9			
-26,2			
-26,5			
-26,8			
-27,1			
-27,4			
-27,7			
-28,0			
-28,3			
-28,6			
-28,9			
-29,2			
-29,5			
-29,8			

ADDITIONAL INFORMATION

TERMINATION DEPTH: 1,85m
REDIVE **FROM:** 1,25m **BLOWS:** 0
FROM: 1,55m **BLOWS:** 0

COMMENTS:



The Blue line represents the 600mm re-drive to check rod friction

DYNAMIC PROBE SUPER HEAVY (DPSH)

PROJECT NAME: MACASSAR WWTW
PROJECT NUMBER: GM/CT/1480
DATE OF TEST: 2023/04/29

TEST NUMBER: #14
OPERATOR: Michael Mohajane

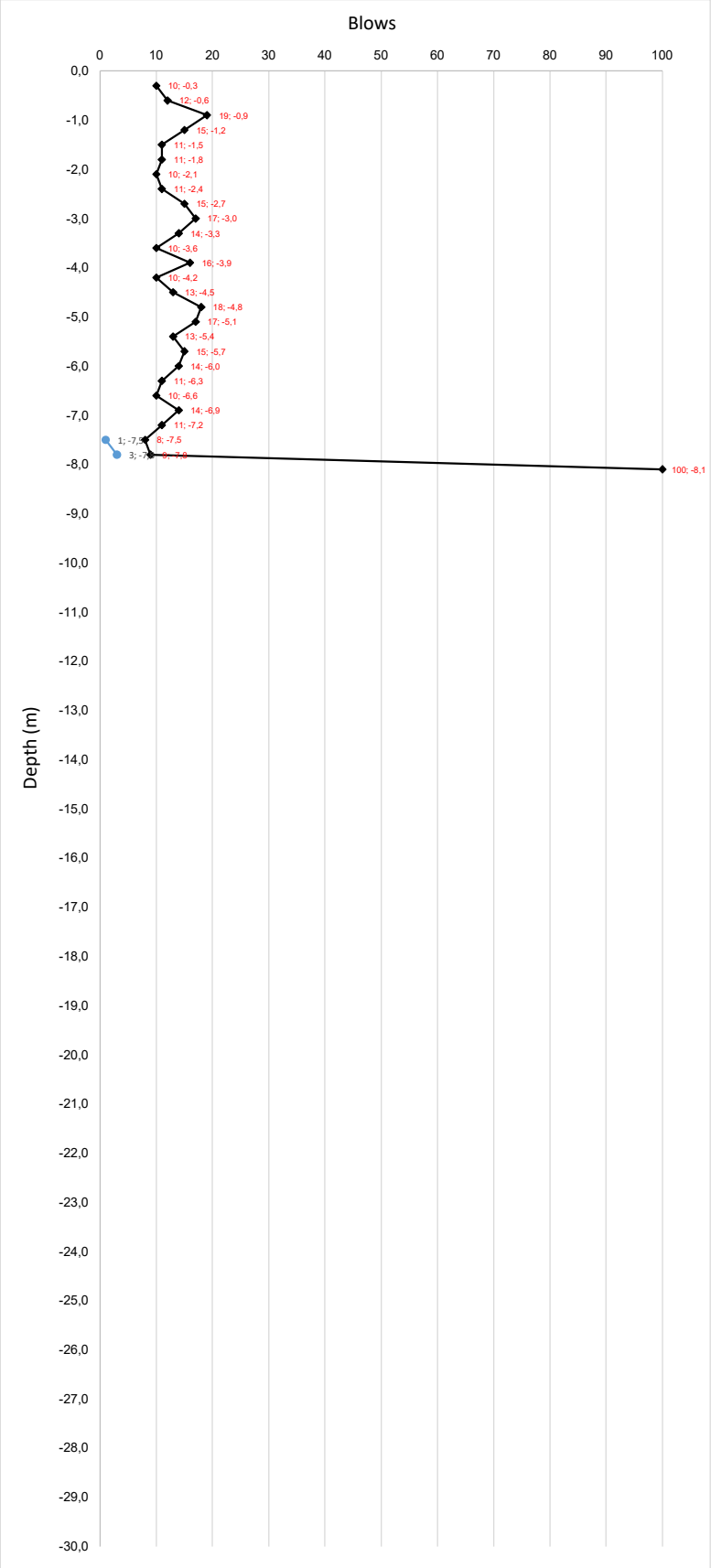
TEST RESULT

Depth (m)	Number of Blows	Redrive Depth (m)	Redrive Number of Blows
0,0			
-0,3	10		
-0,6	12		
-0,9	19		
-1,2	15		
-1,5	11		
-1,8	11		
-2,1	10		
-2,4	11		
-2,7	15		
-3,0	17		
-3,3	14		
-3,6	10		
-3,9	16		
-4,2	10		
-4,5	13		
-4,8	18		
-5,1	17		
-5,4	13		
-5,7	15		
-6,0	14		
-6,3	11		
-6,6	10		
-6,9	14		
-7,2	11		
-7,5	8	-7,5	1
-7,8	9	-7,8	3
-8,1	100		
-8,4			
-8,7			
-9,0			
-9,3			
-9,6			
-9,9			
-10,2			
-10,5			
-10,8			
-11,1			
-11,4			
-11,7			
-12,0			
-12,3			
-12,6			
-12,9			
-13,2			
-13,5			
-13,8			
-14,1			
-14,4			
-14,7			
-15,0			
-15,3			
-15,6			
-15,9			
-16,2			
-16,5			
-16,8			
-17,1			
-17,4			
-17,7			
-18,0			
-18,3			
-18,6			
-18,9			
-19,2			
-19,5			
-19,8			
-20,1			
-20,4			
-20,7			
-21,0			
-21,3			
-21,6			
-21,9			
-22,2			
-22,5			
-22,8			
-23,1			
-23,4			
-23,7			
-24,0			
-24,3			
-24,6			
-24,9			
-25,2			
-25,5			
-25,8			
-26,1			
-26,4			
-26,7			
-27,0			
-27,3			
-27,6			
-27,9			
-28,2			
-28,5			
-28,8			
-29,1			
-29,4			
-29,7			
-30,0			

ADDITIONAL INFORMATION

TERMINATION DEPTH: 8,10m
REDIVE **FROM:** 7,50m **BLOWS:** 1
FROM: 7,80m **BLOWS:** 3

COMMENTS:



The Blue line represents the 600mm re-drive to check rod friction

DYNAMIC PROBE SUPER HEAVY (DPSH)

PROJECT NAME: MACASSAR WWTW
PROJECT NUMBER: GM/CT/1480
DATE OF TEST: 2023/04/29

TEST NUMBER: #15
OPERATOR: Michael Mohajane

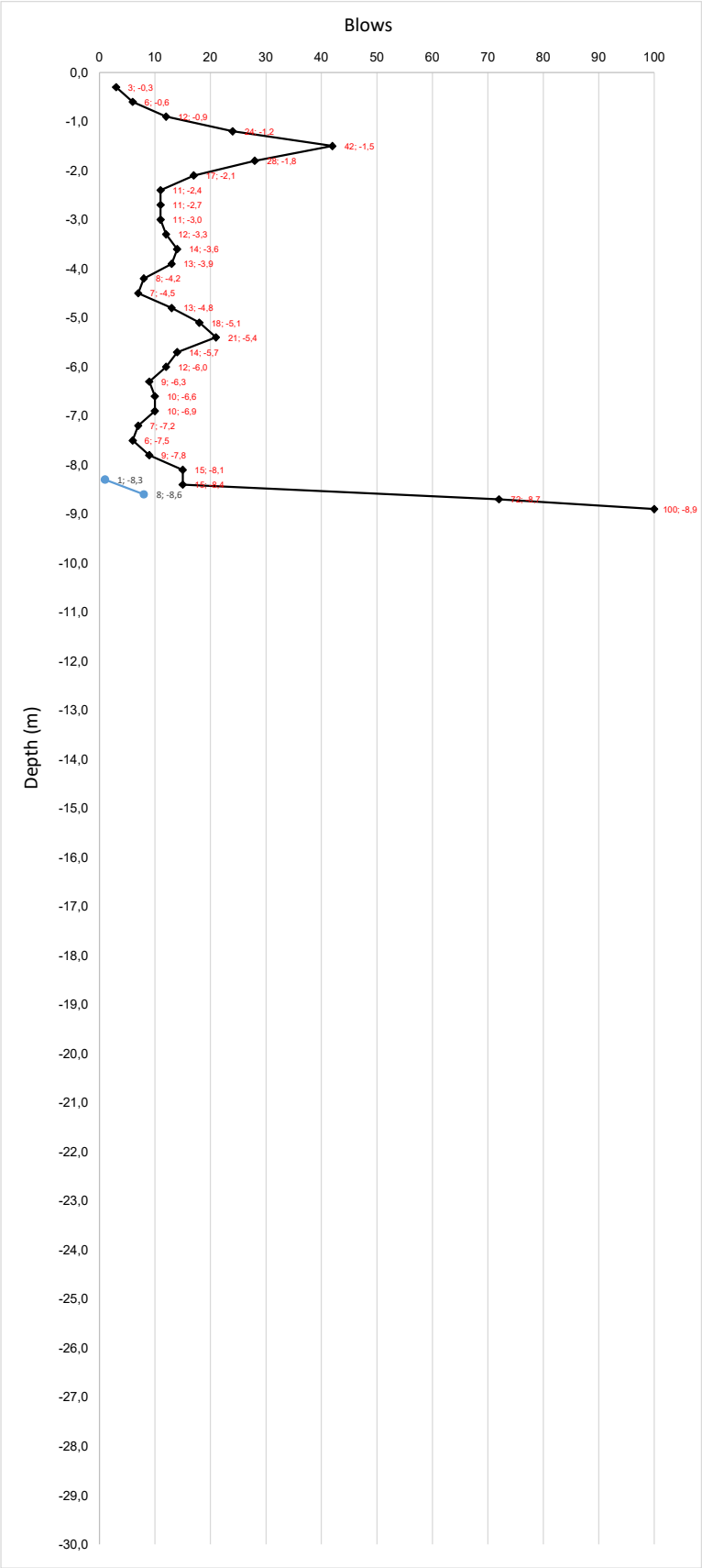
TEST RESULT

Depth (m)	Number of Blows	Redrive Depth (m)	Redrive Number of Blows
0,0			
-0,3	3		
-0,6	6		
-0,9	12		
-1,2	24		
-1,5	42		
-1,8	28		
-2,1	17		
-2,4	11		
-2,7	11		
-3,0	11		
-3,3	12		
-3,6	14		
-3,9	13		
-4,2	8		
-4,5	7		
-4,8	13		
-5,1	18		
-5,4	21		
-5,7	14		
-6,0	12		
-6,3	9		
-6,6	10		
-6,9	10		
-7,2	7		
-7,5	6		
-7,8	9		
-8,1	15		
-8,4	15	-8,3	1
-8,7	72	-8,6	8
-8,9	100		
-9,2			
-9,5			
-9,8			
-10,1			
-10,4			
-10,7			
-11,0			
-11,3			
-11,6			
-11,9			
-12,2			
-12,5			
-12,8			
-13,1			
-13,4			
-13,7			
-14,0			
-14,3			
-14,6			
-14,9			
-15,2			
-15,5			
-15,8			
-16,1			
-16,4			
-16,7			
-17,0			
-17,3			
-17,6			
-17,9			
-18,2			
-18,5			
-18,8			
-19,1			
-19,4			
-19,7			
-20,0			
-20,3			
-20,6			
-20,9			
-21,2			
-21,5			
-21,8			
-22,1			
-22,4			
-22,7			
-23,0			
-23,3			
-23,6			
-23,9			
-24,2			
-24,5			
-24,8			
-25,1			
-25,4			
-25,7			
-26,0			
-26,3			
-26,6			
-26,9			
-27,2			
-27,5			
-27,8			
-28,1			
-28,4			
-28,7			
-29,0			
-29,3			
-29,6			
-29,9			

ADDITIONAL INFORMATION

TERMINATION DEPTH: 8,90m
REDIVE **FROM:** 8,30m **BLOWS:** 1
FROM: 8,60m **BLOWS:** 8

COMMENTS:



The Blue line represents the 600mm re-drive to check rod friction

DYNAMIC PROBE SUPER HEAVY (DPSH)

PROJECT NAME: MACASSAR WWTW
PROJECT NUMBER: GM/CT/1480
DATE OF TEST: 2023/05/05

TEST NUMBER: #16
OPERATOR: Michael Mohajane

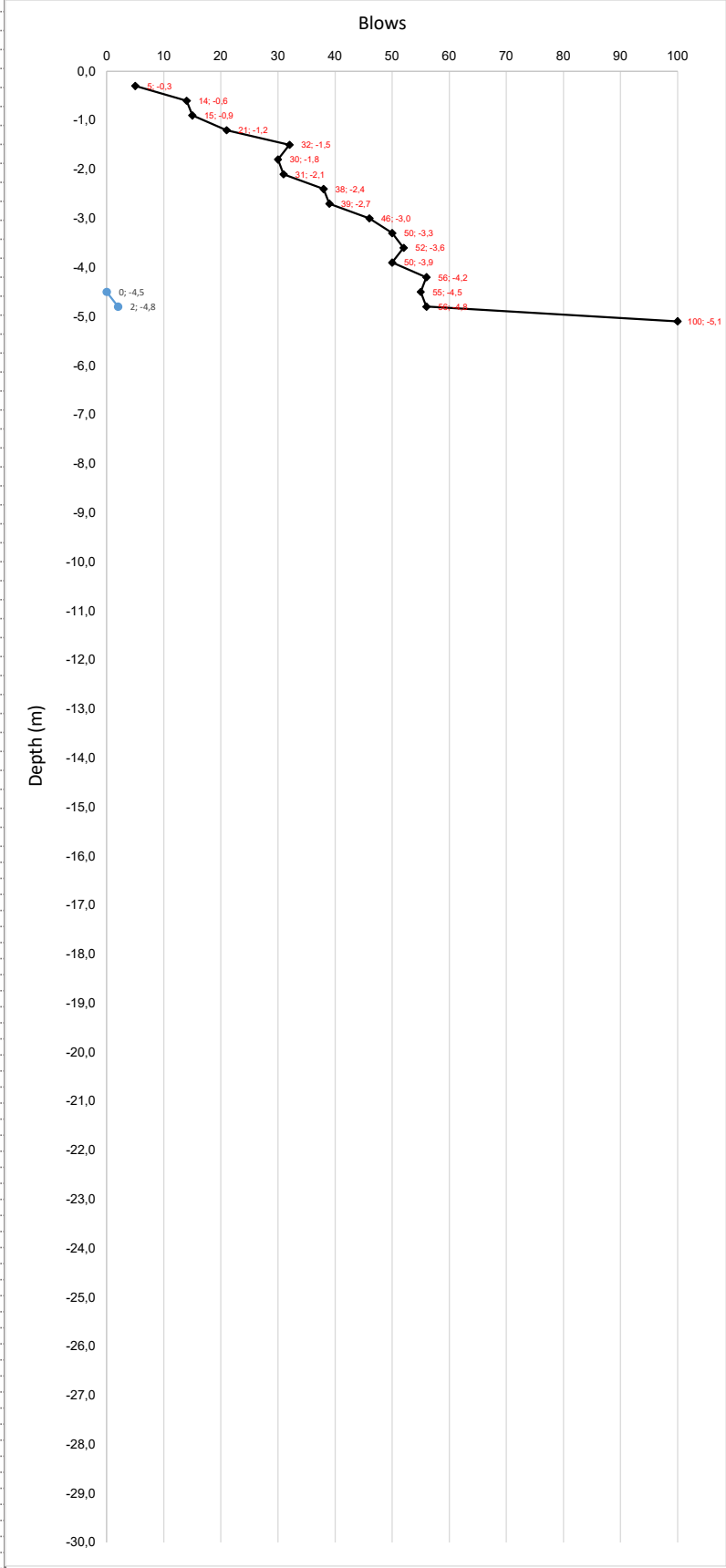
TEST RESULT

Depth (m)	Number of Blows	Redrive Depth (m)	Redrive Number of Blows
0,0			
-0,3	5		
-0,6	14		
-0,9	15		
-1,2	21		
-1,5	32		
-1,8	30		
-2,1	31		
-2,4	38		
-2,7	39		
-3,0	46		
-3,3	50		
-3,6	52		
-3,9	50		
-4,2	56		
-4,5	55	-4,5	0
-4,8	56	-4,8	2
-5,1	100		
-5,4			
-5,7			
-6,0			
-6,3			
-6,6			
-6,9			
-7,2			
-7,5			
-7,8			
-8,1			
-8,4			
-8,7			
-9,0			
-9,3			
-9,6			
-9,9			
-10,2			
-10,5			
-10,8			
-11,1			
-11,4			
-11,7			
-12,0			
-12,3			
-12,6			
-12,9			
-13,2			
-13,5			
-13,8			
-14,1			
-14,4			
-14,7			
-15,0			
-15,3			
-15,6			
-15,9			
-16,2			
-16,5			
-16,8			
-17,1			
-17,4			
-17,7			
-18,0			
-18,3			
-18,6			
-18,9			
-19,2			
-19,5			
-19,8			
-20,1			
-20,4			
-20,7			
-21,0			
-21,3			
-21,6			
-21,9			
-22,2			
-22,5			
-22,8			
-23,1			
-23,4			
-23,7			
-24,0			
-24,3			
-24,6			
-24,9			
-25,2			
-25,5			
-25,8			
-26,1			
-26,4			
-26,7			
-27,0			
-27,3			
-27,6			
-27,9			
-28,2			
-28,5			
-28,8			
-29,1			
-29,4			
-29,7			
-30,0			

ADDITIONAL INFORMATION

TERMINATION DEPTH: 5,10m
REDIVE **FROM:** 4,50m **BLOWS:** 0
FROM: 4,80m **BLOWS:** 2

COMMENTS:



The Blue line represents the 600mm re-drive to check rod friction

DYNAMIC PROBE SUPER HEAVY (DPSH)

PROJECT NAME: MACASSAR WWTW
PROJECT NUMBER: GM/CT/1480
DATE OF TEST: 2023/05/06

TEST NUMBER: #18
OPERATOR: Michael Mohajane

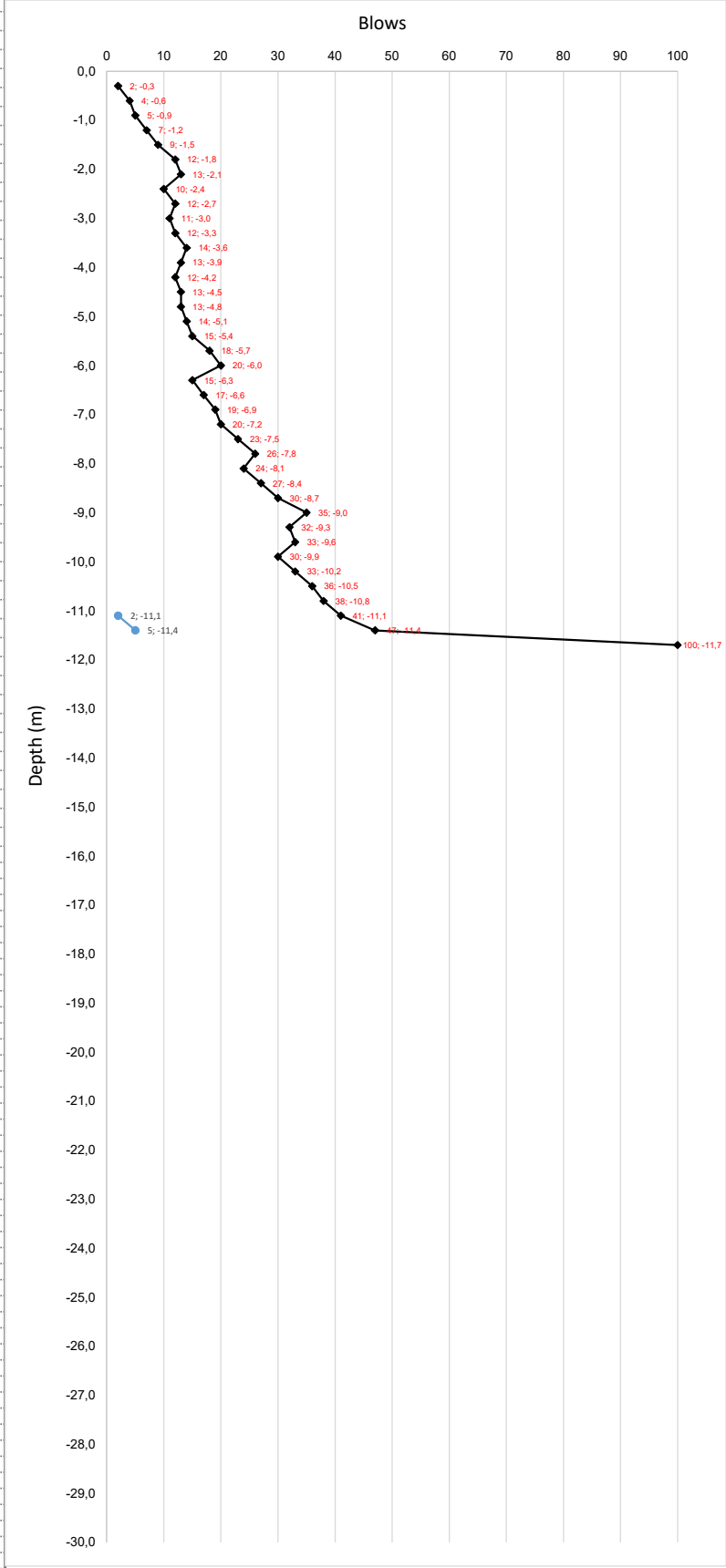
TEST RESULT

Depth (m)	Number of Blows	Redrive Depth (m)	Redrive Number of Blows
0,0			
-0,3	2		
-0,6	4		
-0,9	5		
-1,2	7		
-1,5	9		
-1,8	12		
-2,1	13		
-2,4	10		
-2,7	12		
-3,0	11		
-3,3	12		
-3,6	14		
-3,9	13		
-4,2	12		
-4,5	13		
-4,8	13		
-5,1	14		
-5,4	15		
-5,7	18		
-6,0	20		
-6,3	15		
-6,6	17		
-6,9	19		
-7,2	20		
-7,5	23		
-7,8	26		
-8,1	24		
-8,4	27		
-8,7	30		
-9,0	35		
-9,3	32		
-9,6	33		
-9,9	30		
-10,2	33		
-10,5	36		
-10,8	38		
-11,1	41	-11,1	2
-11,4	47	-11,4	5
-11,7	100		
-12,0			
-12,3			
-12,6			
-12,9			
-13,2			
-13,5			
-13,8			
-14,1			
-14,4			
-14,7			
-15,0			
-15,3			
-15,6			
-15,9			
-16,2			
-16,5			
-16,8			
-17,1			
-17,4			
-17,7			
-18,0			
-18,3			
-18,6			
-18,9			
-19,2			
-19,5			
-19,8			
-20,1			
-20,4			
-20,7			
-21,0			
-21,3			
-21,6			
-21,9			
-22,2			
-22,5			
-22,8			
-23,1			
-23,4			
-23,7			
-24,0			
-24,3			
-24,6			
-24,9			
-25,2			
-25,5			
-25,8			
-26,1			
-26,4			
-26,7			
-27,0			
-27,3			
-27,6			
-27,9			
-28,2			
-28,5			
-28,8			
-29,1			
-29,4			
-29,7			
-30,0			

ADDITIONAL INFORMATION

TERMINATION DEPTH: 11,70m
REDIVE **FROM:** 11,10m **BLOWS:** 2
FROM: 11,4 **BLOWS:** 5

COMMENTS:



The Blue line represents the 600mm re-drive to check rod friction

DYNAMIC PROBE SUPER HEAVY (DPSH)

PROJECT NAME: MACASSAR WWTW
PROJECT NUMBER: GM/CT/1480
DATE OF TEST: 2023/04/20

TEST NUMBER: #19
OPERATOR: Michael Mohajane

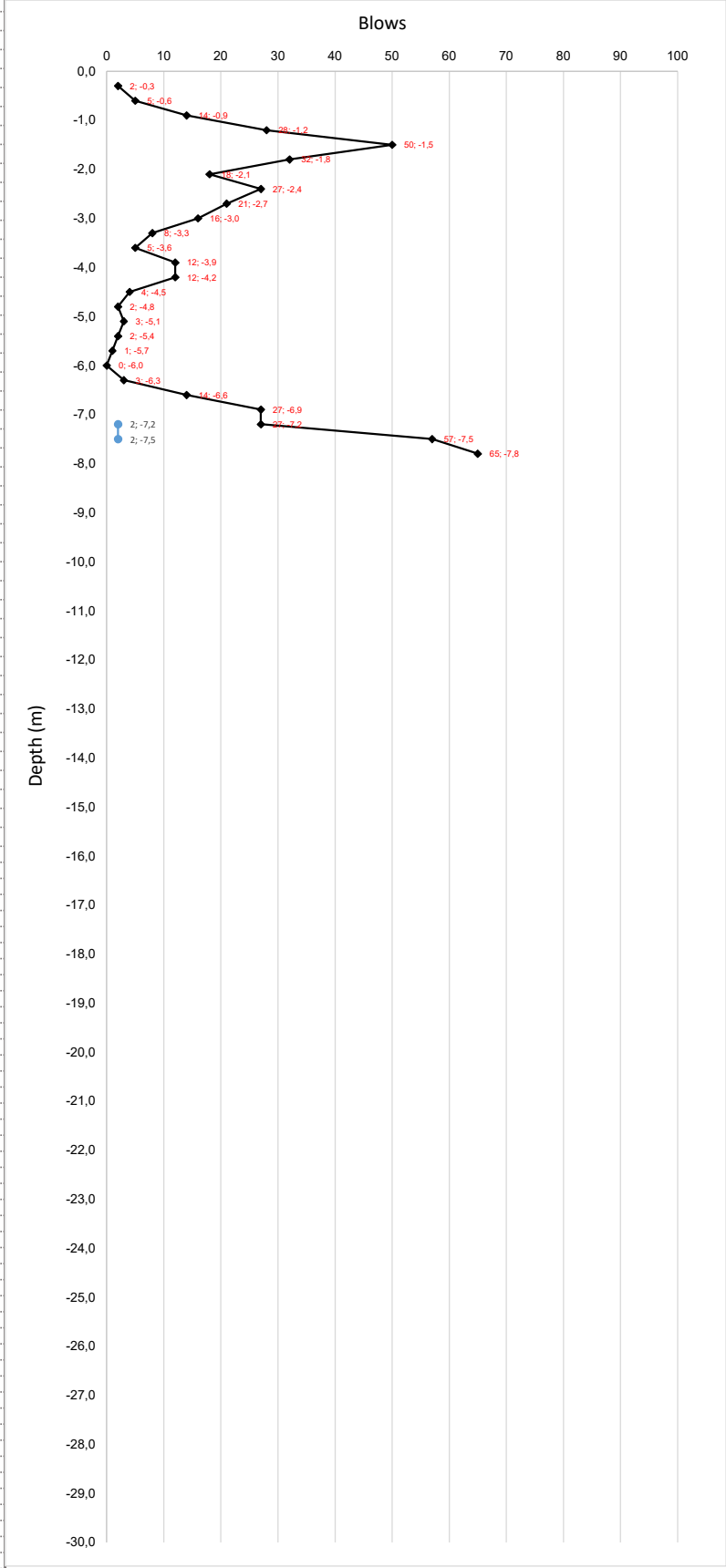
TEST RESULT

Depth (m)	Number of Blows	Redrive Depth (m)	Redrive Number of Blows
0,0			
-0,3	2		
-0,6	5		
-0,9	14		
-1,2	28		
-1,5	50		
-1,8	32		
-2,1	18		
-2,4	27		
-2,7	21		
-3,0	16		
-3,3	8		
-3,6	5		
-3,9	12		
-4,2	12		
-4,5	4		
-4,8	2		
-5,1	3		
-5,4	2		
-5,7	1		
-6,0	0		
-6,3	3		
-6,6	14		
-6,9	27		
-7,2	27	-7,2	2
-7,5	57	-7,5	2
-7,8	65		
-8,1			
-8,4			
-8,7			
-9,0			
-9,3			
-9,6			
-9,9			
-10,2			
-10,5			
-10,8			
-11,1			
-11,4			
-11,7			
-12,0			
-12,3			
-12,6			
-12,9			
-13,2			
-13,5			
-13,8			
-14,1			
-14,4			
-14,7			
-15,0			
-15,3			
-15,6			
-15,9			
-16,2			
-16,5			
-16,8			
-17,1			
-17,4			
-17,7			
-18,0			
-18,3			
-18,6			
-18,9			
-19,2			
-19,5			
-19,8			
-20,1			
-20,4			
-20,7			
-21,0			
-21,3			
-21,6			
-21,9			
-22,2			
-22,5			
-22,8			
-23,1			
-23,4			
-23,7			
-24,0			
-24,3			
-24,6			
-24,9			
-25,2			
-25,5			
-25,8			
-26,1			
-26,4			
-26,7			
-27,0			
-27,3			
-27,6			
-27,9			
-28,2			
-28,5			
-28,8			
-29,1			
-29,4			
-29,7			
-30,0			

ADDITIONAL INFORMATION

TERMINATION DEPTH: 7,80m
REDIVE **FROM:** 7,20m **BLOWS:** 2
FROM: 7,50m **BLOWS:** 2

COMMENTS:



The Blue line represents the 600mm re-drive to check rod friction

DYNAMIC PROBE SUPER HEAVY (DPSH)

PROJECT NAME: MACASSAR WWTW
PROJECT NUMBER: GM/CT/1480
DATE OF TEST: 2023/04/29

TEST NUMBER: #21
OPERATOR: Michael Mohajane

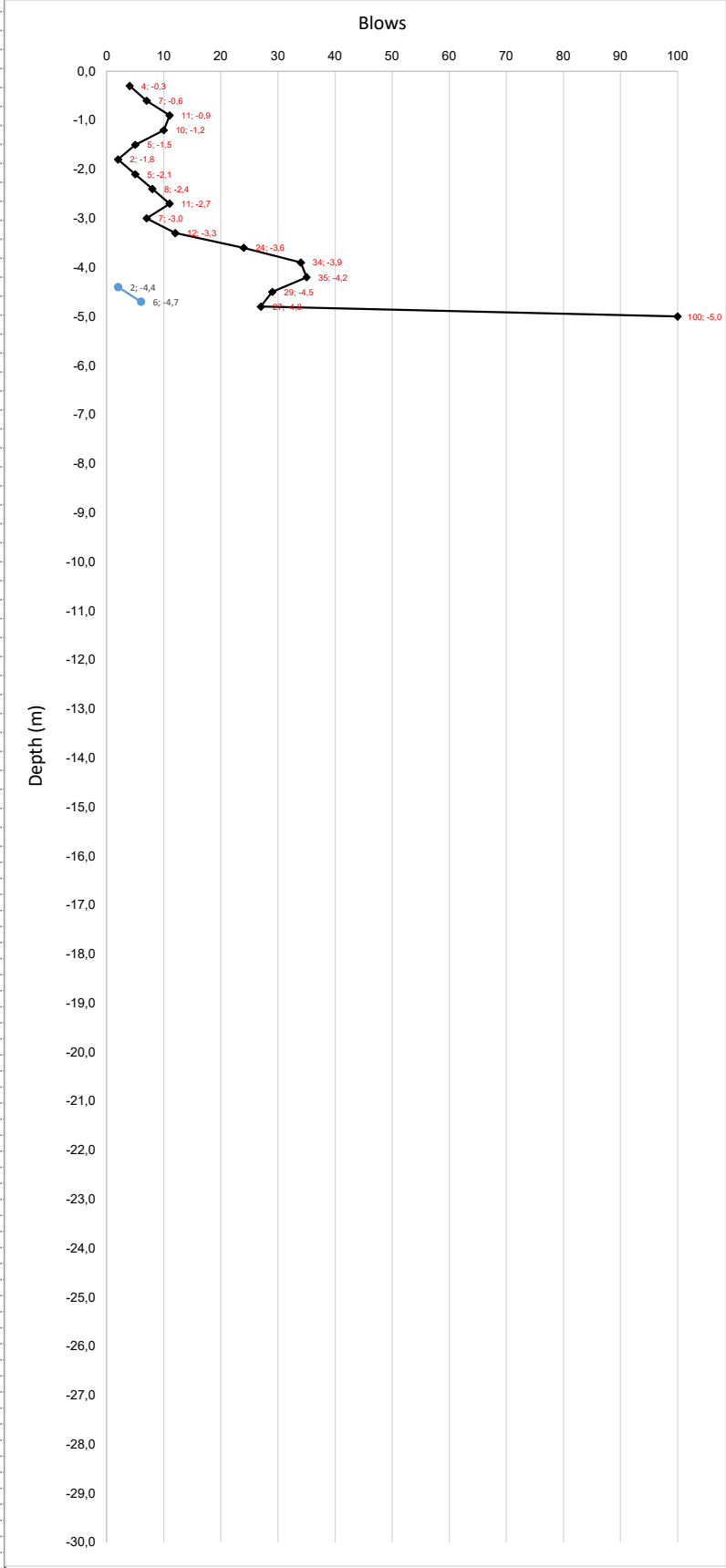
TEST RESULT

Depth (m)	Number of Blows	Redrive Depth (m)	Redrive Number of Blows
0,0			
-0,3	4		
-0,6	7		
-0,9	11		
-1,2	10		
-1,5	5		
-1,8	2		
-2,1	5		
-2,4	8		
-2,7	11		
-3,0	7		
-3,3	12		
-3,6	24		
-3,9	34		
-4,2	35		
-4,5	29	-4,4	2
-4,8	27	-4,7	6
-5,0	100		
-5,3			
-5,6			
-5,9			
-6,2			
-6,5			
-6,8			
-7,1			
-7,4			
-7,7			
-8,0			
-8,3			
-8,6			
-8,9			
-9,2			
-9,5			
-9,8			
-10,1			
-10,4			
-10,7			
-11,0			
-11,3			
-11,6			
-11,9			
-12,2			
-12,5			
-12,8			
-13,1			
-13,4			
-13,7			
-14,0			
-14,3			
-14,6			
-14,9			
-15,2			
-15,5			
-15,8			
-16,1			
-16,4			
-16,7			
-17,0			
-17,3			
-17,6			
-17,9			
-18,2			
-18,5			
-18,8			
-19,1			
-19,4			
-19,7			
-20,0			
-20,3			
-20,6			
-20,9			
-21,2			
-21,5			
-21,8			
-22,1			
-22,4			
-22,7			
-23,0			
-23,3			
-23,6			
-23,9			
-24,2			
-24,5			
-24,8			
-25,1			
-25,4			
-25,7			
-26,0			
-26,3			
-26,6			
-26,9			
-27,2			
-27,5			
-27,8			
-28,1			
-28,4			
-28,7			
-29,0			
-29,3			
-29,6			
-29,9			

ADDITIONAL INFORMATION

TERMINATION DEPTH: 5,00m
REDIVE **FROM:** 4,40m **BLOWS:** 2
FROM: 4,70m **BLOWS:** 6

COMMENTS:



The Blue line represents the 600mm re-drive to check rod friction

DYNAMIC PROBE SUPER HEAVY (DPSH)

PROJECT NAME: MACASSAR WWTW
PROJECT NUMBER: GM/CT/1480
DATE OF TEST: 2023/04/20

TEST NUMBER: #22
OPERATOR: Michael Mohajane

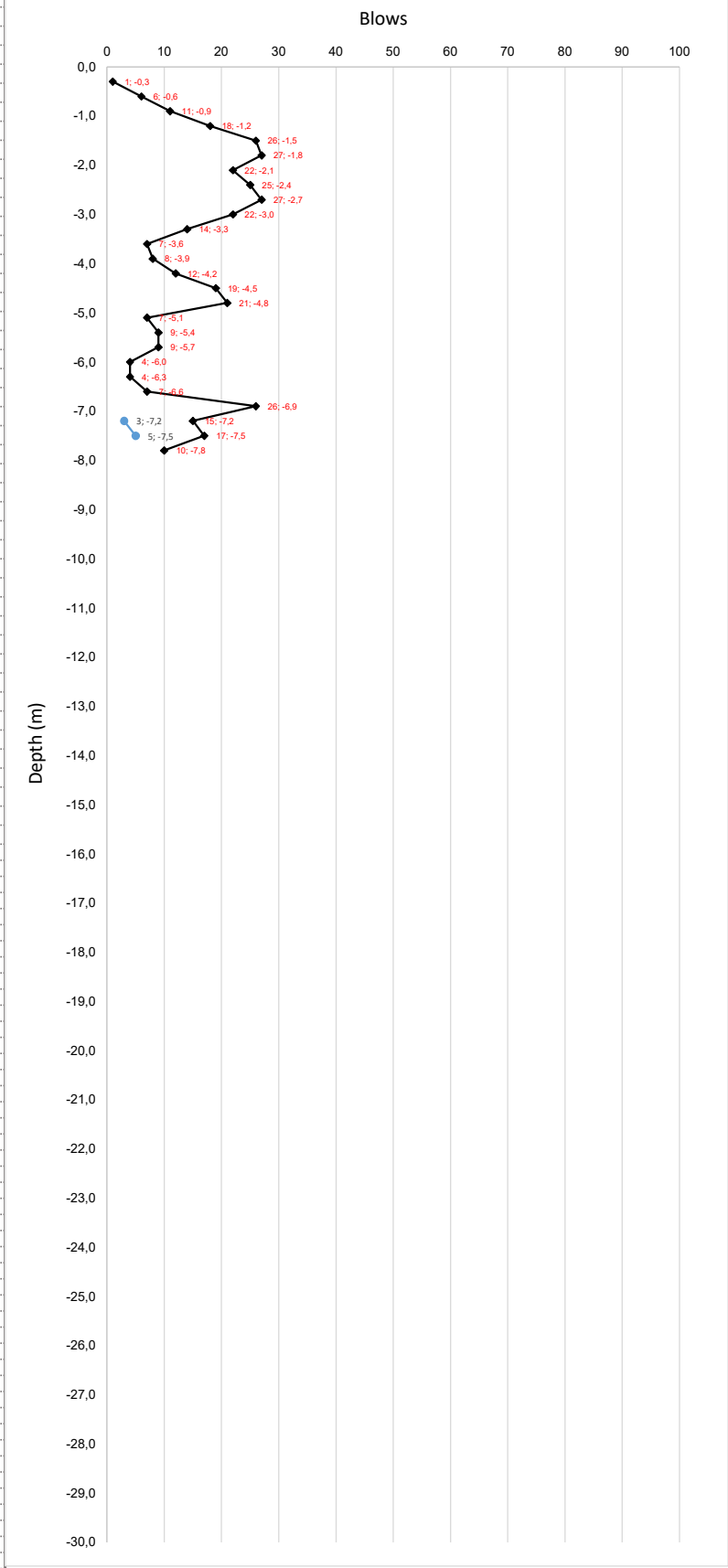
TEST RESULT

Depth (m)	Number of Blows	Redrive Depth (m)	Redrive Number of Blows
0,0			
-0,3	1		
-0,6	6		
-0,9	11		
-1,2	18		
-1,5	26		
-1,8	27		
-2,1	22		
-2,4	25		
-2,7	27		
-3,0	22		
-3,3	14		
-3,6	7		
-3,9	8		
-4,2	12		
-4,5	19		
-4,8	21		
-5,1	7		
-5,4	9		
-5,7	9		
-6,0	4		
-6,3	4		
-6,6	7		
-6,9	26		
-7,2	15	-7,2	3
-7,5	17	-7,5	5
-7,8	10		
-8,1			
-8,4			
-8,7			
-9,0			
-9,3			
-9,6			
-9,9			
-10,2			
-10,5			
-10,8			
-11,1			
-11,4			
-11,7			
-12,0			
-12,3			
-12,6			
-12,9			
-13,2			
-13,5			
-13,8			
-14,1			
-14,4			
-14,7			
-15,0			
-15,3			
-15,6			
-15,9			
-16,2			
-16,5			
-16,8			
-17,1			
-17,4			
-17,7			
-18,0			
-18,3			
-18,6			
-18,9			
-19,2			
-19,5			
-19,8			
-20,1			
-20,4			
-20,7			
-21,0			
-21,3			
-21,6			
-21,9			
-22,2			
-22,5			
-22,8			
-23,1			
-23,4			
-23,7			
-24,0			
-24,3			
-24,6			
-24,9			
-25,2			
-25,5			
-25,8			
-26,1			
-26,4			
-26,7			
-27,0			
-27,3			
-27,6			
-27,9			
-28,2			
-28,5			
-28,8			
-29,1			
-29,4			
-29,7			
-30,0			

ADDITIONAL INFORMATION

TERMINATION DEPTH: 7,80m
REDIVE **FROM:** 7,20m **BLOWS:** 3
FROM: 7,50m **BLOWS:** 5

COMMENTS:



The Blue line represents the 600mm re-drive to check rod friction

DYNAMIC PROBE SUPER HEAVY (DPSH)

PROJECT NAME: MACASSAR WWTW
PROJECT NUMBER: GM/CT/1480
DATE OF TEST: 2023/04/20

TEST NUMBER: #24
OPERATOR: Michael Mohajane

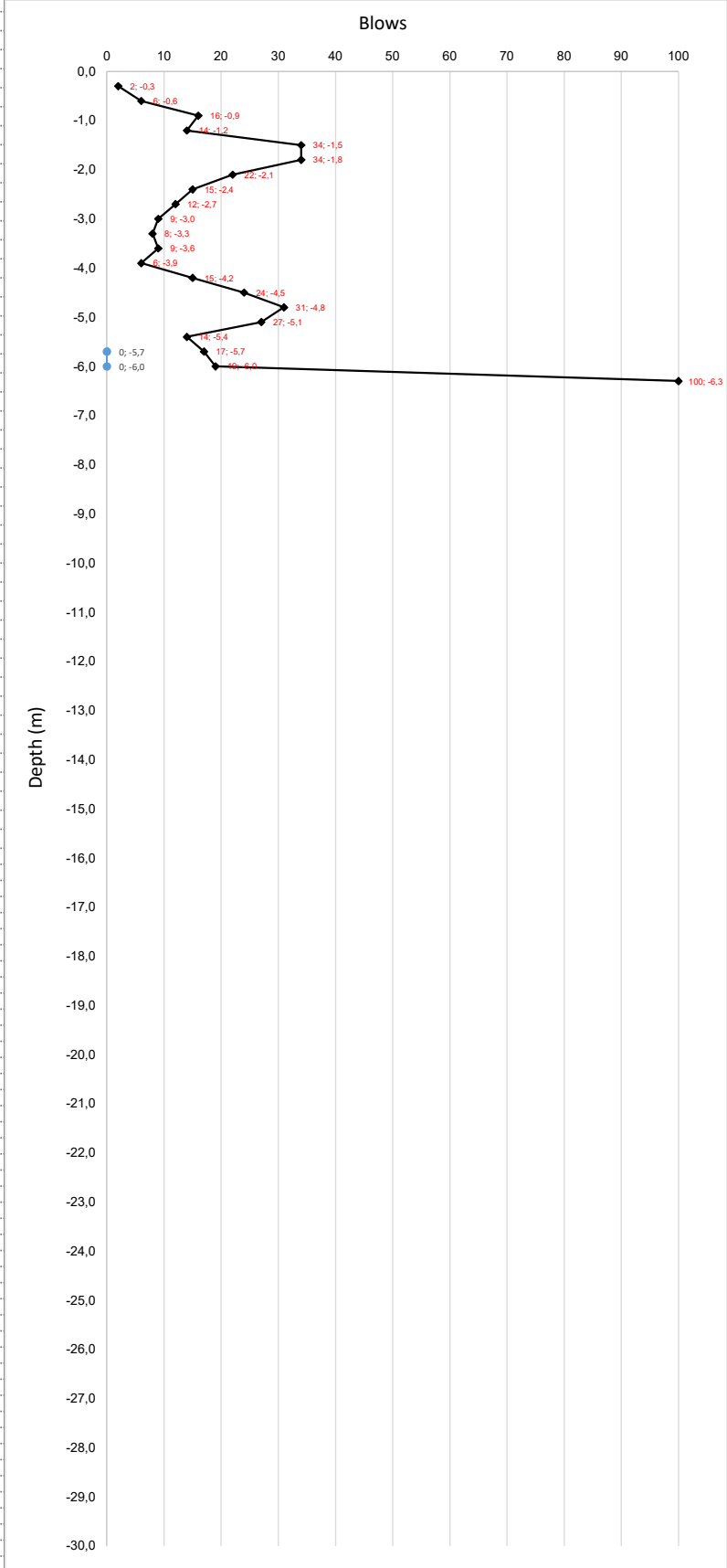
TEST RESULT

Depth (m)	Number of Blows	Redrive Depth (m)	Redrive Number of Blows
0,0			
-0,3	2		
-0,6	6		
-0,9	16		
-1,2	14		
-1,5	34		
-1,8	34		
-2,1	22		
-2,4	15		
-2,7	12		
-3,0	9		
-3,3	8		
-3,6	9		
-3,9	6		
-4,2	15		
-4,5	24		
-4,8	31		
-5,1	27		
-5,4	14		
-5,7	17	-5,7	0
-6,0	19	-6,0	0
-6,3	100		
-6,6			
-6,9			
-7,2			
-7,5			
-7,8			
-8,1			
-8,4			
-8,7			
-9,0			
-9,3			
-9,6			
-9,9			
-10,2			
-10,5			
-10,8			
-11,1			
-11,4			
-11,7			
-12,0			
-12,3			
-12,6			
-12,9			
-13,2			
-13,5			
-13,8			
-14,1			
-14,4			
-14,7			
-15,0			
-15,3			
-15,6			
-15,9			
-16,2			
-16,5			
-16,8			
-17,1			
-17,4			
-17,7			
-18,0			
-18,3			
-18,6			
-18,9			
-19,2			
-19,5			
-19,8			
-20,1			
-20,4			
-20,7			
-21,0			
-21,3			
-21,6			
-21,9			
-22,2			
-22,5			
-22,8			
-23,1			
-23,4			
-23,7			
-24,0			
-24,3			
-24,6			
-24,9			
-25,2			
-25,5			
-25,8			
-26,1			
-26,4			
-26,7			
-27,0			
-27,3			
-27,6			
-27,9			
-28,2			
-28,5			
-28,8			
-29,1			
-29,4			
-29,7			
-30,0			

ADDITIONAL INFORMATION

TERMINATION DEPTH: 6,30m
REDIVE **FROM:** 5,70m **BLOWS:** 0
FROM: 6,00m **BLOWS:** 0

COMMENTS:



The Blue line represents the 600mm re-drive to check rod friction

DYNAMIC PROBE SUPER HEAVY (DPSH)

PROJECT NAME: MACASSAR WWTW
PROJECT NUMBER: GM/CT/1480
DATE OF TEST: 2023/04/29

TEST NUMBER: #25
OPERATOR: Michael Mohajane

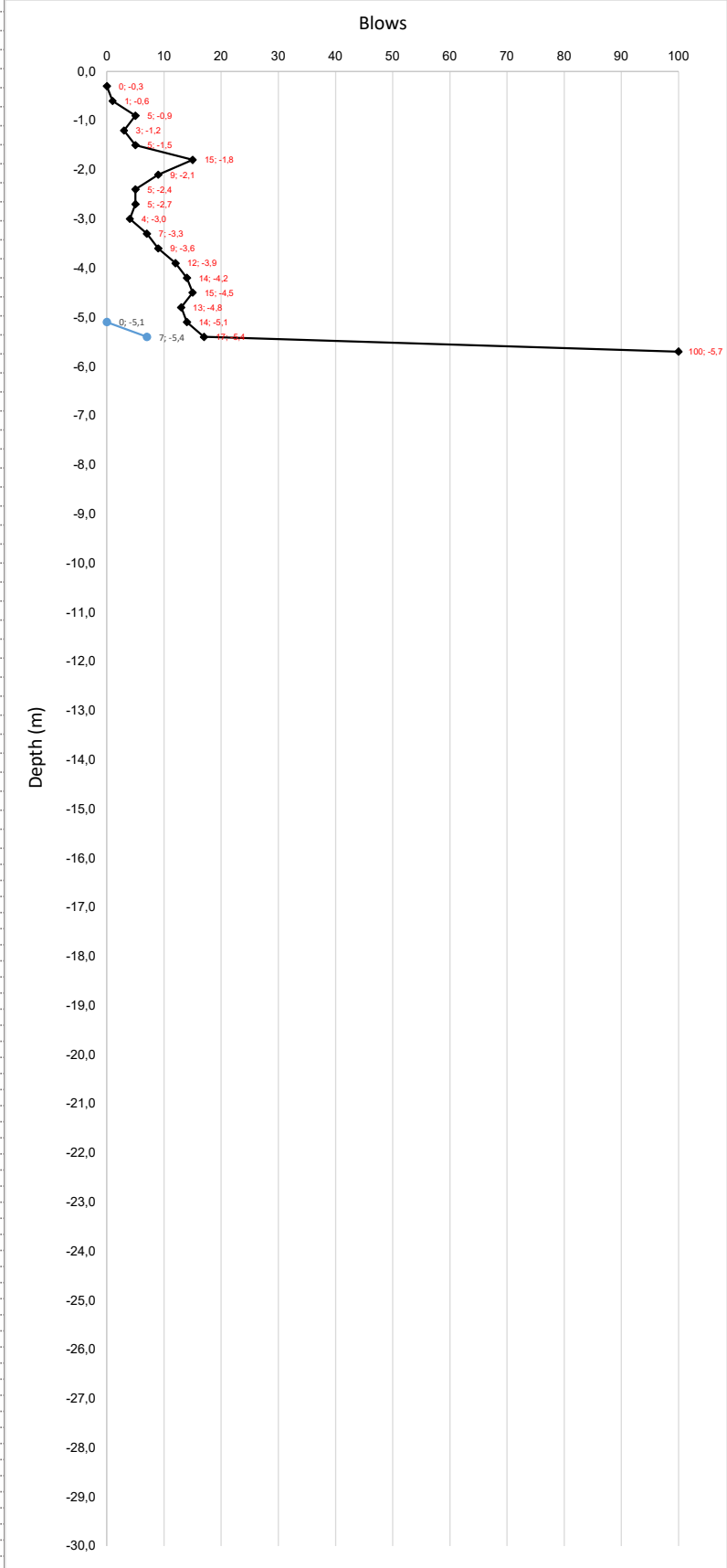
TEST RESULT

Depth (m)	Number of Blows	Redrive Depth (m)	Redrive Number of Blows
0,0			
-0,3	0		
-0,6	1		
-0,9	5		
-1,2	3		
-1,5	5		
-1,8	15		
-2,1	9		
-2,4	5		
-2,7	5		
-3,0	4		
-3,3	7		
-3,6	9		
-3,9	12		
-4,2	14		
-4,5	15		
-4,8	13		
-5,1	14	-5,1	0
-5,4	17	-5,4	7
-5,7	100		
-6,0			
-6,3			
-6,6			
-6,9			
-7,2			
-7,5			
-7,8			
-8,1			
-8,4			
-8,7			
-9,0			
-9,3			
-9,6			
-9,9			
-10,2			
-10,5			
-10,8			
-11,1			
-11,4			
-11,7			
-12,0			
-12,3			
-12,6			
-12,9			
-13,2			
-13,5			
-13,8			
-14,1			
-14,4			
-14,7			
-15,0			
-15,3			
-15,6			
-15,9			
-16,2			
-16,5			
-16,8			
-17,1			
-17,4			
-17,7			
-18,0			
-18,3			
-18,6			
-18,9			
-19,2			
-19,5			
-19,8			
-20,1			
-20,4			
-20,7			
-21,0			
-21,3			
-21,6			
-21,9			
-22,2			
-22,5			
-22,8			
-23,1			
-23,4			
-23,7			
-24,0			
-24,3			
-24,6			
-24,9			
-25,2			
-25,5			
-25,8			
-26,1			
-26,4			
-26,7			
-27,0			
-27,3			
-27,6			
-27,9			
-28,2			
-28,5			
-28,8			
-29,1			
-29,4			
-29,7			
-30,0			

ADDITIONAL INFORMATION

TERMINATION DEPTH: 5,70m
REDIVE **FROM:** 5,10m **BLOWS:** 0
FROM: 5,40m **BLOWS:** 7

COMMENTS:



The Blue line represents the 600mm re-drive to check rod friction

APPENDIX E

Rotary-cored Borehole Logs

HOLE No: BH01
Sheet 1 of 2

JOB NUMBER: 22-1172

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

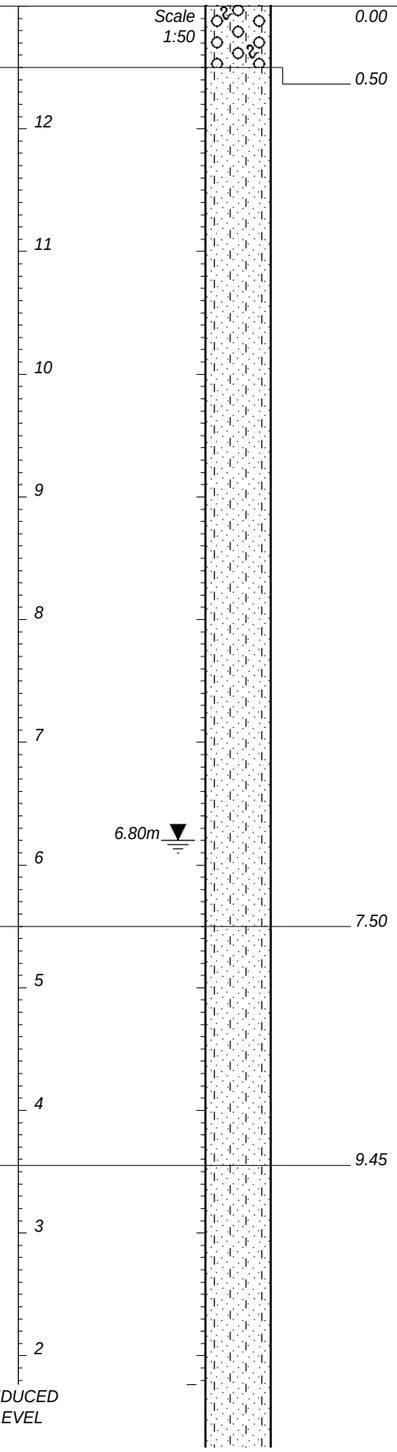
ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

Zutari
Macassar WWTW

HOLE No: BH01
Sheet 1 of 2

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL
Sonic		100												
SPT1	2,2,2,2,2,3 (N=9)	100												
Sonic		100												
SPT2	2,4,4,5,6,6 (N=21)	100												
Sonic		100												
SPT3	5,6,6,6,5,5 (N=22)	100												
Sonic		100												
SPT4	2,3,3,4,5,5 (N=17)	100												
Sonic		100												
SPT5	1,1,1,4,5,5 (N=15)	100												
Sonic		100												
SPT6	3,1,1,1,1,1 (N=4)	100												
Sonic		100												



0.00 — Brown, silty SAND, with scattered sub-angular gravel of mixed origin and roots. TOPSOIL.

0.50 — Yellowish-white, MEDIUM DENSE, silty fine SAND. TRANSPORTED AEOLIAN.

7.50 — Yellowish-white to light brown, VERY LOOSE, silty SAND. TRANSPORTED AEOLIAN.

9.45 — Grey to greyish-brown, LOOSE, silty SAND. TRANSPORTED ESTUARINE.

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

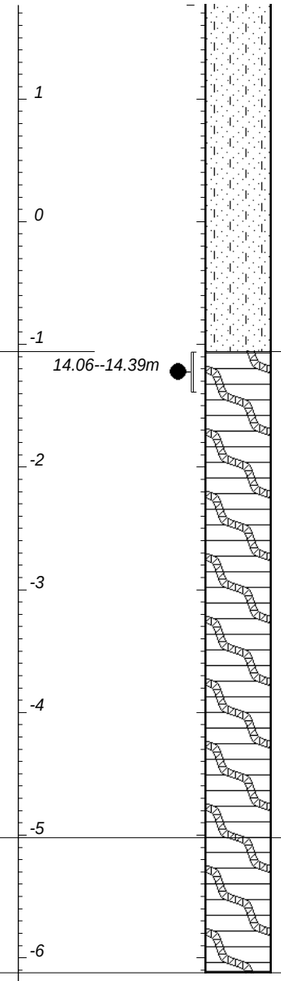
JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

Zutari
Macassar WWTW

HOLE No: BH01
Sheet 2 of 2
JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL
SPT7	4,4,3,1,1,1 (N=6)	100												
Sonic		0												
HQ			100	82	>20	J1 J2	15-25 55	C-M C	STE STE	RJ MRJ	Silty CLAY -	5-10 2-5		
HQ			83	65	11	J1 J2	15-25 55	C M	STE STE	RJ MRJ	Silty CLAY -	5-10 2-5		
HQ			100	32	>20	J1 J2 J3	15-20 45 80	C M M	STE IRR IRR	RJ MRJ SRJ	Silty CLAY - -	2-5 5-10 2-5		
HQ			100	84	6	J1 J2	15-20 45	M M	STE IRR	RJ MRJ	Silty CLAY -	<5 <5		
HQ			100	34	10	J1 J2 J3	<15 45 70-80	C C-M M	IRR IRR IRR	RJ MRJ MRJ	Silty CLAY - -	5-10 <5 <5		
HQ			100	100	3	J1	60	W	IRR	SRJ	Qtz	2-5		



14.06

Dark grey to grey stained brown streaked white, sightly weathered, very fine grained, closely to medium fractured, soft rock greywacke, with closed quartz veins and greyish-brown, silty clay infilling. SLIGHTLY WEATHERED GREYWACKE.

18.02

Dark grey streaked white and light grey, unweathered, very fine grained, closely to medium fractured, soft rock greywacke, with closed quartz veins. UNWEATHERED GREYWACKE.

19.12

NOTES

1) Final Depth = 19.12m.
2) No SPT at 10.5m due to very loose material falling out of barrel back into borehole.
3) Samples taken: 14.06--14.39m.
4) Cores retained in 6 coreboxes.
5) Water table at 6.80m.

CONTRACTOR : Geomechanics
MACHINE : Comachio P253
DRILLED BY : Michael Mohajane
PROFILED BY : HH(Reviewed by WK PriSciNat)

INCLINATION : Vertical
DIAM : 63-75mm DIAM.
DATE : 04/05/2023 - 05/05/2023
DATE : 05/05/2023

ELEVATION : 13m
X-COORD : 34´°04'28.2"S
Y-COORD : 18´°45'55.5"E

HOLE No: BH01

TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

DATE : 07/07/2023 11:50
TEXT : ..1172MacassarWWTWBH01.txt

Zutari
Macassar WWTW

LEGEND
Sheet 1 of 1

JOB NUMBER: 22-1172

	GRAVEL	{SA02}
	SAND	{SA04}
	SILTY	{SA07}
	MUDROCK/mudstone/siltstone/shale	{SA12}
	QUARTZ VEINS	{SA20}
5.5	PERMANENT WATER TABLE	{SA35}
Name	DISTURBED SAMPLE	{SA38}
	ROOTS	{SA40}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

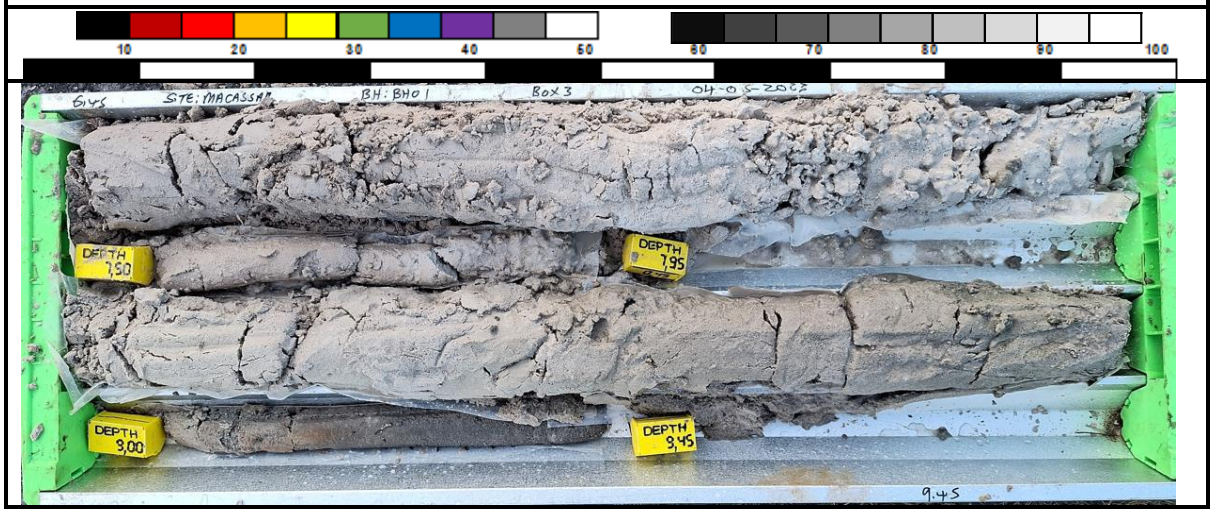
DATE : 07/07/2023 11:50
TEXT : ..1172MacassarWWTWBH01.txt

LEGEND
SUMMARY OF SYMBOLS

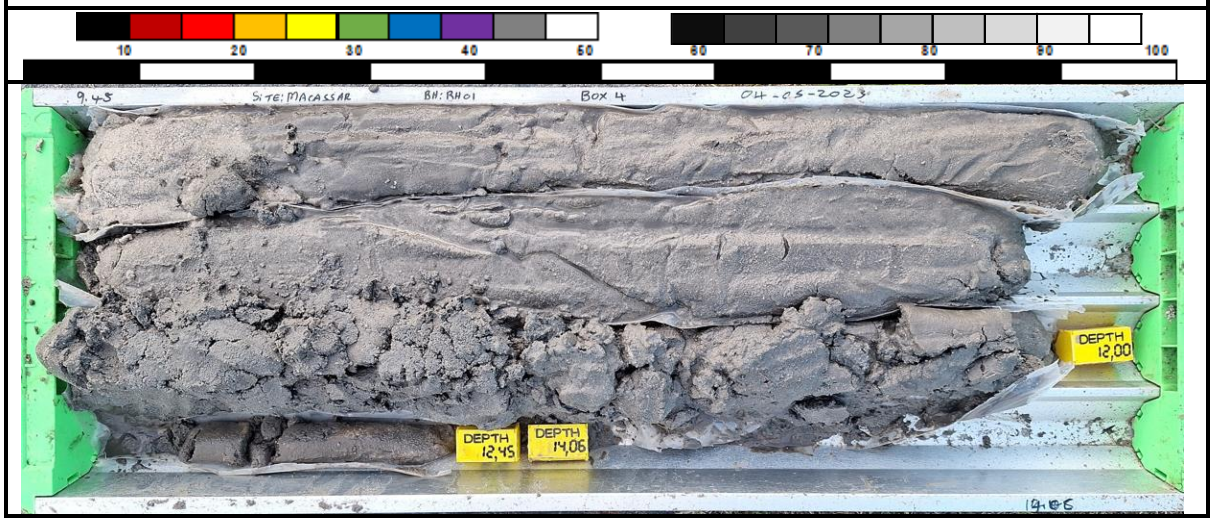
Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	0.00m – 3.45m	**BH No.:**	BH01
Corebox No.:	1 of 6	**Date drilled:**	04/05/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	3.45m – 6.45m	**BH No.:**	BH01
Corebox No.:	2 of 6	**Date drilled:**	04/05/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	6.45m – 9.45m	**BH No.:**	BH01
Corebox No.:	3 of 6	**Date drilled:**	04/05/2023

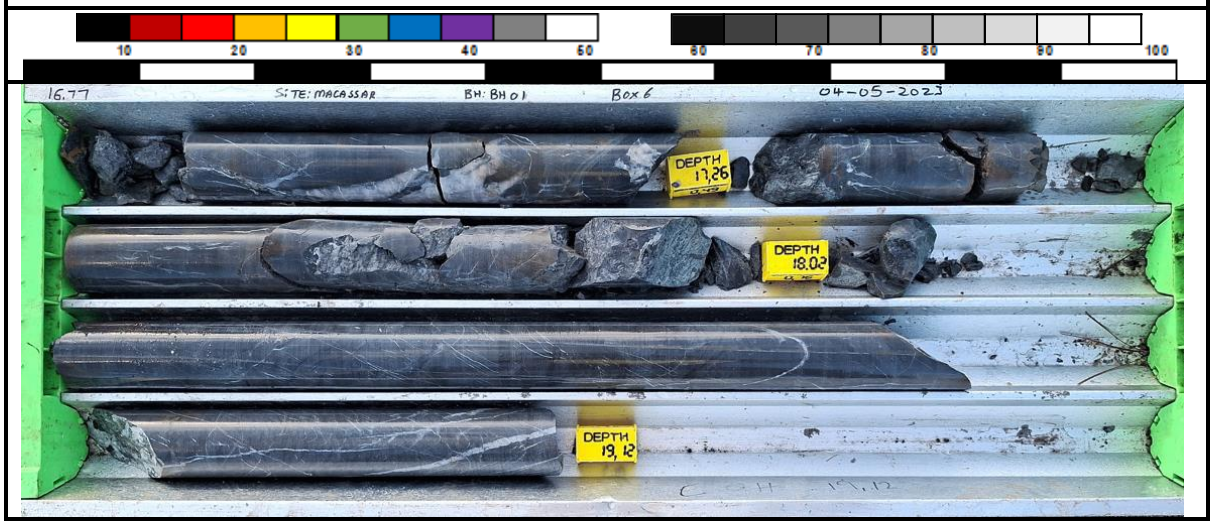


Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	9.45m – 14.06m	**BH No.:**	BH01
Corebox No.:	4 of 6	**Date drilled:**	04/05/2023



Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	14.06m – 16.77m	**BH No.:**	BH01
Corebox No.:	5 of 6	**Date drilled:**	04/05/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	16.77m – 19.12m	**BH No.:**	BH01
Corebox No.:	6 of 6	**Date drilled:**	04/05/2023



HOLE No: BH02
Sheet 1 of 2

JOB NUMBER: 22-1172

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
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JOINT ROUGHNESS
SLJ-slickensided
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JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

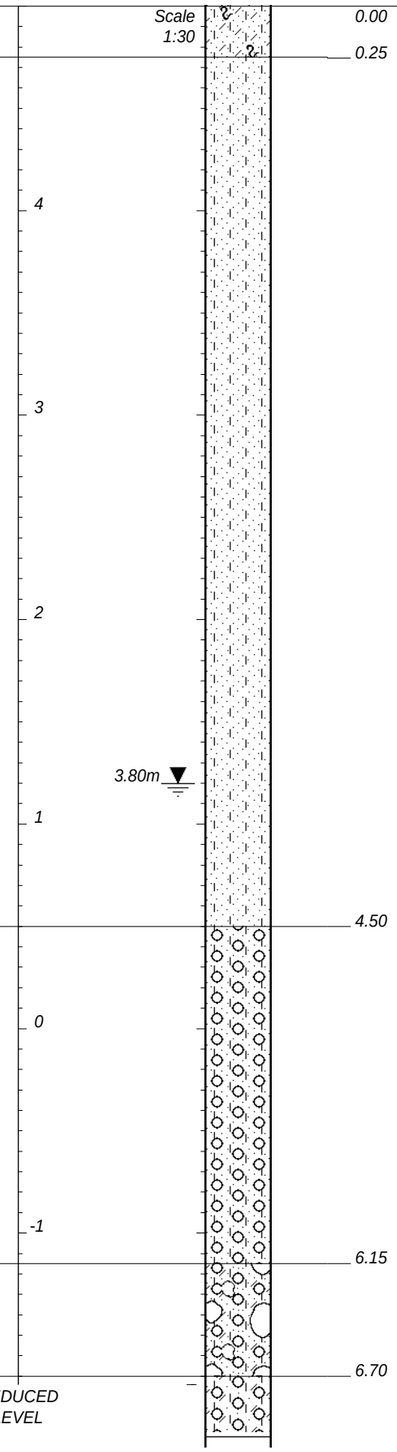
GCS Geotechnical Engineering

Zutari
Macassar WWTW

HOLE No: BH02
Sheet 1 of 2

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL	
Sonic		100												0.00	Dark brown, clayey silty SAND, with scattered roots. TOPSOIL.
														0.25	Yellowish-white to light grey, VERY LOOSE to LOOSE, silty fine SAND. TRANSPORTED AEOLIAN.
SPT1	1,2,1,1,1,1 (N=4)	0													
Sonic		100													
SPT2	1,1,1,1,1,1 (N=4)	100													
Sonic		100												4.50	Light grey to grey speckled white and black, LOOSE, silty SAND with scattered gravel. TRANSPORTED ESTUARINE.
SPT3	3,2,1,1,1,2 (N=5)	100													
Sonic		100													
SPT4	3,5,7,28,Ref (N=Ref)	100												6.15	Light grey to grey becoming olive-green blotched black and brown, silty gravelly SAND to clayey silty sandy GRAVEL with scattered cobbles of mixed origin. REWORKED RESIDUAL GREYWACKE.
														6.70	



ROCK FABRIC
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JOINT ROUGHNESS
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SJ -smooth
RJ -rough

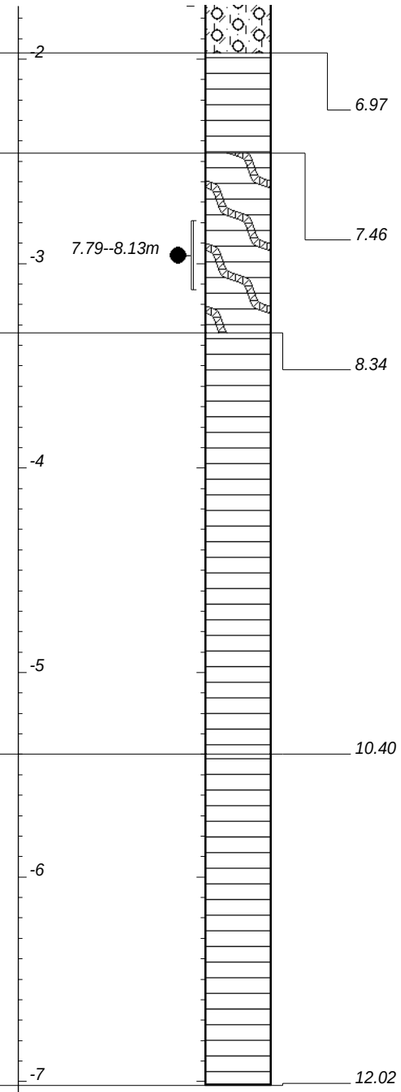
JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

Zutari
Macassar WWTW

HOLE No: BH02
Sheet 2 of 2
JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL
Sonic		100				J1 J2 J2	20 45 70-80	C-M C-M C	IRR STE STE	SRJ SRJ MRJ	Silty CLAY Silty CLAY -	5-10 5-10 <2		
HQ			100	63	9									
HQ			100	80	>20	J1 J2 J3	20 45 70-80	C-M C-M C-M	IRR STE IRR	SRJ SRJ MRJ	Silty CLAY Silty CLAY Qtz	5-10 5-10 <2		
HQ			100	84	14	J1 J2 J3	<20 45 75-90	C-M C-M C-M	IRR STE IRR	SRJ SRJ MRJ	- - Qtz	5 5 <2		
HQ			100	32	12	J1 J2 J3	<20 45 75-90	C-M C-M C-M	IRR STE IRR	SRJ SRJ MRJ	- - -	5 5 <2		
HQ			100	40	5	J1 J2	<15 45	C C-M	IRR IRR	RJ MRJ	Silty CLAY -	5-10 <5		
HQ			100	42	>20	J1 J2 J3	<20 45 75-90	C-M C-M M	IRR STE IRR	SRJ SRJ MRJ	Silty CLAY Qtz -	5-10 <2 5		
HQ			100	100	0	J1	<20	C-M	IRR	SRJ	-	<5		
HQ			100	100	5	J1 J2 J3	<20 45 75-90	C-M C-M M	STE STE IRR	SRJ SRJ MRJ	- - -	5-10 5 <2		



Olive-green and light grey blotched dark brown, clayey silty sandy GRAVEL with scattered angular GREYWACKE. RESIDUAL GREYWACKE.

Olive-green streaked yellow stained brown, medium weathered, medium to fine grained, closely to medium fractured, soft rock GREYWACKE, with greenish-brown, silty CLAY infilling. MEDIUM WEATHERED GREYWACKE.

Greenish-grey to grey stained brown, slightly weathered, fine to very fine grained, closely to medium fractured, soft rock greywacke, with closed quartz veins and greenish-brown, silty CLAY infilling. SLIGHTLY WEATHERED GREYWACKE.

Light grey to grey stained brown, slightly weathered, very fine grained, closely to medium fractured, soft rock greywacke, with greenish-brown, silty CLAY infilling. SLIGHTLY WEATHERED GREYWACKE.

Grey to dark grey stained brown, unweathered, very fine grained, closely to medium fractured, soft rock greywacke, with greenish-brown, silty CLAY infilling. UNWEATHERED GREYWACKE.

NOTES
1) Final Depth = 12.02m.
2) Samples taken: 7.79--8.13m.
3) Cores retained in 5 coreboxes.
4) Water table at 3.80m.

CONTRACTOR : Geomechanics
MACHINE : Comachio P253
DRILLED BY : Michael Mohajane
PROFILED BY : HH(Reviewed by WK PriSciNat)
TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

INCLINATION : Vertical
DIAM : 63-75mm DIAM.
DATE : 01/05/2023 - 02/05/2023
DATE : 02/05/2023
DATE : 07/07/2023 11:49
TEXT : ..1172MacassarWWTWBH02.txt

ELEVATION : 5m
X-COORD : 34´°04'39.1"S
Y-COORD : 18´°45'55.6"E

HOLE No: BH02

Zutari
Macassar WWTW

LEGEND
Sheet 1 of 1

JOB NUMBER: 22-1172

	GRAVEL	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SANDY	{SA05}
	SILTY	{SA07}
	CLAYEY	{SA09}
	MUDROCK/mudstone/siltstone/shale	{SA12}
	QUARTZ VEINS	{SA20}
8.5	PERMANENT WATER TABLE	{SA35}
Name	DISTURBED SAMPLE	{SA38}
	ROOTS	{SA40}
	COBBLES	{SA58}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

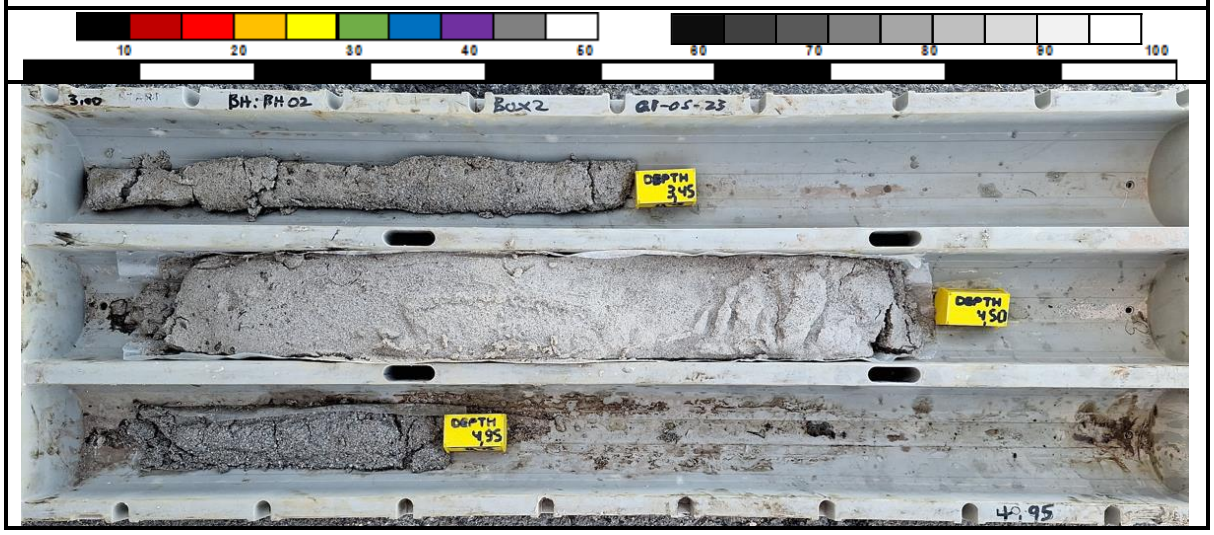
LEGEND
SUMMARY OF SYMBOLS

TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

DATE : 07/07/2023 11:49
TEXT : ..1172MacassarWWTWBH02.txt

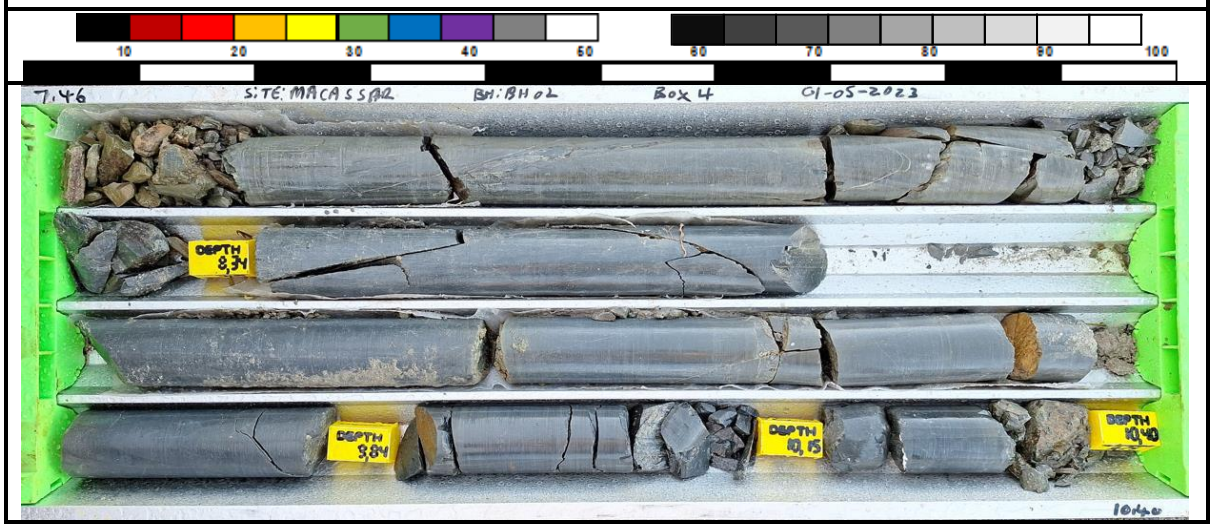
Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	0.00m – 3.00m	**BH No.:**	BH02
Corebox No.:	1 of 5	**Date drilled:**	01/05/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	3.00m – 4.95m	**BH No.:**	BH02
Corebox No.:	2 of 5	**Date drilled:**	01/05/2023



Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	4.95m – 7.46m	**BH No.:**	BH02
Corebox No.:	3 of 5	**Date drilled:**	01/05/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	7.46m – 10.40m	**BH No.:**	BH02
Corebox No.:	4 of 5	**Date drilled:**	01/05-2023



Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	10.40m – 12.02m	**BH No.:**	BH02
Corebox No.:	5 of 5	**Date drilled:**	02/05/2023

HOLE No: BH03
Sheet 1 of 2

JOB NUMBER: 22-1172

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

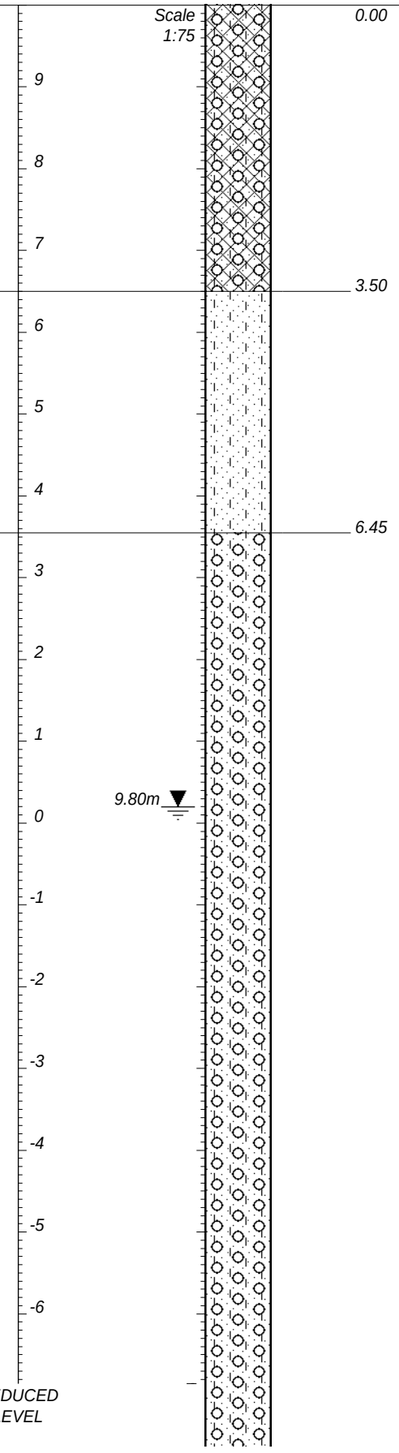
GCS Geotechnical Engineering

Zutari
Macassar WWTW

HOLE No: BH03
Sheet 1 of 2

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL
Sonic		100												
SPT1	2,3,3,4,3,3 (N=13)	100												
Sonic		100												
SPT2	3,4,5,4,3,3 (N=15)	100												
Sonic		100												
SPT3	4,6,6,6,8,6 (N=26)	100												
Sonic		100												
SPT4	3,3,2,4,2,4 (N=12)	100												
Sonic		100												
SPT5	2,1,2,1,2,2 (N=7)	100												
Sonic		100												
SPT6	1,1,2,2,3,6 (N=13)	100												
Sonic		100												
Sonic		100												
SPT7	2,1,1,1,1,1 (N=4)	100												
Sonic		100												
SPT8	1,1,1,1,1,1 (N=4)	100												
Sonic		100												
SPT9	4,2,2,2,4,2	0												



0.00 — Yellowish-white to yellow-brown, MEDIUM DENSE, silty SAND, with scattered angular gravel. EMBANKMENT FILL MATERIAL.

3.50 — Yellowish-white to brown, MEDIUM DENSE, silty fine SAND to silty SAND. TRANSPORTED AEOLIAN.

6.45 — Light grey to grey specled white and black, LOOSE, silty SAND with scattered gravel. TRANSPORTED ESTUARINE.

HOLE No: BH03
Sheet 2 of 2

JOB NUMBER: 22-1172

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
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JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

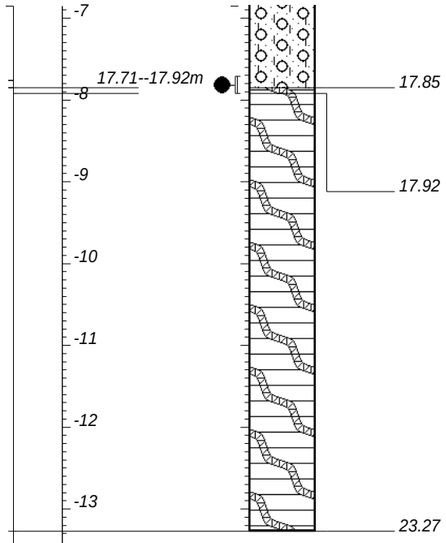
ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

Zutari
Macassar WWTW

HOLE No: BH03
Sheet 2 of 2

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL
Sonic	(N=10)	0												
HQ			120	61	>20	J1 J2	<20 80	C-M W	IRR IRR	MRJ SRJ	Silty CLAY Qtz	5-10 2-10		
HQ			100	73	4	J1 J2	<20 60-80	C-M C-M	IRR IRR	MRJ SRJ	- Qtz	5 2-6		
HQ			100	96	3	J1 J2	35 60-80	M-W C-M	IRR IRR	MRJ -	- Qtz	5 2-6		
HQ			100	100	2	J1 J2	25-35 60-80	M C-M	IRR IRR	MRJ -	- Qtz	<5 2-6		
HQ			100	100	7	J1 J2	25-35 60-80	M M	IRR IRR	MRJ -	- Qtz	<5 2-6		
HQ			100	97	3	J1 J2	25-35 60-80	M M	IRR IRR	MRJ -	- Qtz	<5 2-3		



Dark grey to grey streaked white, slightly weathered, very fine grained, closely medium fractured, soft rock greywacke, with sub-vertical closed quartz veins. SLIGHTLY WEATHERED GREYWACKE.

Dark grey to grey streaked white, unweathered, very fine grained, medium to widely fractured, soft rock greywacke, with sub-vertical closed quartz veins. UNWEATHERED GREYWACKE.

NOTES

1) Final Depth = 23.27m.
2) Samples taken: 17.71--17.92m.
3) Cores retained in 9 coreboxes.
4) Water table at 9.80m.

CONTRACTOR : Geomechanics
MACHINE : Comachio P253
DRILLED BY : Michael Mohajane
PROFILED BY : HH(Reviewed by WK PriSciNat)

INCLINATION : Vertical
DIAM : 63-75mm DIAM.
DATE : 02/05/2023 - 04/05/2023
DATE : 04/05/2023

ELEVATION : 10m
X-COORD : 34´°04'37.0"S
Y-COORD : 18´°45'50.2"E

TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

DATE : 07/07/2023 10:37
TEXT : ..1172MacassarWWTWBH03.txt

HOLE No: BH03

Zutari
Macassar WWTW

LEGEND
Sheet 1 of 1

JOB NUMBER: 22-1172

	GRAVEL	{SA02}
	SAND	{SA04}
	SILTY	{SA07}
	MUDROCK/mudstone/siltstone/shale	{SA12}
	QUARTZ VEINS	{SA20}
	FILL	{SA32}
6.5	PERMANENT WATER TABLE	{SA35}
Name	DISTURBED SAMPLE	{SA38}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

DATE : 07/07/2023 10:37
TEXT : ..1172MacassarWWTWBH03.txt

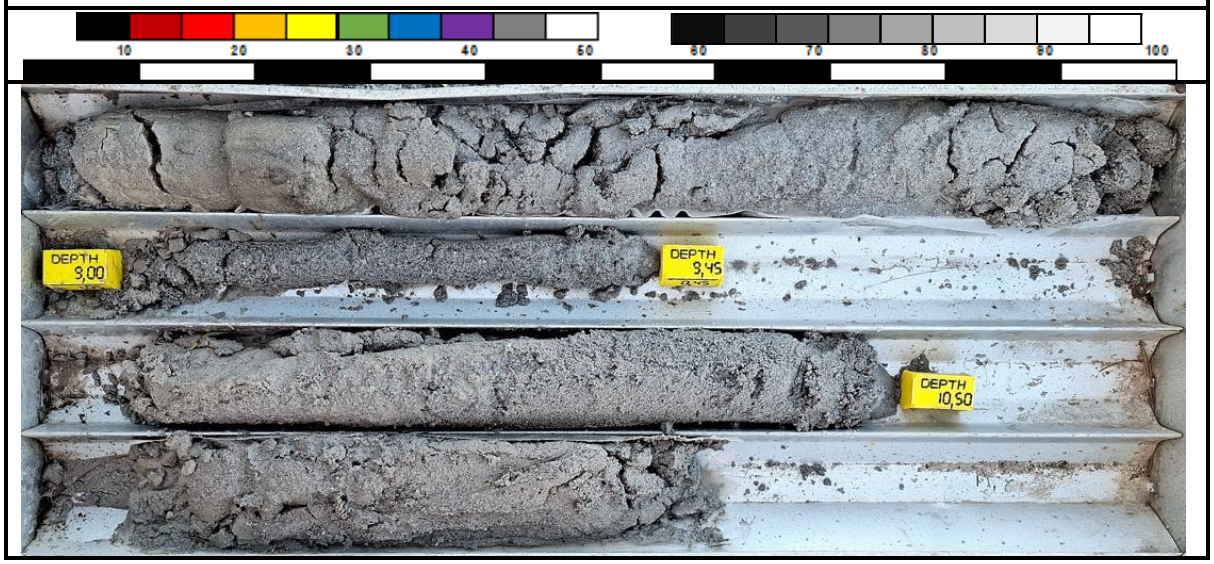
LEGEND
SUMMARY OF SYMBOLS

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	0.00m – 3.00m	**BH No.:**	BH03
Corebox No.:	1 of 9	**Date drilled:**	02/05/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	3.00m – 4.95m	**BH No.:**	BH03
Corebox No.:	2 of 9	**Date drilled:**	02/05/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	4.95m – 7.95m	**BH No.:**	BH03
Corebox No.:	3 of 9	**Date drilled:**	02/05/2023

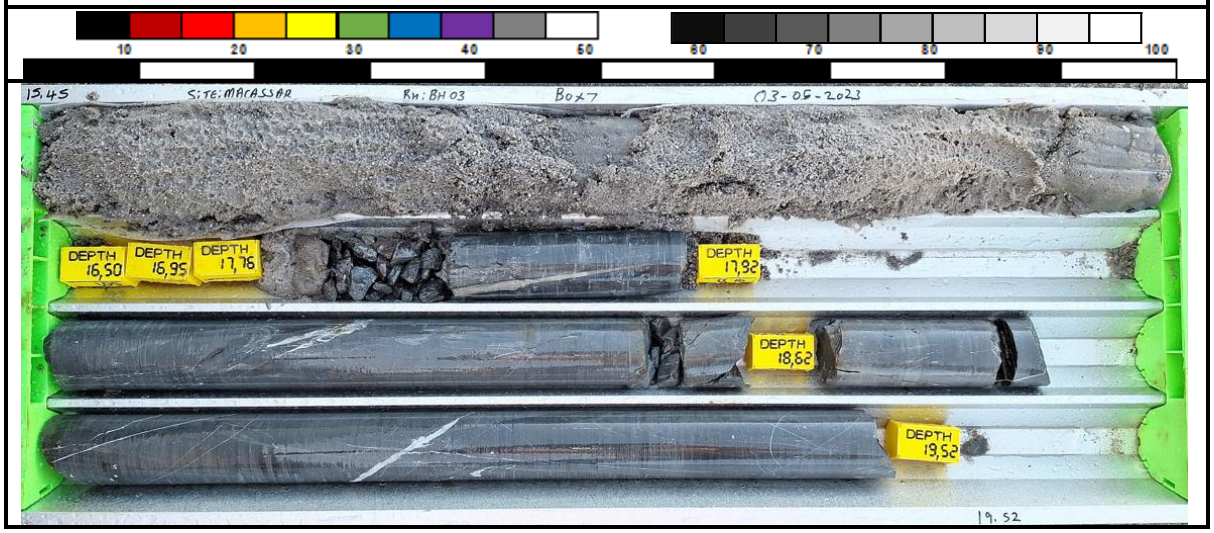
Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	7.95m – 11.00m	**BH No.:**	BH03
Corebox No.:	4 of 9	**Date drilled:**	02/05/2023



Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	11.00m – 13.45m	**BH No.:**	BH03
Corebox No.:	5 of 9	**Date drilled:**	03/05/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	13.45m – 15.45m	**BH No.:**	BH03
Corebox No.:	6 of 9	**Date drilled:**	03/05/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	15.45m – 19.52m	**BH No.:**	BH03
Corebox No.:	7 of 9	**Date drilled:**	03/05/2023



Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	19.52m – 22.19m	**BH No.:**	BH03
Corebox No.:	8 of 9	**Date drilled:**	03/05/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	22.19m – 23.27m	**BH No.:**	BH03
Corebox No.:	9 of 9	**Date drilled:**	03/05/2023

HOLE No: BH04
Sheet 1 of 2

JOB NUMBER: 22-1172

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

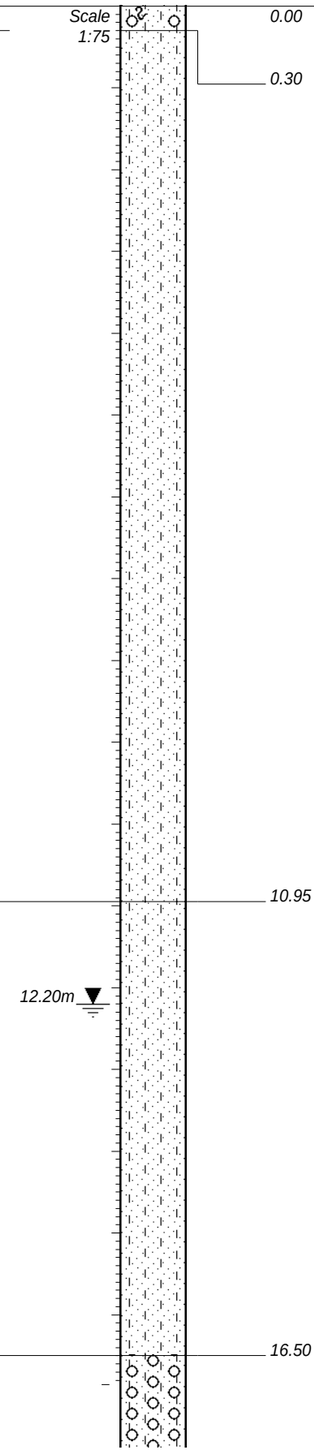
GCS Geotechnical Engineering

Zutari
Macassar WWTW

HOLE No: BH04
Sheet 1 of 2

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING
Sonic		100											
SPT1	2,1,2,2,2,2 (N=8)	100											
Sonic		100											
SPT2	3,4,4,4,3,4 (N=15)	100											
Sonic		38											
SPT3	3,2,3,3,4,3 (N=13)	100											
Sonic		100											
SPT4	3,3,2,4,3,3 (N=12)	100											
Sonic		100											
SPT5	4,3,3,4,4,5 (N=16)	100											
Sonic		100											
SPT6	5,4,4,5,5,8 (N=22)	100											
Sonic		100											
SPT7	6,6,7,8,9,9 (N=33)	100											
Sonic		100											
SPT8	6,8,8,7,9,7 (N=31)	100											
Sonic		100											
SPT9	4,5,6,8,8,8 (N=30)	100											
Sonic		100											
SPT10	4,5,5,6,6,6 (N=23)	100											
Sonic		67											
SPT11	1,3,3,2,3,3	100											



0.00 — Brown to yellowish-white, gravelly silty SAND, with scattered roots. TOPSOIL.

0.30 — Yellowish-white to light brown, MEDIUM DENSE, silty fine SAND. TRANSPORTED AEOLIAN.

10.95 — Yellowish-white to light brown, MEDIUM DENSE, silty SAND. TRANSPORTED AEOLIAN.

16.50

HOLE No: BH04
Sheet 2 of 2

JOB NUMBER: 22-1172

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

Zutari
Macassar WWTW

HOLE No: BH04
Sheet 2 of 2

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL		
	(N=11)													0		
Sonic		100									Clayey SILT Clayey SILT			-1	Light grey to grey specled white and black, MEDIUM DENSE, silty SAND with scattered gravel and shell fragments. TRANSPORTED ESTUARINE.	18.00
SPT12	15,17,25,Ref (Ref)	100													Grey to olive-green and brown, VERY DENSE, silty sandy GRAVEL with angular to sub-angular gravel and cobbles. RESIDUAL GREYWACKE.	18.33
HQ			86	74	7	J1 J2	45 80-90	C-M W	STE IRR	MRJ SRJ-MRJ	Clayey SILT Clayey SILT	5-10 2-10		-2		
HQ			80	25	>20	J1 J2	45 80-90	VC-M C-W	STE IRR	MRJ SRJ-MRJ	Clayey SILT Clayey SILT	5-10 2-10		-3	Grey to olive-green stained brown, medium weathered, very fine grained, widely to closely fractured, soft rock greywacke, with grey-brown clayey SILT infilling. MEDIUM WEATHERED GREYWACKE.	20.36
HQ			76	19	>20	J1 J2	45 75-90	VC-M C-W	STE IRR	MRJ SRJ-MRJ	Clayey SILT Clayey SILT	5-10 2-10		-4	Dark grey to olive-green stained brown, medium to slightly weathered, very fine grained, widely to closely fractured, soft rock greywacke, with grey-brown clayey SILT infilling. SLIGHTLY WEATHERED GREYWACKE.	
HQ			94	17	>20	J1 J2	45 75-90	VC-M C	STE IRR	MRJ SRJ-MRJ	Clayey SILT Clayey SILT	5-10 2-10		-5		
HQ			100	85	>20	J1 J2 J3	45 65 75-90	C-M C-W W	STE IRR IRR	MRJ SRJ-MRJ SRJ-MRJ	Clayey SILT	5-10 2-5 2-5		-6		
HQ			92	15	>20	J1 J2	45 65	C-M W	STE IRR	MRJ SRJ-MRJ	Clayey SILT Clayey SILT -	5-10 2-5				23.77
											Clayey SILT -					

NOTES

1) Final Depth = 23.77m.
2) No samples taken.
3) Cores retained in 9 coreboxes.
4) Water table at 12.20m.

CONTRACTOR : Geomechanics
MACHINE : Comachio P253
DRILLED BY : Michael Mohajane
PROFILED BY : HH(Reviewed by WK PriSciNat)

INCLINATION : Vertical
DIAM : 63-75mm DIAM.
DATE : 28/04/2023 - 01/05/2023
DATE : 01/05/2023

ELEVATION : 17m
X-COORD : 34´°04'32.2"S
Y-COORD : 18´°45'50.5"E

HOLE No: BH04

TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

DATE : 07/07/2023 10:38
TEXT : ..1172MacassarWWTWBH04.txt

Zutari
Macassar WWTW

LEGEND
Sheet 1 of 1

JOB NUMBER: 22-1172

	GRAVEL	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SANDY	{SA05}
	SILTY	{SA07}
	MUDROCK/mudstone/siltstone/shale	{SA12}
6.5	PERMANENT WATER TABLE	{SA35}
	ROOTS	{SA40}
	COBBLES	{SA58}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

DATE : 07/07/2023 10:38
TEXT : ..1172MacassarWWTWBH04.txt

LEGEND
SUMMARY OF SYMBOLS

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	0.00m – 3.00m	**BH No.:**	BH04
Corebox No.:	1 of 9	**Date drilled:**	28/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	3.00m – 6.00m	**BH No.:**	BH04
Corebox No.:	2 of 9	**Date drilled:**	28/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	6.00m – 7.95m	**BH No.:**	BH04
Corebox No.:	3 of 9	**Date drilled:**	28/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	7.95m – 10.50m	**BH No.:**	BH04
Corebox No.:	4 of 9	**Date drilled:**	28/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	10.50m – 12.45m	**BH No.:**	BH04
Corebox No.:	5 of 9	**Date drilled:**	28/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	12.45m – 15.00m	**BH No.:**	BH04
Corebox No.:	6 of 9	**Date drilled:**	28/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	15.00m – 18.00m	**BH No.:**	BH04
Corebox No.:	7 of 9	**Date drilled:**	28/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	18.00m – 21.67m	**BH No.:**	BH04
Corebox No.:	8 of 9	**Date drilled:**	28/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	21.67m – 23.77m	**BH No.:**	BH04
Corebox No.:	9 of 9	**Date drilled:**	28/04/2023

HOLE No: BH05
Sheet 1 of 3

JOB NUMBER: 22-1172

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

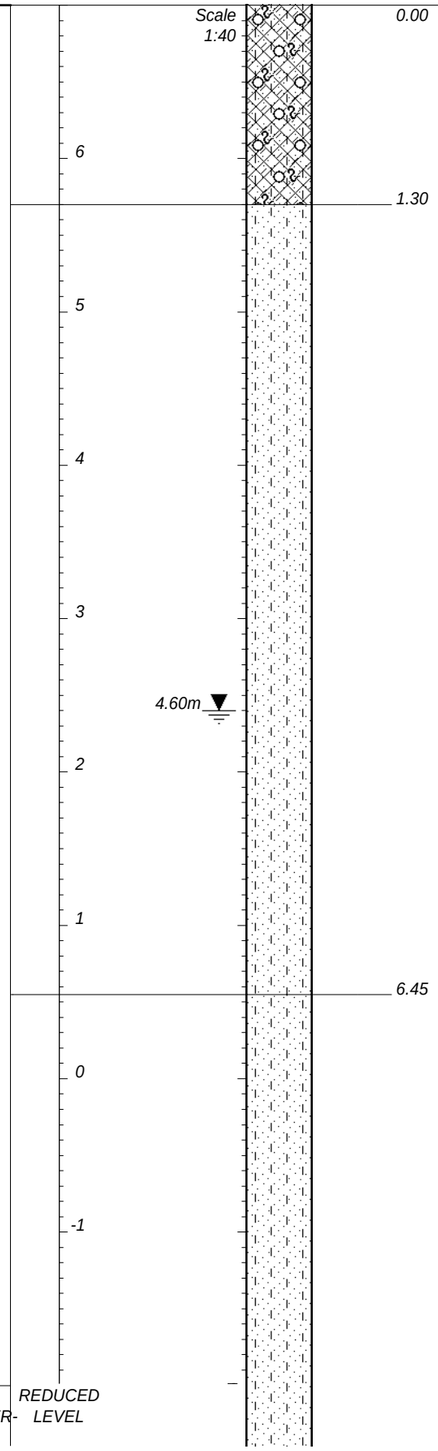
ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

Zutari
Macassar WWTW

HOLE No: BH05
Sheet 1 of 3

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL	Description
Sonic		100												0.00	Black to dark brown, clayey gravelly silty SAND, with scattered roots and organic material. ORGANIC FILL.
														1.30	Yellowish-white to light brown, MEDIUM DENSE, silty fine SAND. TRANSPORTED AEOLIAN.
SPT1	4,3,5,7,8,6 (N=26)	100													
Sonic		100													
SPT2	5,4,8,6,6,6 (N=26)	100													
Sonic		100													
SPT3	2,4,5,4,5,5 (N=19)	100													
Sonic		100													
SPT4	4,4,4,6,5,7 (N=22)	100													
Sonic		100												6.45	Yellowish-white to brown, LOOSE with DENSE zones, silty SAND. TRANSPORTED AEOLIAN.
SPT5	1,1,1,1,1,1 (N=4)	100													
Sonic		100													



HOLE No: BH05
Sheet 2 of 3

JOB NUMBER: 22-1172

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GCS Geotechnical Engineering

Zutari
Macassar WWTW

HOLE No: BH05
Sheet 2 of 3

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL	
SPT6	3,5,6,6,15,18 (N=45)	100												-2	
Sonic		100												-3	
SPT7	3,2,1,1,1,1 (N=4)	100												-4	
Sonic		100													11.40 Yellowish-brown to brown, clayey sandy SILT to sandy clayey SILT. TRANSPORTED ESTUARINE.
SPT8	3,8,17,21,23,24 (N=85)	100												-5	12.00 Light grey to grey specled white and black, VERY DENSE, silty SAND with scattered gravel and shell fragments. TRANSPORTED ESTUARINE.
Sonic		100												-6	12.45 Light olive-green and greyish-brown, sandy silty GRAVEL with gravel and cobbles. REWORKED RESIDUAL GREYWACKE.
SPT9	25,Ref (N=Ref)	100													13.10 Light olive-green and greenis-brown, VERY DENSE, sandy silty GRAVEL with angular to sub-angular gravel and cobbles of friable greywacke. RESIDUAL GREYWACKE.
HQ			100	0	>20	J1 J2	40-60 80-90	C-M M	IRR IRR	MRJ SRJ-MRJ	Clayey SILT Clayey SILT	5-10 2-10		-7	13.55 Light grey to greenish-grey stained reddish-brown, highly weathered, very fine grained, very closely to closely fractured, very soft rock greywacke, with grey-brown clayey SILT infilling. HIGHLY WEATHERED VERY SOFT GREYWACKE.
HQ			100	73	>20	J1 J2 J3	45 60-70 80-90	M C-M M-W	STE IRR IRR	MRJ SRJ-MRJ SRJ-MRJ	Clayey SILT Clayey SILT Clayey SILT	5-10 2-10 2-5		-8 15.01--15.13m	14.20 Light grey to grey stained reddish-brown, medium weathered, very fine grained, closely to medium fractured, soft rock greywacke, with grey-brown clayey SILT infilling. MEDIUM WEATHERED VERY SOFT GREYWACKE.
HQ			40	0	>20	J1 J2	40-60 80-90	C-M M	IRR IRR	MRJ SRJ-MRJ	- -	5-10 2-10		-9	15.57 Light grey to grey stained reddish-brown, slightly weathered, very fine grained, very closely to closely fractured, soft rock greywacke, with grey-brown clayey SILT infilling. SLIGHTLY WEATHERED SOFT GREYWACKE.
HQ			60	36	>20	J1 J2	40-60 80-90	C-M M	IRR IRR	MRJ SRJ-MRJ	- -	5-10 2-5		-10	17.10 Light grey to grey stained reddish-brown, unweathered, very fine grained, closely to medium fractured, soft rock greywacke. UNWEATHERED SOFT GREYWACKE.

JOB NUMBER: 22-1172

ROCK FABRIC
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Zutari
Macassar WWTW

HOLE No: BH05
Sheet 3 of 3

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL
HQ			100	49	>20	J1 J2 J3	45 60-70 80-90	M C-M M-W	IRR IRR IRR	SRJ SRJ-MRJ SRJ-MRJ	- - -	5-8 2-10 2-5		-11
HQ			100	68	>20	J1 J2	45 60-70	C-M M	IRR IRR	SRJ SRJ-MRJ	- -	5-10 2-4		-12 -13
														20.22

NOTES

1) Final Depth = 20.22m.
2) Samples taken at 15.01--15.13m.
3) Cores retained in 6 coreboxes.
4) Water table at 4.60m.

CONTRACTOR : Geomechanics
MACHINE : Comachio P253
DRILLED BY : Michael Mohajane
PROFILED BY : HH(Reviewed by WK PriSciNat)

INCLINATION : Vertical
DIAM : 63-75mm DIAM.
DATE : 25/04/2023
DATE : 26/04/2023

ELEVATION : 7m
X-COORD : 34´°04'34.9"S
Y-COORD : 18´°45'44.5"E

HOLE No: BH05

TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

DATE : 07/07/2023 10:39
TEXT : ..1172MacassarWWTWBH05.txt

Zutari
Macassar WWTW

LEGEND
Sheet 1 of 1

JOB NUMBER: 22-1172

	GRAVEL	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SANDY	{SA05}
	SILT	{SA06}
	SILTY	{SA07}
	CLAYEY	{SA09}
	MUDROCK/mudstone/siltstone/shale	{SA12}
	FILL	{SA32}
9.5	PERMANENT WATER TABLE	{SA35}
Name	DISTURBED SAMPLE	{SA38}
	ROOTS	{SA40}
	COBBLES	{SA58}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

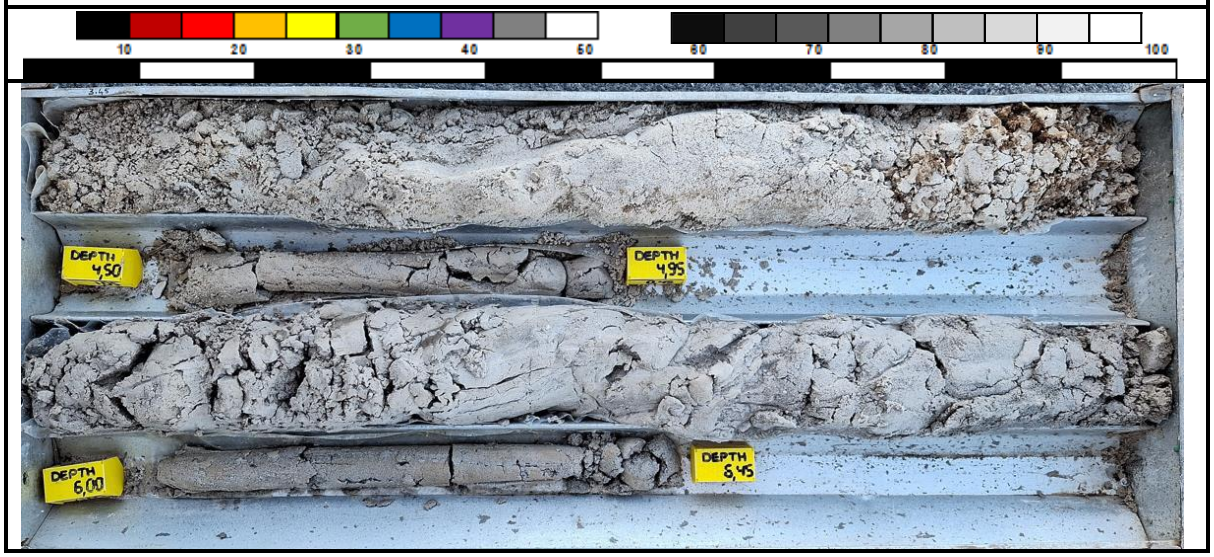
TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

DATE : 07/07/2023 10:39
TEXT : ..1172MacassarWWTWBH05.txt

LEGEND
SUMMARY OF SYMBOLS

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	0.00m – 3.45m	**BH No.:**	BH05
Corebox No.:	1 of 6	**Date drilled:**	25/04/2023

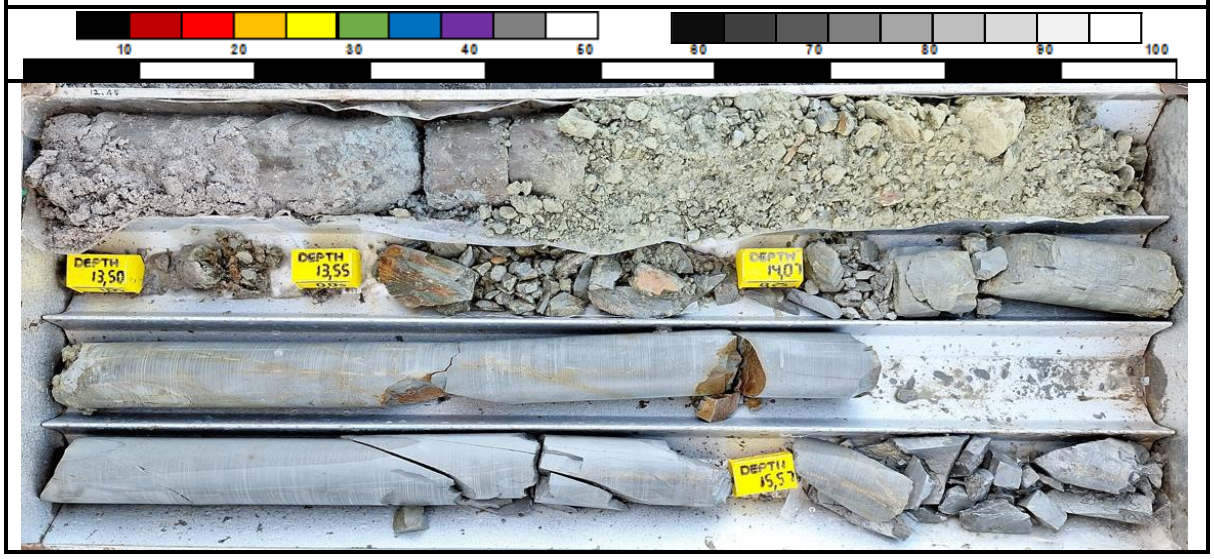
Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	3.45m – 6.45m	**BH No.:**	BH05
Corebox No.:	2 of 6	**Date drilled:**	25/04/2023



Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	6.45m – 9.45m	**BH No.:**	BH05
Corebox No.:	3 of 6	**Date drilled:**	25/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	9.45m – 12.45m	**BH No.:**	BH05
Corebox No.:	4 of 6	**Date drilled:**	25/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	12.45m – 15.87m	**BH No.:**	BH05
Corebox No.:	5 of 6	**Date drilled:**	25/04/2023



Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	15.87m – 20.22m	**BH No.:**	BH05
Corebox No.:	6 of 6	**Date drilled:**	25/04/2023

HOLE No: BH06
Sheet 1 of 2

JOB NUMBER: 22-1172

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

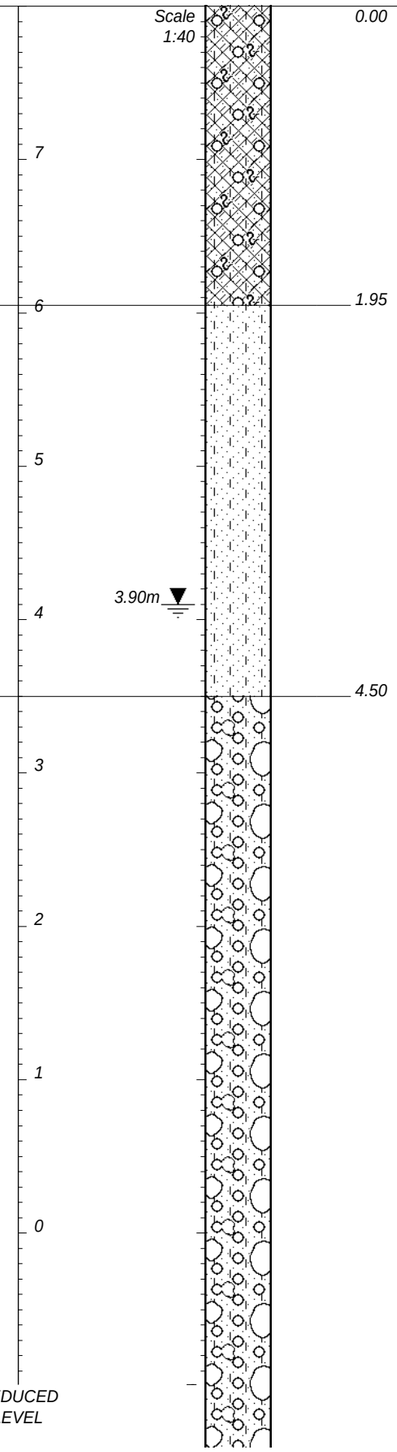
ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

Zutari
Macassar WWTW

HOLE No: BH06
Sheet 1 of 2

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL
Sonic		100												
SPT1	1,5,6,6,7,7 (N=26)	100												
Sonic		100												
SPT2	4,4,4,5,5,5 (N=19)	100												
Sonic		100												
SPT3	3,4,4,5,6,6 (N=21)	100												
Sonic		100												
SPT4	3,4,5,5,5,6 (N=21)	100												
Sonic		100												
SPT5	5,10,10,11,10,10 (N=41)	100												
Sonic		100												



0.00 — Black to dark brown becoming yellowish-white and red, MEDIUM DENSE, clayey gravelly silty SAND, with scattered roots and organic material. ORGANIC FILL.

1.95 — Yellowish-white to light brown, MEDIUM DENSE, silty fine SAND. TRANSPORTED AEOLIAN.

4.50 — Yellowish-white to brown, MEDIUM DENSE becoming DENSE, silty SAND with scattered gravel and cobbles of mixed origin. TRANSPORTED AEOLIAN.

HOLE No: BH06
Sheet 2 of 2

JOB NUMBER: 22-1172

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

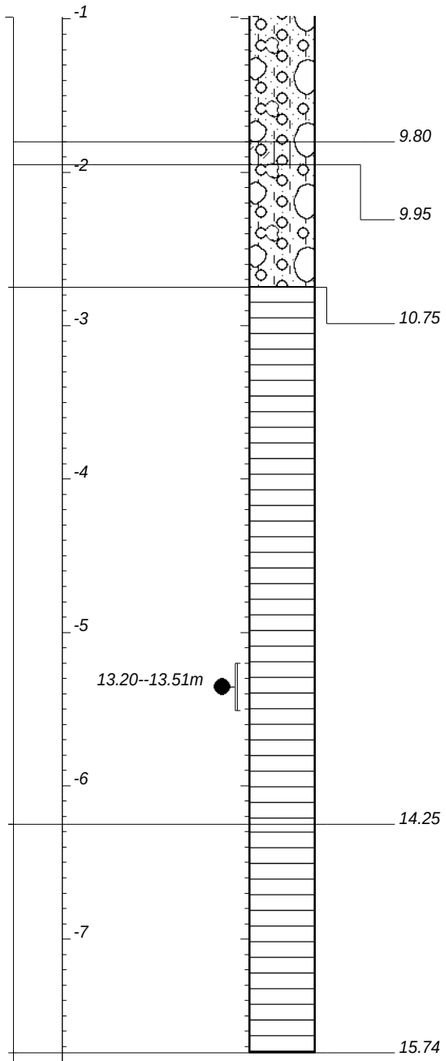
ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

Zutari
Macassar WWTW

HOLE No: BH06
Sheet 2 of 2

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL
SPT6	8,9,10,10,11,10 (N=41)	100												
Sonic		100									Clayey SILT			
SPT7	25,Ref (Ref)	100									Clayey SILT			
Sonic		100									-			
HQ			100	16	11	J1 J2 J3	30 60 80-90	M C M	IRR IRR IRR	MRJ SRJ-MRJ SRJ-SJ	Clayey SILT	5-60 2-10 2-10		
HQ			100	90	3	J1 J2	30 60	M C-M	IRR IRR	MRJ SRJ-MRJ	Clayey SILT	5 2-10		
HQ			100	20	9	J1 J2 J3	30 60 80-90	M C M	IRR IRR IRR	MRJ SRJ-MRJ SRJ-SJ	Clayey SILT	5-10 2-10 2-10		
HQ			100	25	9	J1 J2 J3	30 60 80-90	M C M	IRR IRR IRR	MRJ SRJ-MRJ SRJ-SJ	Clayey SILT -	5-10 2-20 2-10		
HQ			83	66	10	J1 J2 J3	30 60 80-90	M C M	IRR IRR IRR	MRJ SRJ-MRJ SRJ-SJ	Clayey SILT -	5-80 2-10 2-10		
HQ			90	13	>20	J1 J2 J3	30 60 80-90	C C M	IRR IRR IRR	MRJ SRJ-MRJ SRJ-SJ	Clayey SILT -	5-10 5-10 2-5		
HQ			100	17	>20	J1 J2 J3	30 60 80-90	C C M	IRR IRR IRR	MRJ SRJ-MRJ SRJ	Clayey SILT -	5-10 5-10 2-5		



9.80

Yellowish-brown to brown, clayey gravelly sandy SILT to sandy clayey SILT with gravels and cobbles. TRANSPORTED ESTUARINE.

9.95

Light olive-green and greenish-brown, VERY DENSE, sandy silty GRAVEL with angular to sub-angular gravel and cobbles of friable greywacke. RESIDUAL GREYWACKE.

10.75

Light grey to greenish-grey stained reddish-brown, highly weathered, very fine grained, very closely to closely fractured, very soft rock greywacke, with grey-brown clayey SILT infilling. HIGHLY WEATHERED VERY SOFT GREYWACKE.

14.25

Light grey to grey stained reddish-brown, medium weathered, very fine grained, closely to medium fractured, soft rock greywacke, with grey-brown clayey SILT infilling. MEDIUM WEATHERED VERY SOFT GREYWACKE.

15.74

NOTES

1) Final Depth = 15.74m.
2) Samples taken at 13.20--13.51m.
3) Cores retained in 7 coreboxes.
4) Water table at 3.90m.

CONTRACTOR : Geomechanics
MACHINE : Comachio P253
DRILLED BY : Michael Mohajane
PROFILED BY : HH(Reviewed by WK PriSciNat)

INCLINATION : Vertical
DIAM : 63-75mm DIAM.
DATE : 26/04/2023
DATE : 05/05/2023

ELEVATION : 8m
X-COORD : 34´°04'33.6"S
Y-COORD : 18´°45'46.4"E

HOLE No: BH06

TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

DATE : 07/07/2023 10:39
TEXT : ..1172MacassarWWTWBH06.txt

Zutari
Macassar WWTW

LEGEND
Sheet 1 of 1

JOB NUMBER: 22-1172

	GRAVEL/gravels	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SANDY	{SA05}
	SILT	{SA06}
	SILTY	{SA07}
	CLAYEY	{SA09}
	MUDROCK/mudstone/siltstone/shale	{SA12}
	FILL	{SA32}
9.5	PERMANENT WATER TABLE	{SA35}
Name	DISTURBED SAMPLE	{SA38}
	ROOTS	{SA40}
	COBBLES	{SA58}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

LEGEND
SUMMARY OF SYMBOLS

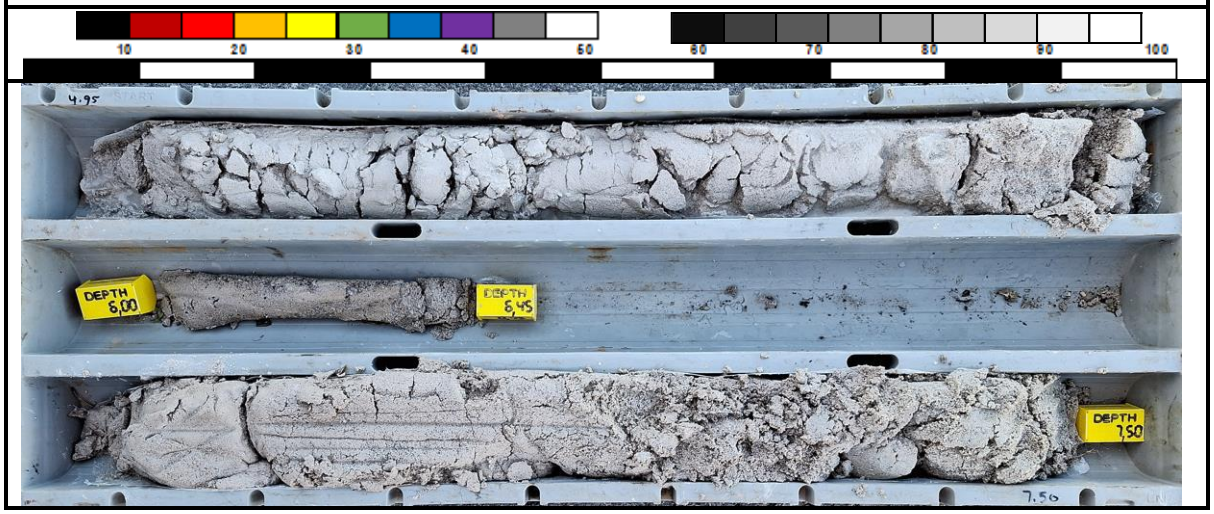
TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

DATE : 07/07/2023 10:39
TEXT : ..1172MacassarWWTWBH06.txt

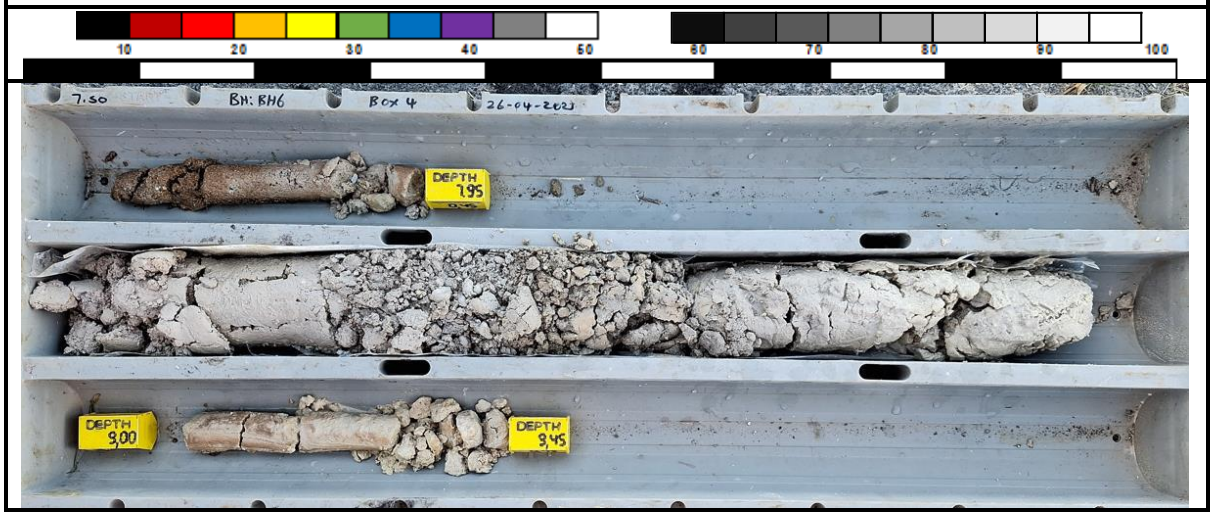
Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	0.00m – 3.00m	**BH No.:**	BH06
Corebox No.:	1 of 7	**Date drilled:**	26/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	3.00m – 4.95 m	**BH No.:**	BH06
Corebox No.:	2 of 7	**Date drilled:**	26/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	4.95m – 7.50m	**BH No.:**	BH06
Corebox No.:	3 of 7	**Date drilled:**	26/04/2023



Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	7.50m – 9.45m	**BH No.:**	BH06
Corebox No.:	4 of 7	**Date drilled:**	26/04/2023



Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	9.45m – 11.56m	**BH No.:**	BH06
Corebox No.:	5 of 7	**Date drilled:**	26/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	11.56m – 14.75m	**BH No.:**	BH06
Corebox No.:	6 of 7	**Date drilled:**	26/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	14.75m – 15.74m	**BH No.:**	BH06
Corebox No.:	7 of 7	**Date drilled:**	26/04/2023

HOLE No: BH08
Sheet 1 of 2

JOB NUMBER: 22-1172

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

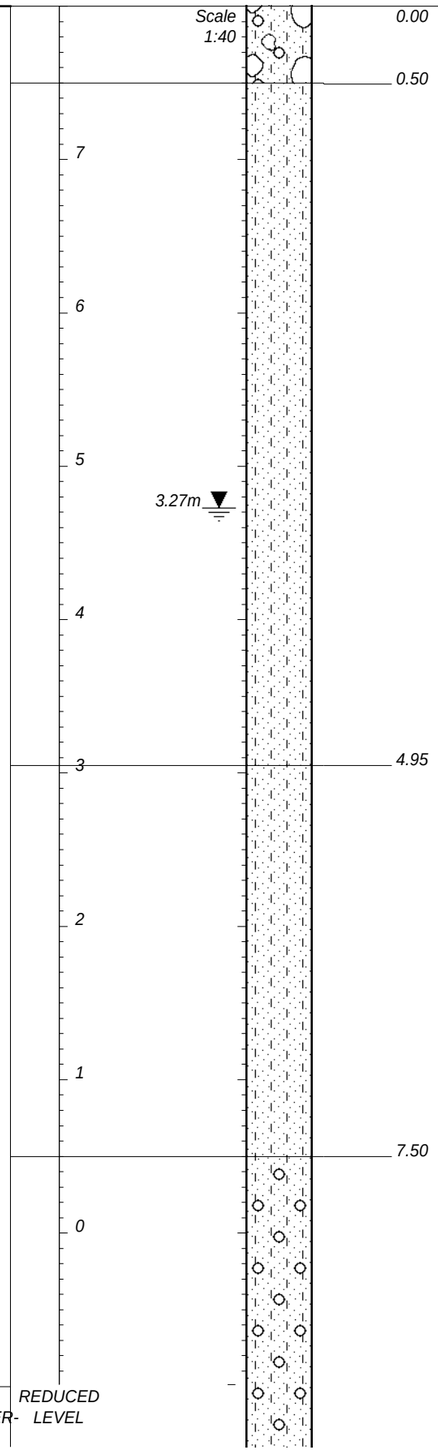
GCS Geotechnical Engineering

Zutari
Macassar WWTW

HOLE No: BH08
Sheet 1 of 2

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL
Sonic		100												
SPT1	3,4,5,5,8,7 (N=25)	100												
Sonic		100												
SPT2	3,3,4,3,3,3 (N=13)	100												
Sonic		100												
SPT3	3.5.7.4.5.3 (N=19)	100												
Sonic		100												
SPT4	5,6,7,7,6,5 (N=25)	100												
Sonic		100												
SPT5	2,4,3,3,4,5 (N=15)	100												
Sonic		100												



0.00 — Brown to yellowish-white, gravelly silty fine SAND, with scattered cobbles at surface. TOPSOIL.

0.50 — Yellowish-white to light brown, MEDIUM DENSE, silty fine SAND. TRANSPORTED AEOLIAN.

4.95 — Yellowish-white to grey-brown, MEDIUM DENSE, silty SAND. TRANSPORTED AEOLIAN.

7.50 — Grey to dark grey speckled white and black, MEDIUM DENSE becoming LOOSE, silty gravelly SAND. TRANSPORTED ESTUARINE.

HOLE No: BH08
Sheet 2 of 2

JOB NUMBER: 22-1172

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

GCS Geotechnical Engineering

Zutari
Macassar WWTW

HOLE No: BH08
Sheet 2 of 2

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL	
SPT6	1,2,2,2,3,3 (N=10)	100													
Sonic		100													
SPT7	14,25,Ref (Ref)	100													
HQ		52													Light olive-green and greenis-brown, VERY DENSE, sandy silty GRAVEL with angular to sub-angular gravel and cobbles of friable greywacke. RESIDUAL GREYWACKE.
HQ			52	34	9	J1 J2	30-45 70-80	C-M C	IRR STE	MRJ SRJ-MRJ	Clayey SILT Clayey SILT	5-10 2-10		10.50	Light olive-green to greenish-grey stained reddish-brown, highly weathered, very fine grained, closely to medium fractured, very soft rock greywacke, with grey-brown clayey SILT infilling. HIGHLY WEATHERED VERY SOFT GREYWACKE.
HQ			42	25	7	J1 J2	30-45 70-80	C C	IRR STE	MRJ SRJ-MRJ	Clayey SILT Clayey SILT	5-10 2-10		11.76	Light olive-green to grey stained reddish-brown, medium weathered, very fine grained, medium to widely fractured, soft rock greywacke, with grey-brown clayey SILT infilling. MEDIUM WEATHERED SOFT GREYWACKE.
HQ			73	38	>20	J1 J2	30-45 70-80	C C	IRR STE	MRJ SRJ-MRJ	Clayey SILT Clayey SILT	5-10 2-5		12.62	Dark grey to grey stained reddish-brown, slightly weathered, very fine grained, medium to widely fractured, soft rock greywacke, with grey-brown clayey SILT infilling. SLIGHTLY WEATHERED SOFT GREYWACKE.
HQ			100	46	15	J1 J2 J3	30 60 70-80	M M-W M	IRR IRR IRR	MRJ SRJ-MRJ SRJ-SJ	Clayey SILT Clayey SILT -	5-10 2-20 2-10		14.32	
HQ			93	87	15	J1 J2 J3	30 60 70-80	M M C-M	IRR IRR IRR	MRJ SRJ-MRJ SRJ-SJ	Clayey SILT - -	5-20 2-10 2-10		17.32	

NOTES
1) Final Depth = 17.32m.
2) No samples taken.
3) Cores retained in 7 coreboxes.
4) Water table at 3.27m.

CONTRACTOR : Geomechanics
MACHINE : Comachio P253
DRILLED BY : Michael Mohajane
PROFILED BY : HH(Reviewed by WK PriSciNat)

INCLINATION : Vertical
DIAM : 63-75mm DIAM.
DATE : 24/04/2023
DATE : 25/04/2023

ELEVATION : 8m
X-COORD : 34´°04'40.7"S
Y-COORD : 18´°45'53.2"E

HOLE No: BH08

TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

DATE : 07/07/2023 10:40
TEXT : ..1172MacassarWWTWBH08.txt

Zutari
Macassar WWTW

LEGEND
Sheet 1 of 1

JOB NUMBER: 22-1172

	GRAVEL	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SANDY	{SA05}
	SILTY	{SA07}
	MUDROCK/mudstone/siltstone/shale	{SA12}
6.5	PERMANENT WATER TABLE	{SA35}
	COBBLES	{SA58}

CONTRACTOR :	*INCLINATION :*	*ELEVATION :*
MACHINE :	*DIAM :*	*X-COORD :*
DRILLED BY :	*DATE :*	*Y-COORD :*
PROFILED BY :	*DATE :*	
TYPE SET BY : Hendre Human	*DATE :* 07/07/2023 10:40	
SETUP FILE : BH1PG-A3.SET	*TEXT :* ..1172MacassarWWTWBH08.txt	

LEGEND
SUMMARY OF SYMBOLS

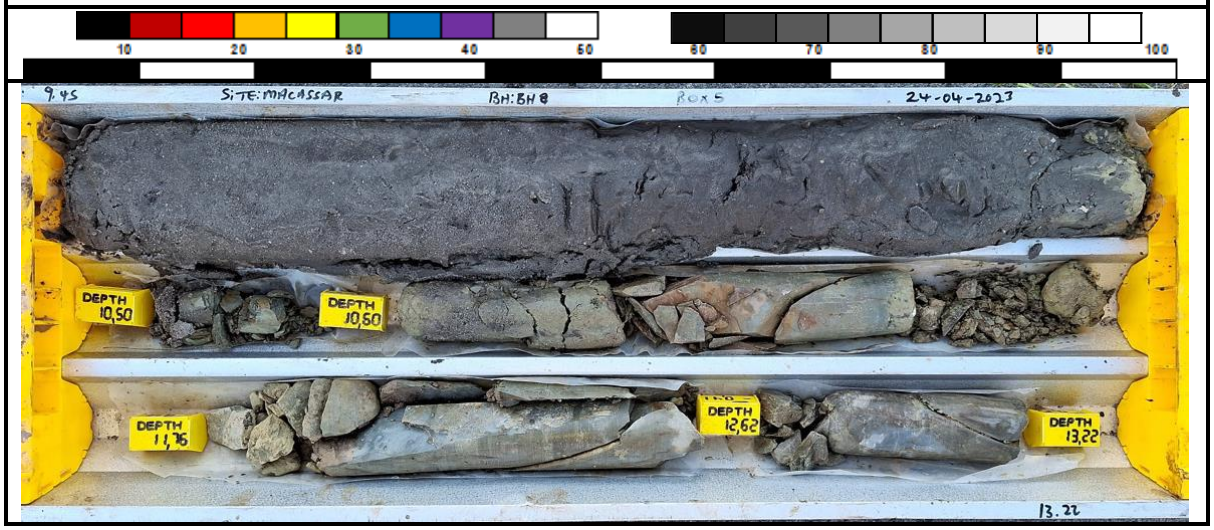
Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	0.00m – 3.00m	**BH No.:**	BH08
Corebox No.:	1 of 7	**Date drilled:**	24/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	3.00m – 4.95 m	**BH No.:**	BH08
Corebox No.:	2 of 7	**Date drilled:**	24/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	4.95m – 7.50m	**BH No.:**	BH08
Corebox No.:	3 of 7	**Date drilled:**	24/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	7.50m – 9.45m	**BH No.:**	BH08
Corebox No.:	4 of 7	**Date drilled:**	24/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	9.45m – 13.22m	**BH No.:**	BH08
Corebox No.:	5 of 7	**Date drilled:**	24/04/2023



Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	13.22m – 15.82m	**BH No.:**	BH08
Corebox No.:	6 of 7	**Date drilled:**	24/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	15.82m – 17.32m	**BH No.:**	BH08
Corebox No.:	7 of 7	**Date drilled:**	24/04/2023

HOLE No: BH09
Sheet 1 of 2

JOB NUMBER: 22-1172

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

GCS Geotechnical Engineering

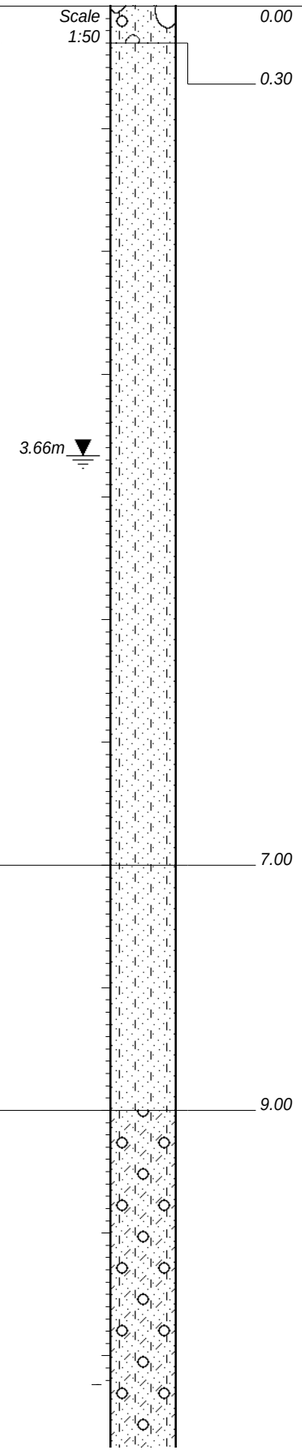
Zutari
Macassar WWTW

HOLE No: BH09
Sheet 1 of 2

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING
Sonic		100											
SPT1	6,10,9,8,9,9 (N=35)	100											
Sonic		100											
SPT2	4,5,5,6,6,7 (N=24)	100											
Sonic		100											
SPT3	3,2,4,5,6,8 (N=23)	100											
Sonic		100											
SPT4	4,6,6,8,9,9 (N=32)	100											
Sonic		100											
SPT5	2,2,2,2,2,4 (N=10)	0											
Sonic		100											
SPT6	1,1,1,1,1,1 (N=4)	100											
Sonic		100											

REDUCED LEVEL



Brown to yellowish-white, gravelly silty fine SAND, with scattered cobbles at surface. TOPSOIL.

Yellowish-white to light brown, MEDIUM DENSE to DENSE, silty fine SAND. TRANSPORTED AEOLIAN.

Yellowish-white to brown, LOOSE, silty SAND. TRANSPORTED AEOLIAN.

Grey to dark grey speckled white and black, LOOSE becoming DENSE, clayey silty gravelly SAND. TRANSPORTED ESTUARINE.

HOLE No: BH09
Sheet 2 of 2

JOB NUMBER: 22-1172

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

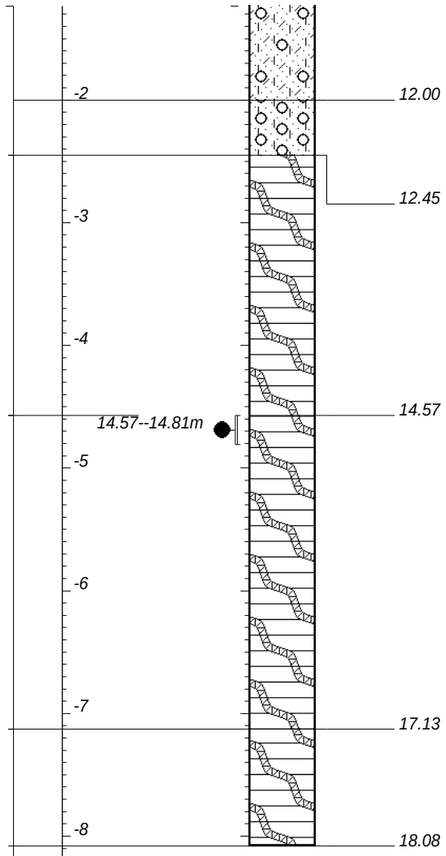
ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

Zutari
Macassar WWTW

HOLE No: BH09
Sheet 2 of 2

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL	
SPT7	1,3,4,5,8,18 (N=35)	100												12.00	Grey to dark grey specled white, DENSE, silty gravelly SAND with icreasing sub-angular gravel with depth. REWORKED RESIDUAL GREYWACKE.
HQ			100	17	11	J1 J2 J3	<20 50-55 70-80	M M M	IRR STE STE	MRJ SRJ-MRJ SRJ-MRJ	- - -	5-10 2-10 2-10		12.45	Grey to dark grey streaked light grey, slightly weathered, very fine grained, medium fractured, soft rock greywacke, with sub-vertical closed quartz veins. SLIGHTLY WEATHERED SOFT GREYWACKE.
HQ			100	30	8	J1 J2 J3	<20 50-55 70-80	M M M	IRR STE STE	MRJ SRJ-MRJ SRJ-MRJ	- - Qtz	5-10 2-10 2-10			
HQ			100	91	10	J1 J2 J3	<20 50-55 70-80	C-M C-M M	IRR STE STE	MRJ SRJ-MRJ SRJ-MRJ	- - Qtz	5-10 2-5 2-5		14.57	Grey to dark grey streaked light grey, slightly weathered, very fine grained, medium to closely fractured, soft rock greywacke, with sub-vertical closed quartz veins and light grey clayey silt infilling. SLIGHTLY WEATHERED SOFT GREYWACKE.
HQ			100	95	3	J1 J2	<20 50-55	M M	IRR STE	MRJ SRJ-MRJ	- Qtz	5-10 2-5			
HQ			100	19	>20	J1 J2 J3	<20 50-55 70-80	C C M	IRR STE STE	MRJ SRJ-MRJ SRJ-MRJ	- Clayey SILT Qtz	5-10 2-5 2-5		17.13	Grey to dark grey streaked light grey, unweathered, very fine grained, medium fractured, soft rock greywacke, with sub-vertical closed quartz veins. UNWEATHERED SOFT GREYWACKE.
HQ			100	86	4	J1 J2 J3	<20 50-55 70-80	M M M	IRR STE STE	MRJ SRJ-MRJ SRJ-MRJ	- - Qtz	5-10 2-5 2-5		18.08	



NOTES

1) Final Depth = 18.08m.
2) Samples taken at 14.57--14.81m.
3) Cores retained in 8 coreboxes.
4) Water table at 3.66m.

CONTRACTOR : Geomechanics
MACHINE : Comachio P253
DRILLED BY : Michael Mohajane
PROFILED BY : HH(Reviewed by WK PriSciNat)

INCLINATION : Vertical
DIAM : 63-75mm DIAM.
DATE : 21/04/2023
DATE : 22/04/2023

ELEVATION : 10m
X-COORD : 34´°04'34.2"S
Y-COORD : 18´°45'52.7"E

TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

DATE : 07/07/2023 10:40
TEXT : ..1172MacassarWWTWBH09.txt

HOLE No: BH09

Zutari
Macassar WWTW

LEGEND
Sheet 1 of 1

JOB NUMBER: 22-1172

	GRAVEL	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SILTY	{SA07}
	CLAYEY	{SA09}
	MUDROCK/mudstone/siltstone/shale	{SA12}
	QUARTZ VEINS	{SA20}
7.5	PERMANENT WATER TABLE	{SA35}
Name	DISTURBED SAMPLE	{SA38}
	COBBLES	{SA58}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

DATE : 07/07/2023 10:40
TEXT : ..1172MacassarWWTWBH09.txt

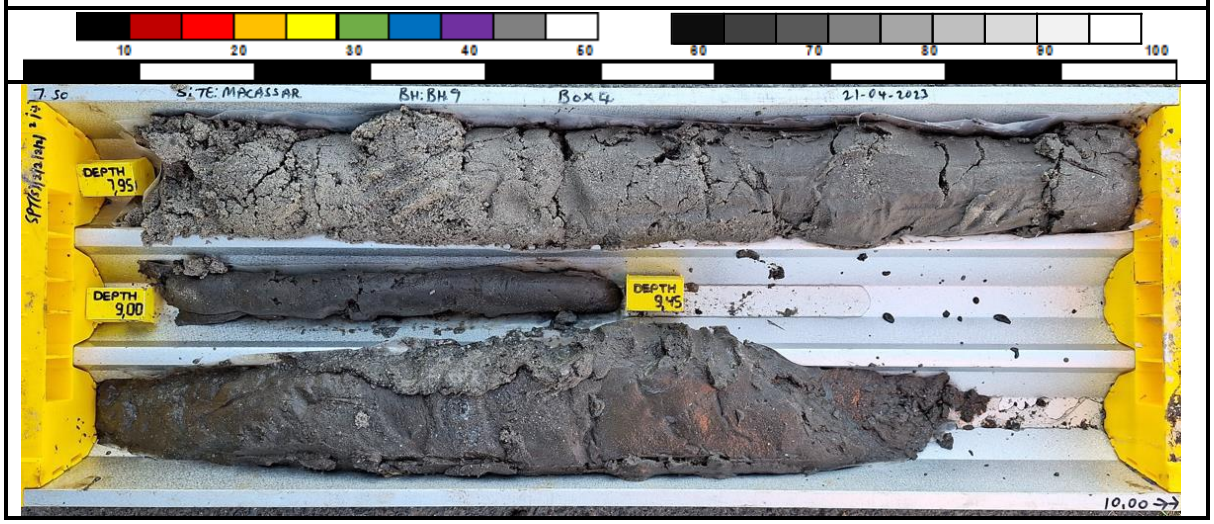
LEGEND
SUMMARY OF SYMBOLS

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	0.00m – 3.00m	**BH No.:**	BH09
Corebox No.:	1 of 8	**Date drilled:**	21/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	3.00m – 4.95m	**BH No.:**	BH09
Corebox No.:	2 of 8	**Date drilled:**	21/04/2023

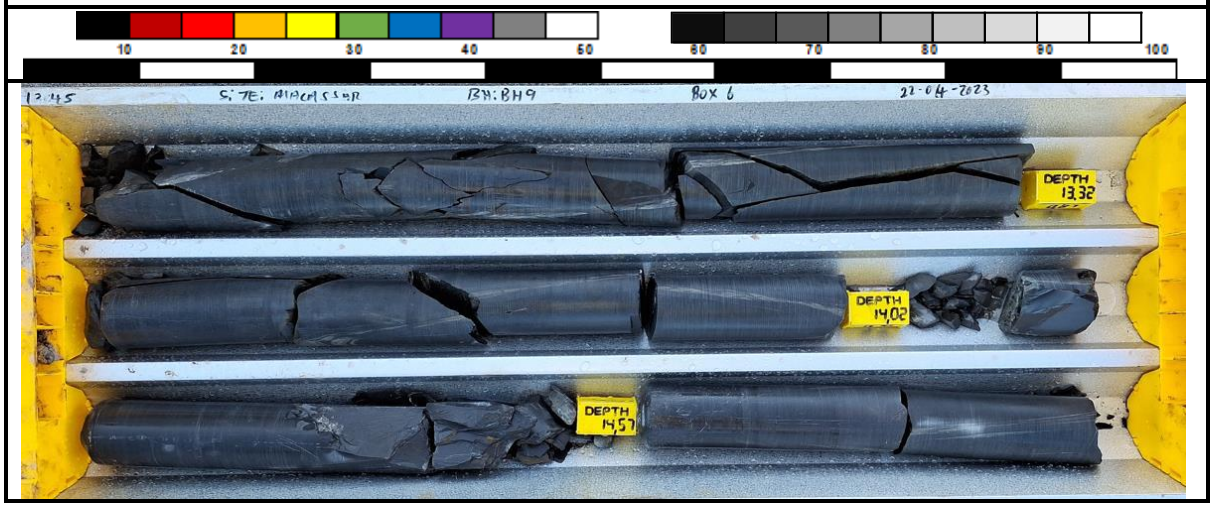
Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	4.95m – 7.50m	**BH No.:**	BH09
Corebox No.:	3 of 8	**Date drilled:**	21/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	7.50m – 10.00m	**BH No.:**	BH09
Corebox No.:	4 of 8	**Date drilled:**	21/04/2023

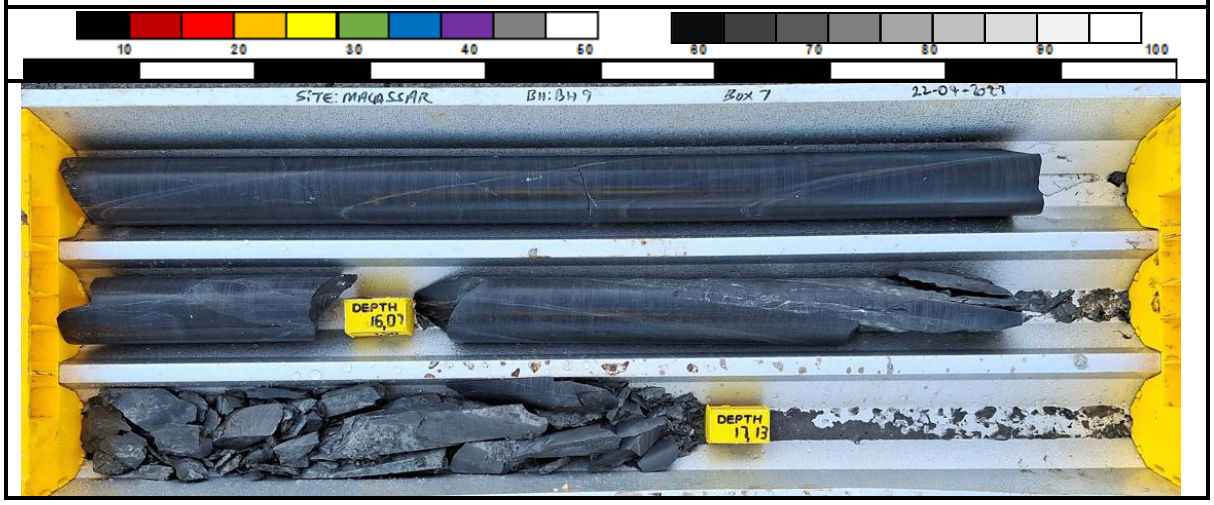


Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	10.00m – 12.45m	**BH No.:**	BH09
Corebox No.:	5 of 8	**Date drilled:**	21/04/2023

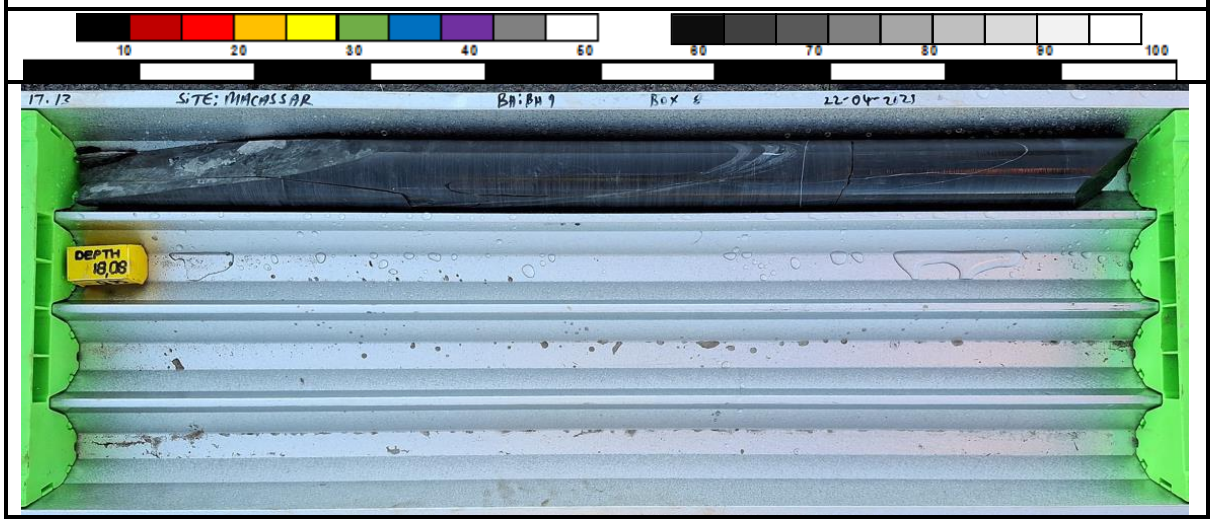
Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	12.45m – 15.00m	**BH No.:**	BH09
Corebox No.:	6 of 8	**Date drilled:**	22/04/2023



Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	15.00m – 17.13m	**BH No.:**	BH09
Corebox No.:	7 of 8	**Date drilled:**	22/04/2023



Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	17.13m – 18.08m	**BH No.:**	BH09
Corebox No.:	8 of 8	**Date drilled:**	22/04/2023



HOLE No: BH11
Sheet 1 of 2

JOB NUMBER: 22-1172

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

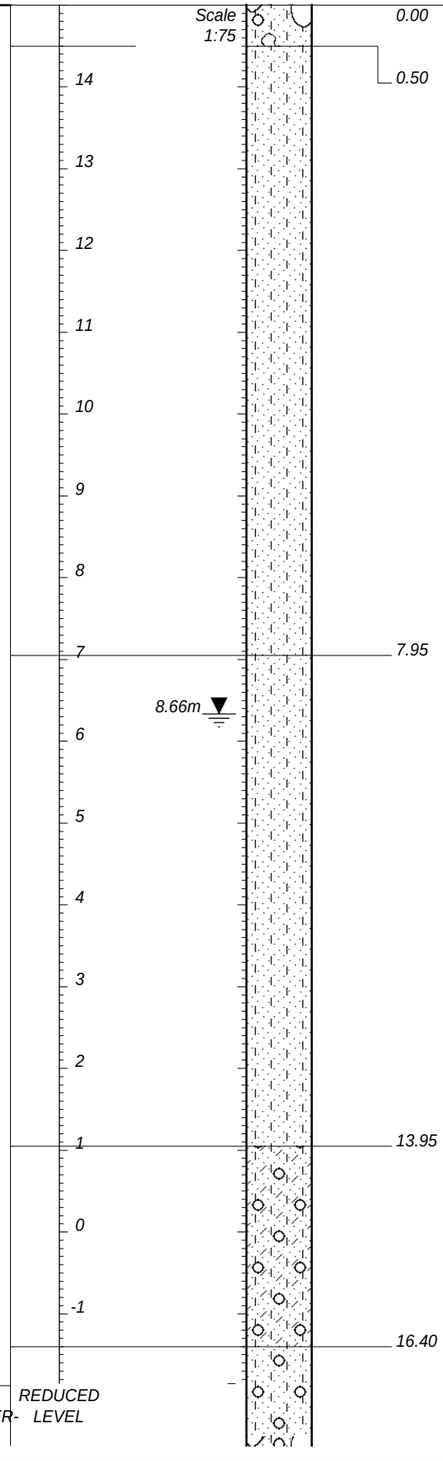
GCS Geotechnical Engineering

Zutari
Macassar WWTW

HOLE No: BH11
Sheet 1 of 2

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING
Sonic		67											
SPT1	1,2,6,6,6,6 (N=24)	100											
Sonic		100											
SPT2	2,4,3,3,3,3 (N=12)	100											
Sonic		100											
SPT3	4,5,6,5,5,5 (N=21)	100											
Sonic		100											
SPT4	3,4,3,5,4,4 (N=16)	100											
Sonic		100											
SPT5	5,6,4,3,3,3 (N=13)	100											
Sonic		100											
SPT6	3,3,4,4,4,4 (N=16)	100											
Sonic		100											
SPT7	2,4,3,6,7,6 (N=22)	100											
Sonic		100											
SPT8	3,5,6,6,7,8 (N=27)	100											
Sonic		100											
SPT9	4,5,4,3,2,3 (N=12)	100											
Sonic		100											
SPT10	1,1,1,1,1,1 (N=4)	100											
Sonic		100											



0.00 Brown to yellowish-white, gravelly silty fine SAND, with scattered cobbles at surface. TOPSOIL.

0.50 Yellowish-white to light brown, MEDIUM DENSE, silty fine SAND. TRANSPORTED AEOLIAN.

7.95 Yellowish-white to brown, MEDIUM DENSE, silty SAND. TRANSPORTED AEOLIAN.

13.95 Grey to dark grey and brown speckled white and black, LOOSE, clayey silty gravelly SAND. TRANSPORTED ESTUARINE.

16.40

HOLE No: BH11
Sheet 2 of 2

JOB NUMBER: 22-1172

ROCK FABRIC
MF -massive
BF -bedded
FF -foliated
CF -cleaved
SF -schistose
GF -gneissose
LF -laminated

GRAIN SIZE
FG -fine grained
MG -medium grain
CG -coarse grain

JOINT SPACING
VCJ-very close spacg
CJ -close spacing
MJ -medium spacing
WJ -wide spacing
VWJ-very wide spacng

JOINT ROUGHNESS
SLJ-slickensided
SJ -smooth
RJ -rough

JOINT SHAPE
CUR-curvilinear
PLA-planar
UND-undulating
STE-stepped
IRR-irregular

ROCK HARDNESS
EHR-extremely hard rock
VHR-very hard rock
HR -hard rock
MHR-medium hard rock
SR -soft rock
VSR-very soft rock

GCS Geotechnical Engineering

Zutari
Macassar WWTW

HOLE No: BH11
Sheet 2 of 2

JOB NUMBER: 22-1172

DRILL METHOD	SPT N	% MAT REC	% CORE REC	% RQD	FRACT FREQ	JOINT NO OF SETS	JOINT INCLIN (deg)	JOINT SPACING	JOINT SHAPE	JOINT ROUGH-NESS	JOINT FILL	FILL THICKNESS (mm)	% WEATHER-ING	REDUCED LEVEL	
											Clayey SILT			-2	Grey to greenish-grey, silty gravelly SAND. REWORKED RESIDUAL GREYWACKE.
														17.50	
HQ		100	62	14		J1 J2 J3	<20 50-55 70-80	C-M M M	IRR STE STE	SRJ SRJ-MRJ SRJ-MRJ	Qtz Qtz	2-8 2-10 2-30		-3	Light olive-green to greenish-grey blotched red, clayey silty gravelly SAND with icreasing sub-angular gravel and cobbles with depth. RESIDUAL GREYWACKE.
											Clayey SILT			-4	
														17.96	
HQ		100	69	14		J1 J2 J3	<20 45-55 70-80	M-W M M	STE STE STE	MRJ SRJ-MRJ SRJ-MRJ	Qtz Qtz	2-8 2-5 2-20		-5	Light grey to grey streaked light grey and white, medium weathered, very fine grained, closely to medium fractured, soft rock greywacke, with sub-vertical quartz veins and light grey clayey SILT infilling. MEDIUM WEATHERED SOFT GREYWACKE.
HQ		100	44	7		J1 J2 J3	<20 45-55 70-80	C-M C-M M	STE IRR STE	MRJ SRJ-MRJ SRJ-MRJ	- Qtz Qtz	2-8 2-5 2-20		-6	
														20.36	
HQ		70	31	10		J1 J2 J3	<20 45-55 70-80	C-M C-M M	STE IRR STE	MRJ SRJ-MRJ SRJ-MRJ	- Qtz Qtz	2-8 2-5 2-20		-7	Light grey to grey streaked light grey and white, slightly weathered, very fine grained, closely to medium fractured, soft rock greywacke, with sub-vertical closed quartz veins. SLIGHTLY WEATHERED SOFT GREYWACKE.
														21.72	
HQ		91	75	6		J1 J2 J3	<20 45-55 70-80	C-M M M	IRR IRR IRR	MRJ SRJ-MRJ SRJ-MRJ	- - Qtz	2-8 2-5 2-20		-8	Grey to dark grey streaked light grey, unweathered, very fine grained, medium fractured, soft rock greywacke, with sub-vertical closed quartz veins. UNWEATHERED SOFT GREYWACKE.
														23.22	

NOTES

1) Final Depth = 23.22m.

2) No samples taken.

3) Cores retained in 9 coreboxes.

4) Water table at 8.66m.

CONTRACTOR : Geomechanics
MACHINE : Comachio P253
DRILLED BY : Michael Mohajane
PROFILED BY : HH (Reviewed by WK PriSciNat)

INCLINATION : Vertical
DIAM : 63-75mm DIAM.
DATE : 27/04/2023 - 28/04/2023
DATE : 28/04/2023

ELEVATION : 15m
X-COORD : 34´°04'32.6"S
Y-COORD : 18´°45'54.2"E

HOLE No: BH11

TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

DATE : 07/07/2023 11:47
TEXT : ..1172MacassarWWTWBH11.txt

Zutari
Macassar WWTW

LEGEND
Sheet 1 of 1

JOB NUMBER: 22-1172

	GRAVEL	{SA02}
	GRAVELLY	{SA03}
	SAND	{SA04}
	SILTY	{SA07}
	CLAYEY	{SA09}
	MUDROCK/mudstone/siltstone/shale	{SA12}
	QUARTZ VEINS	{SA20}
7.5	PERMANENT WATER TABLE	{SA35}
	COBBLES	{SA58}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : Hendre Human
SETUP FILE : BH1PG-A3.SET

DATE : 07/07/2023 11:47
TEXT : ..1172MacassarWWTWBH11.txt

LEGEND
SUMMARY OF SYMBOLS

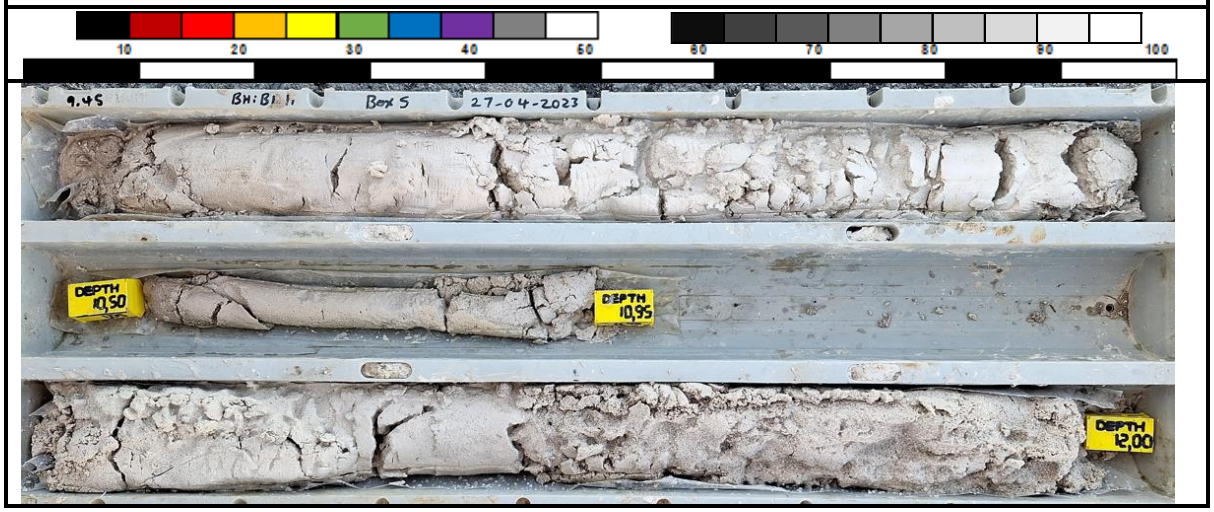
Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	0.00m – 3.00m	**BH No.:**	BH11
Corebox No.:	1 of 9	**Date drilled:**	27/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	3.00m – 4.95m	**BH No.:**	BH11
Corebox No.:	2 of 9	**Date drilled:**	27/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	4.95m – 7.50m	**BH No.:**	BH11
Corebox No.:	3 of 9	**Date drilled:**	27/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	7.50m – 9.45m	**BH No.:**	BH11
Corebox No.:	4 of 9	**Date drilled:**	27/04/2023

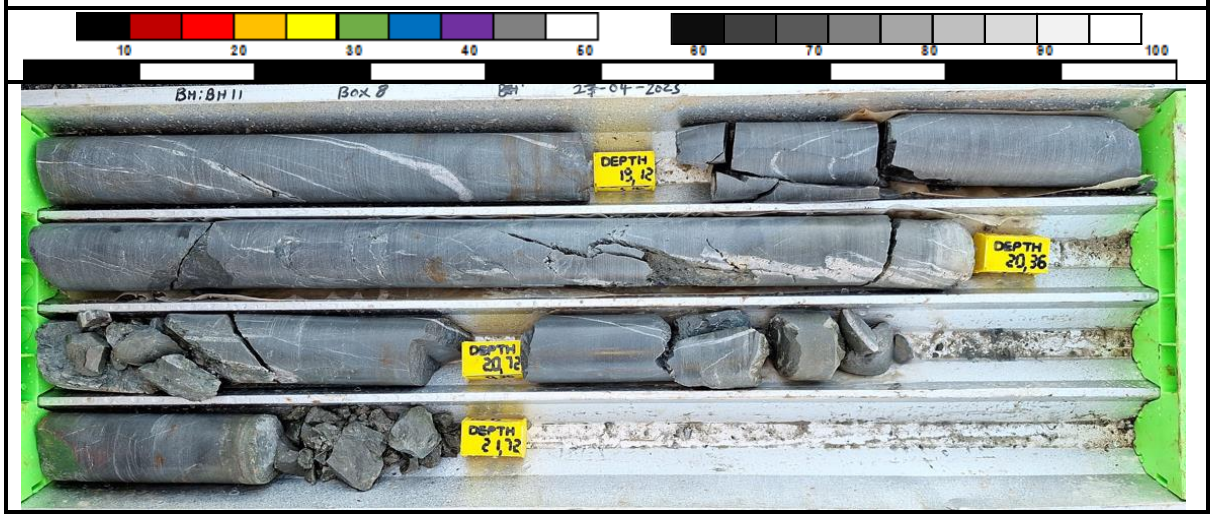
Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	9.45m – 12.00m	**BH No.:**	BH11
Corebox No.:	5 of 9	**Date drilled:**	27/04/2023



Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	12.00m – 15.00m	**BH No.:**	BH11
Corebox No.:	6 of 9	**Date drilled:**	27/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	15.00m – 18.50m	**BH No.:**	BH11
Corebox No.:	7 of 9	**Date drilled:**	27/04/2023

Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	18.50m – 21.72m	**BH No.:**	BH11
Corebox No.:	8 of 9	**Date drilled:**	27/04/2023



Client:	Zutari	**GCS PN:**	22-1172
Project:	Macassar WWTW		
Zutari PN:	1001780	**Contract No.:**	340C/2018/19
Depth:	21.72m – 23.22m	**BH No.:**	BH11
Corebox No.:	9 of 9	**Date drilled:**	28/04/2023

APPENDIX F

Geophysical Survey

To:	Nino Welland	**From:**	Bjorn Havemann
Company:	GCS Geotechnical Engineering	**Company:**	Geofocus
Email:	ninow@gcs-sa.biz	**Reg:**	2016 / 324488 / 07
Date:	13 June 2023	**Email:**	bjorn@geofocus.co.za

Report on geophysical surveys carried out at Macassar WWTW (Western Cape)

GENERAL

Geophysical surveys, including Soil Electrical Resistivity (SER) and Multichannel Analysis of Surface Waves (MASW), were undertaken at the Macassar Wastewater Treatment Works (WWTW), the results of which are reported here. Seismic refraction (SRF) data, which did not form part of the original scope, were also collected.

The Macassar WWTW site is located between Khayelitsha and Strand, just south of the N2 highway and abutting the coastline. The work was undertaken on behalf of GCS Geotechnical Engineers who are conducting a geotechnical study in support of an upgrade and extension of the facility.

The geology is comprised of Quarternary sands up to 20m thick overlying greywacke of the Tygerberg Formation sediments. Coastal dune sands are also present which can vary from unconsolidated to consolidated and, at times, including clay.

SER surveys measure changes in ground resistance with depth, this data are then transformed into corrosion potential parameters which informs foundation and grounding specifications. MASW is a geotechnical tool which measures changes in shear wave velocities (Vs) with depth. The measurements are transformed into rock stiffness parameters which inform the load bearing capacity of an underlying formation. SRF surveys measure the propagation of percussion wave velocities (Vp) with depth from which dept to bedrock can be inferred.

SER data were surveyed over two sites with MASW and SRF data collected along twelve lines – Figure 1. The survey lines and locations were provided by the client following a field visit. Fieldwork was completed in mid-May 2023.

METHODOLOGY

SER

An ABEM Lund LS2 resistivity instrument was employed to measure ground resistance whilst a GNNS (RTK) GPS was used to locate points along the traverse. Data were acquired using the 4-electrode Wenner array whereby current is passed through current electrodes and the potential drop is measured by two potential electrodes. The array is expanded by increasing the distance between the electrodes from 'a' = 1m, 2m, 5m, 10m, 15m, 20m, 24m, 32m, 40m to 50m or as access allows. The earth resistance (R), measured in Ohms (Ω), are tabled against the probe spacing (a), measured in metres (m). Soil resistivity (ρ), measured in Ohms-meter (Ω.m), is derived by applying the following equation:

$$\rho = R \cdot 2 \pi a$$

Where:	ρ	is the soil resistivity in Ohm.m (Ω.m)
	R	is the resistance reading in Ohms (Ω)
	a	is the test probe spacing in metres (m)
	2πa	is also known as the geometric factor

The data quality was of a high standard with good repeatability.

MASW/SRF

A 24-channel Geometrics Geode seismograph was used along with geophones with a natural frequency of 4½ Hz. Each array consisted of 24 geophones spaced 3m apart, hence each traverse was 69m long except for Site 2 where only 12 geophones were laid out. A sledge hammer was used as energy source with near and far off-shots taken for the SRF. The shot locations for the MASW were taken near and at alternating geophones. The SRF record length was set at 0.15 seconds with a sample time of 62us. The record length was increased to 1.8 seconds for the MASW with a sample time of 0.5 milliseconds. All geophone locations were recorded using a GNNS (RTK) GPS).

MASW data were processed in the Seis-Imager software suite where surface wave analysis was conducted using a bin size of 6 meters to stack records with common center points. Wave-Eq was used to visualize the frequency range distribution of the data and edit as required prior to running the inversion. SRF data are also processed through Seis-Imager starting with PickWin to select the p-wave first arrivals. Thereafter PlotRefa was used to determine travel time curves by least squares inversion. The Geosoft suite of programmes was used to grid and generate Vs and Vp sections.

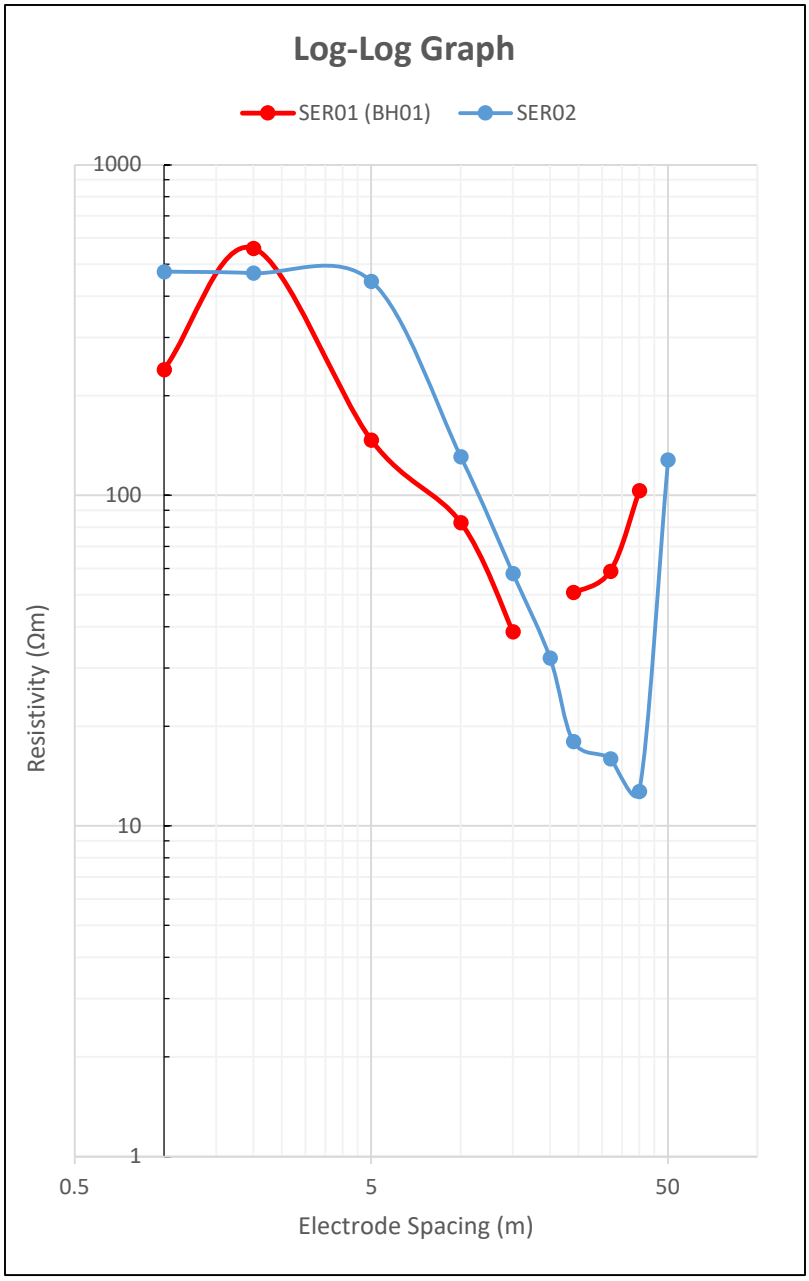
***Note**: 1) SRF is limited to mapping the depth to the fastest layer encountered. Hence, rock overlain by a layer with a higher acoustic velocity remains hidden.*
2) The s-wave velocities (Vs) displayed at the surface of a MASW section are extrapolations as data are not measured at depths less than the geophone spacing.
3) At depth, the distance between Vs estimates increases and the resolution of the method decreases.

The seismic data was adversely affected by high noise levels from the treatment plant, coast (wave action) and wind. The effect of the latter is usually reduced by clearing the lines of vegetation however, this was not allowed due to environmental restrictions. Nevertheless, the seismic results are deemed of fair quality.

RESULTS

SER

The soil resistivity results for sites SER01/BH01 and SRT02 (Figure 1) are shown in the Log-Log graph below. The results are similar, showing comparatively high resistivities of around 450 – 550 Ω.m near surface i.e. 'a' ≤ 5m. The first reading of 'a' = 1m at Site SER01 is lower than at Site SER02, the increased conductivity is likely due to higher saturation levels and / or clay. Both graphs show resistivities decreasing with depth with an upturn (i.e. increasing resistivities) at 'a' = 24m and 50m for sites SER01/BH01 and SER02 respectively. This suggests that the dryer surficial overburden is resistive becoming more conductive with depth as the saturation and/or clay content increases. The sedimentary bedrock (greywacke) shows resistivities in keeping with the formation, increasing at depth as the weathering decreases.



Based on the DIN 50 929 corrosivity index (see illustration below), site SER01/BH01 is mostly mildly corrosive with a moderately corrosive horizon at 'a' = 15m i.e. ~ 8m deep. Site SER02 is similar in that it is also mildly corrosive for the most part however, it becomes moderately corrosive at 'a' = 20m and severely corrosive from 'a' = 24m to 40m; the clay content is likely to be higher here. Bedrock is again mildly corrosive.

	SER01/BH01	SER02	
Probe Spacing (a)	Resistivity (R2πa)	Resistivity (R2πa)	Depth
m	Ωm	Ωm	mbgl
1	240	476	0.5
2	559	471	1
5	147	444	2.6
10	83	131	5.2
15	39	58	7.8
20		32	10.4
24	51	18	12.5
32	59	16	16.6
40	103	13	20.8
50	NA	128	26

Range Ω.m	Corrosion Potential
<10	Very severly corrosive
10 - 20	Severely corrosive
20 - 50	Moderately corrosive
>50	Mildly corrosive

Corrosivity Classification – DIN 50 929 (1985)

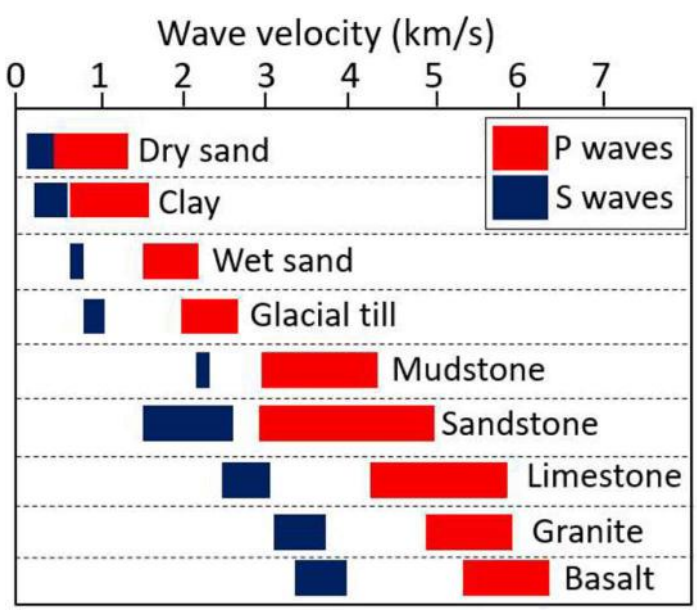
MASW/SRF

Figures 2a to 2l at the end of the report present the SRF and MASW results of the twelve lines surveyed. The upper section displays the percussion wave results (Vp) using individualized pseudo colour stretches on a linear distributions. The lower section displays the shear wave velocities (Vs) distribution using a colour stretch associated with the NEHRP [2003] rock and soil type classification scheme summarised in the table below.

Site class	Soil profile	Shear Wave velocity - Vs (m/s)	Colour Code
A	Hard rock	>1524	
B	Rock	762 - 1524	
C	Very dense soil & soft rock	366 - 762	
D	Stiff soil	183 - 366	
E	Soft soil	<183	
F	Problematic soil	Site spec. eval.	

NEHRP [2003] shear wave classification scheme

The SRF results suggest a mostly horizontally layered earth with percussion wave velocities ranging from 300 m/s – Vp – 4,200 m/s. The top of the unweathered greywacke, mapped in boreholes BH01 and BH05 at roughly 18m depth, coincides with percussion wave velocities of 2,400 – 2,500 m/s. This combined with the generalized velocities for sands and sedimentary rocks, see illustration below, suggests that sedimentary bedrock (Vp > 3,000 m/s) ranges from 30 masl (~12 mbgl) at the plant (Figure 2k) down to 20 masl (~25 mbgl) observed at BH05 (Figure 2b) and Site 5 & 6 (Figures 2f & 2g). This suggests that bedrock is mostly flat lying or dipping slightly from NE to SW. The overlying formations, including weathered sediments, transported sands and/or regolith show a gradational change in velocities with no discernable velocity gradient that can be attributed to a change in geology or structure.



Typical P-wave (red) & S-wave (blue) velocities [Physical Geology, 2nd addition, S. Earle, 2019]

The shear wave velocities (Vs) also show horizontal layering for the most part but, a higher degree of lateral variation is observed which is attributed to variations in compaction levels and saturation. Nevertheless, based on the NEHRP [2003]

rock hardness classification (see table above), most of the sites are typified by Stiff Soils (D) or Very Dense soil / Soft Rock (C). The only instance of Soft Soil (E) is re-corded at Site 5 (Figure 2f).

DISCUSSION

Site BH01 (Figure 2a)

Gradational horizontal layering with bedrock at roughly 28 masl dipping slightly towards the SE. Subtle lateral variation observed in Vs but overall, the site is classified as Stiff Soils (D).

Site BH05 (Figure 2b)

Gradational horizontal layering with fairly flat lying bedrock at roughly 20 masl. Subtle lateral variation observed in Vs but overall the site classification ranges from the higher end of Stiff Soils (D) to the lower end of Soft Rock (C), the latter increasing at depth.

Site BH06 (Figure 2c)

Gradational horizontal layering with fairly flat lying bedrock at roughly 20 masl. Subtle lateral variation observed in Vs as well as a velocity reversal from circa 30m to 69m. Overall, the site is classified as Soft Rock (C).

Site 2 (Figure 2d)

Bedrock was not intersected along this shorter line which had shallower penetration. Nevertheless, the horizontal layering is still observed in the overlying, slower velocity formations. The lateral variation is more subtle here with the site classified overall as Stiff Soils (D). A thin surficial horizon of Soft Rock (C) is present in the central SE however, caution is advised given its shallow nature.

Site 3 (Figure 2e)

Gradational horizontal layering with fairly flat lying bedrock at roughly 24 masl. Subtle lateral variation observed in Vs but overall, the site classification ranges from the higher end of Stiff Soils (D) to the lower end of Soft Rock (C).

Site 5 (Figure 2f)

Gradational horizontal layering with fairly flat lying bedrock at roughly 22 masl. Subtle lateral variation observed in Vs but overall, the site is classified as Stiff Soils (D) with Soft Soil (E) recorded on the far NNE of the section.

Site 6 (Figure 2g)

Gradational horizontal layering with bedrock at roughly 22 masl dipping slightly towards the start of the line. Subtle lateral variation observed in Vs but overall, the site is classified as Soft Rock (C) with a thin horizon of Stiff Soils (D) present in the latter half of the traverse.

Site 7 (Figure 2h)

Gradational horizontal layering with fairly flat lying bedrock at roughly 222 masl. Less lateral variation is observed in Vs at this location. Overall, the site is classified as Stiff Soils (D) with Soft Rock (C) present at depth in the far SSW.

Site 10 (Figure 2i)

Gradational horizontal layering with bedrock at roughly 28 masl dipping slightly towards the SE. Subtle lateral variation observed in Vs but overall, the site is classified as Stiff Soils (D). A thin surficial horizon of Soft Rock (C) is present towards the SE however, caution is advised given its shallow nature.

Site 11 (Figure 2j)

Gradational horizontal layering with fairly flat lying bedrock at roughly 26 masl. The lateral Vs variation is less at this location which is classified as Stiff Soils (D) overall. The classification changes to Soft Rock (C) at depth in the latter part of the section.

Site 11 – Plant (Figure 2k)

Gradational horizontal layering with bedrock at roughly 28 masl. The shear wave contours are also mostly horizontal with Stiff Soils (D) present in the upper 10m following which it is Soft Rock (C).

Site 12 (Figure 2l)

Mostly gradational horizontal layering with bedrock at roughly 23 masl. The shear wave contours are also mostly horizontal and, as seen at the plant and site 11, the site shows Stiff Soils (D) overlying Soft Rock (C).

SUMMARY

The geophysical surveys at Macassar, commissioned by GCS Consulting Engineers in support of the upgrade and extension works, were successfully executed and the data are of an overall high quality.

The overburden, consisting of weathered sediments and transported sands, are mostly mildly corrosive. The underlying sedimentary bedrock is also mildly corrosive at the location of BH01 (SER01) and moderately corrosive at SER02.

Sedimentary bedrock, with percussion velocities in excess of 3,000 m/s, is between 30 masl (~12 mbgl) and 20 masl (~25 mbgl) deep and is either flat lying or slightly dipping. The overburden is mostly horizontally layered showing moderate to low lateral shear wave velocity variation which is attributed to changes in compaction levels and saturation.

Overall the underlying formation is either Stiff Soils (D) or Soft Rock (C) with only one localised recording of Soft Soils (E).

DISCLAIMER

Owing to the nature of geophysical measurements in a 3D geological space, whereby surface measurements are taken in order to infer changes occurring at depth, and owing to the ambiguous nature of all geophysical modelling, Geofocus (Pty) Ltd nor its directors can bear no responsibility for incorrect interpretations made on the basis of geophysical datasets. An interpretation is just that, an interpretation.

WGS 84 / UTM zone 34S

25 0 25 50 75

(meters)

Figure 1

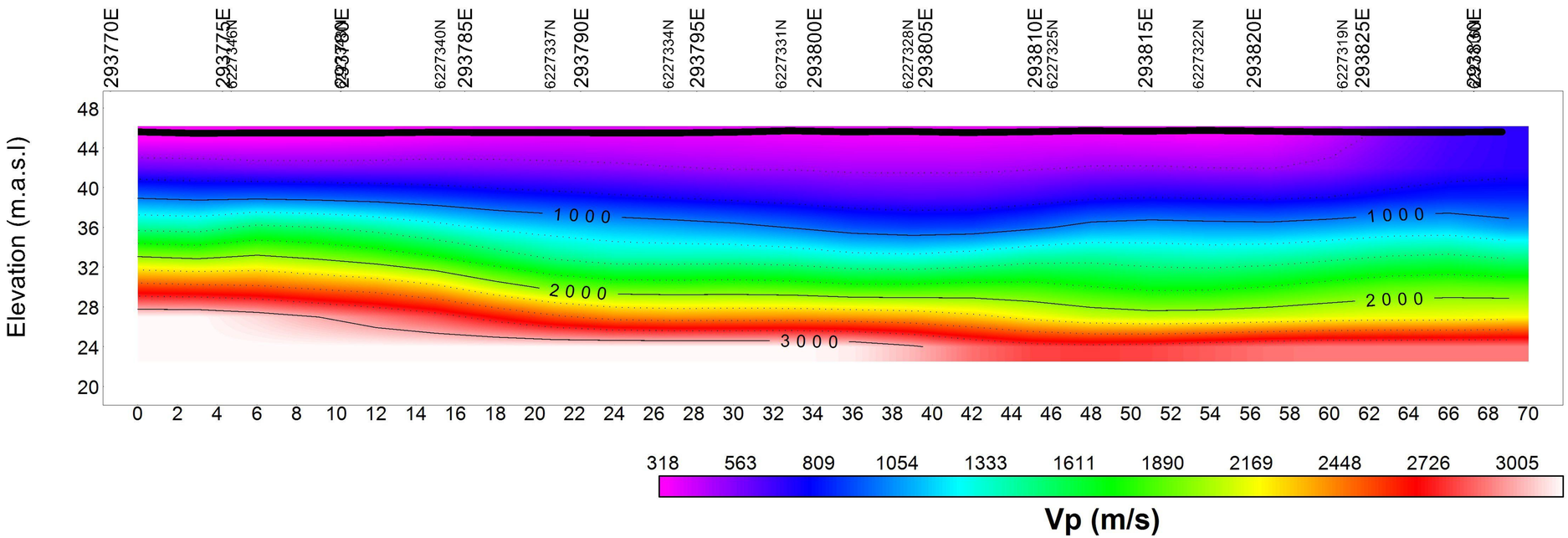
Macassar WWTW

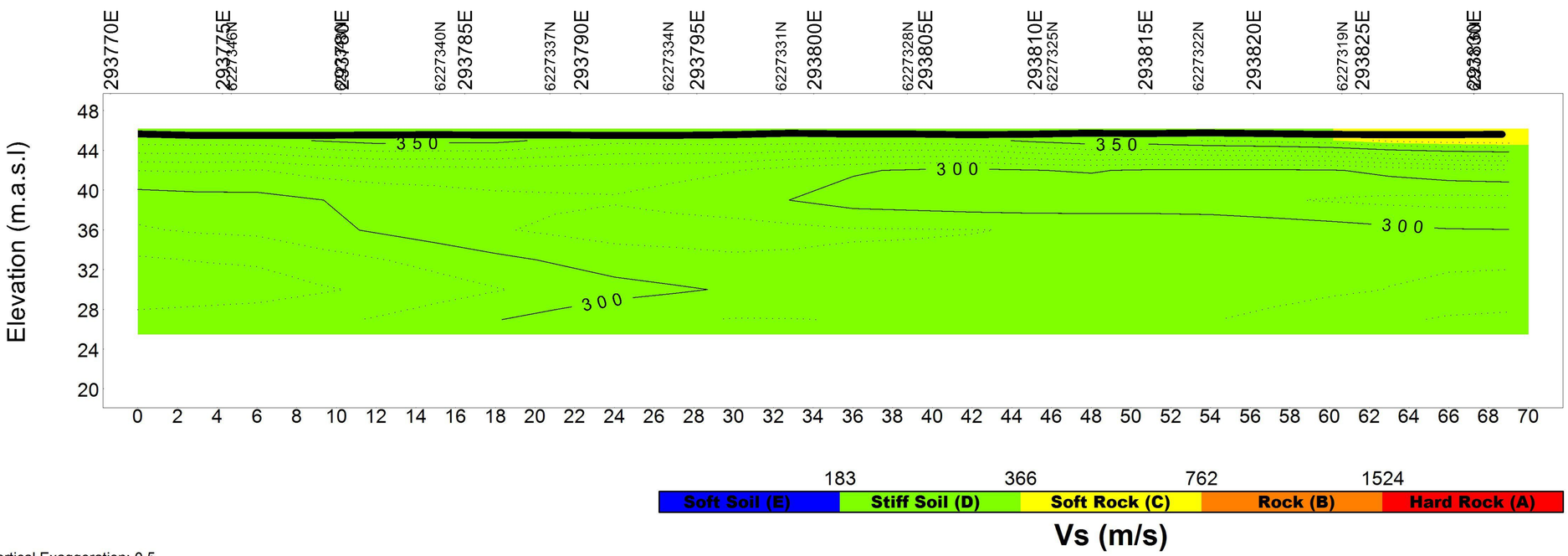
Geophysical Surveys

GeoFocus

Geophysical Services

Figure 2a: Site BH01





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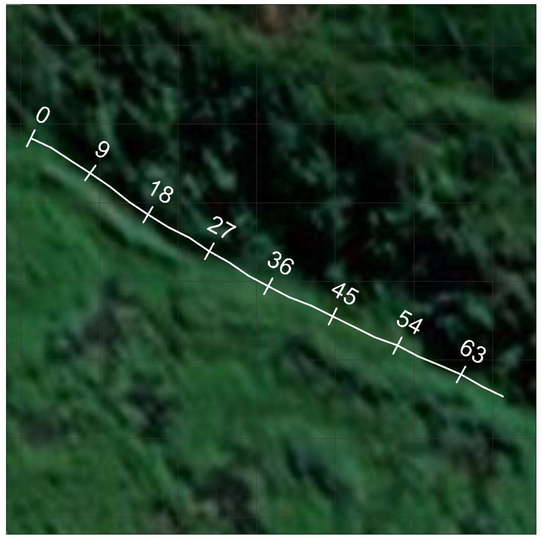

Section Trace Plan View

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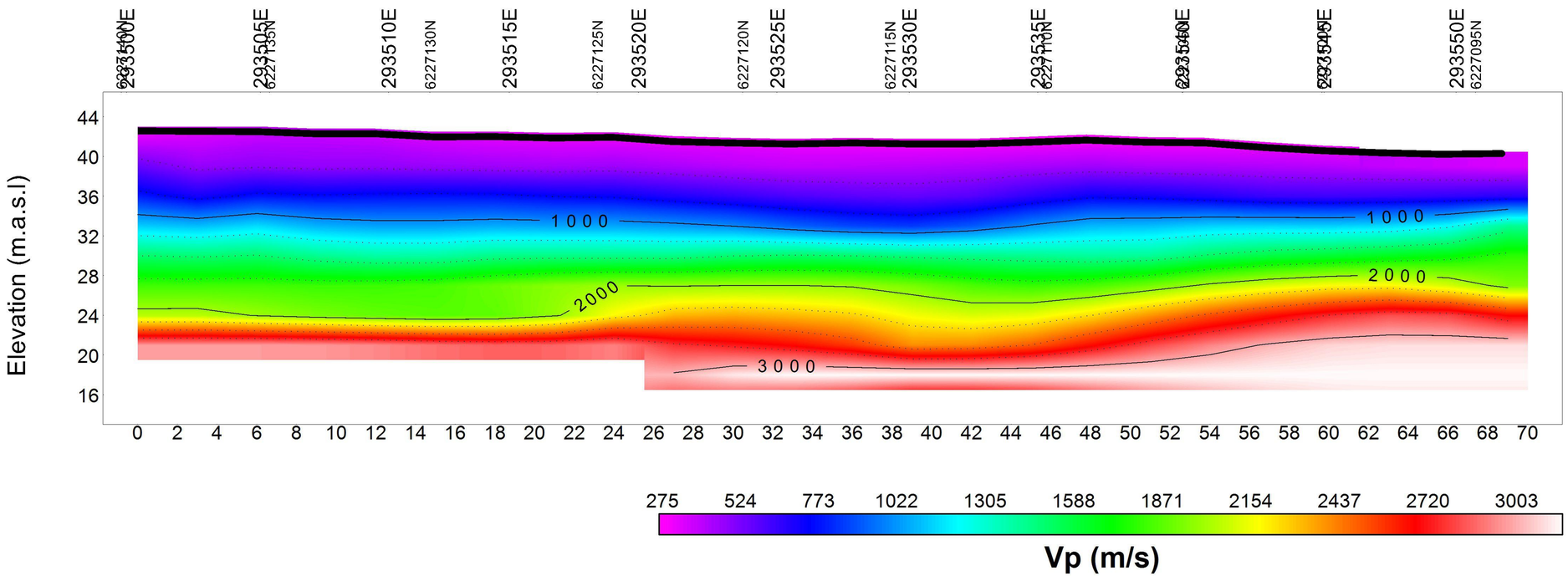
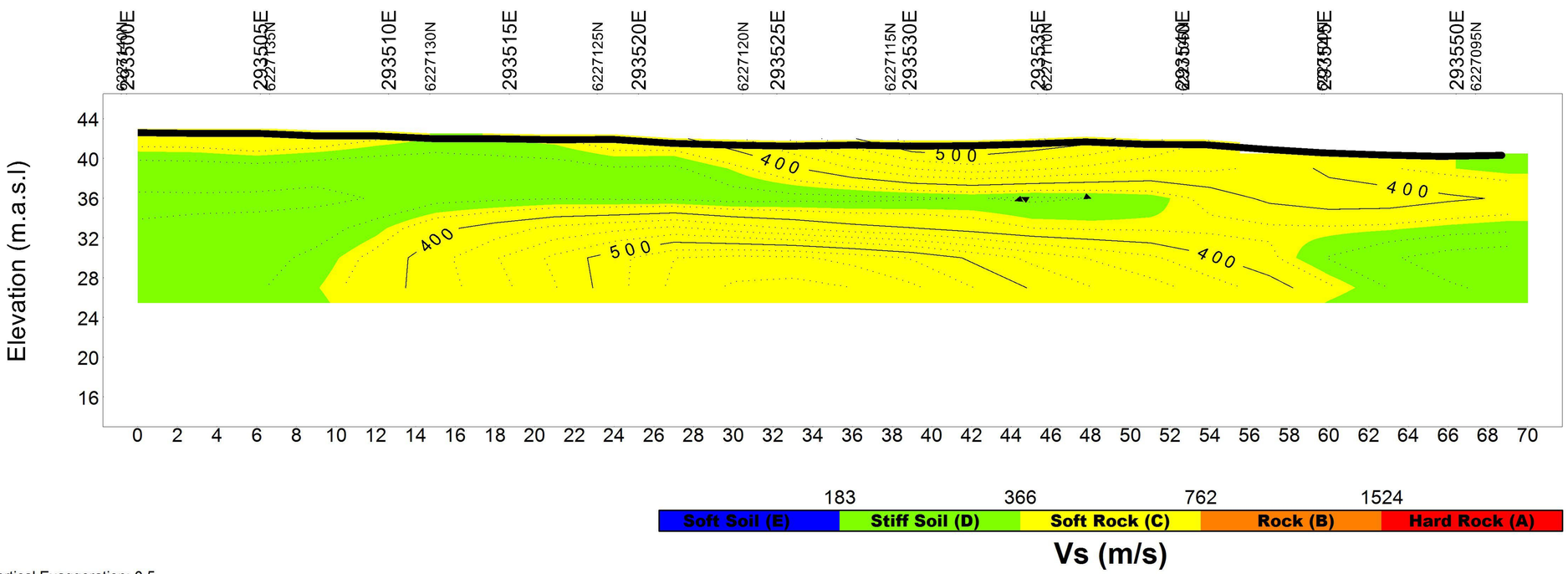
Figure 2b: Site BH05





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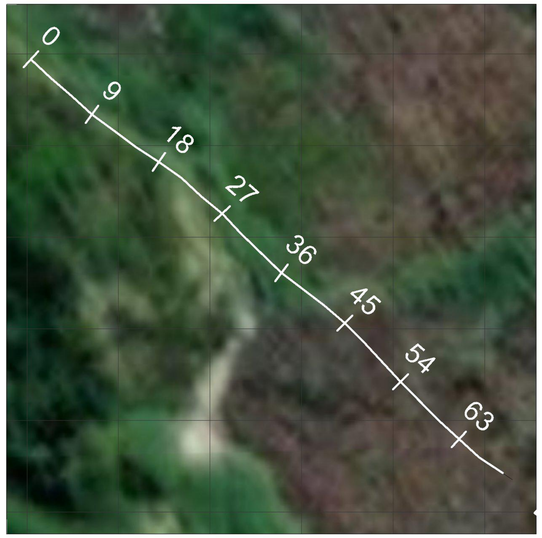

Section Trace Plan View

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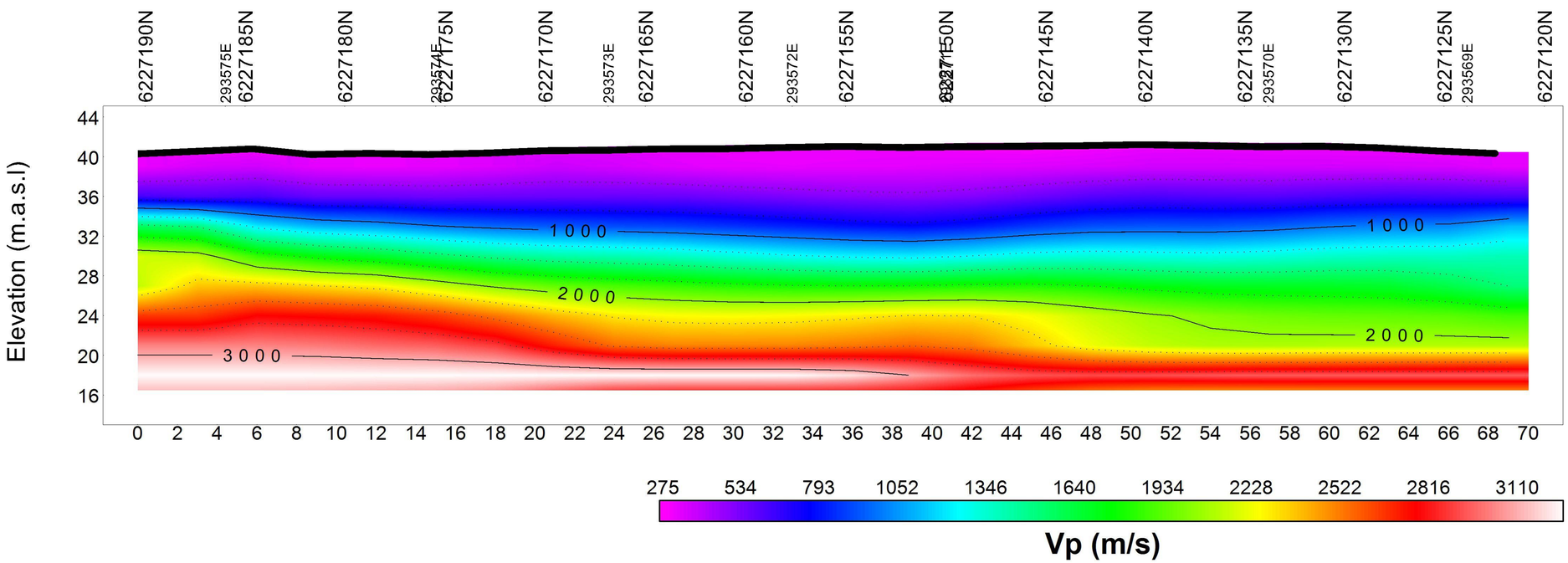
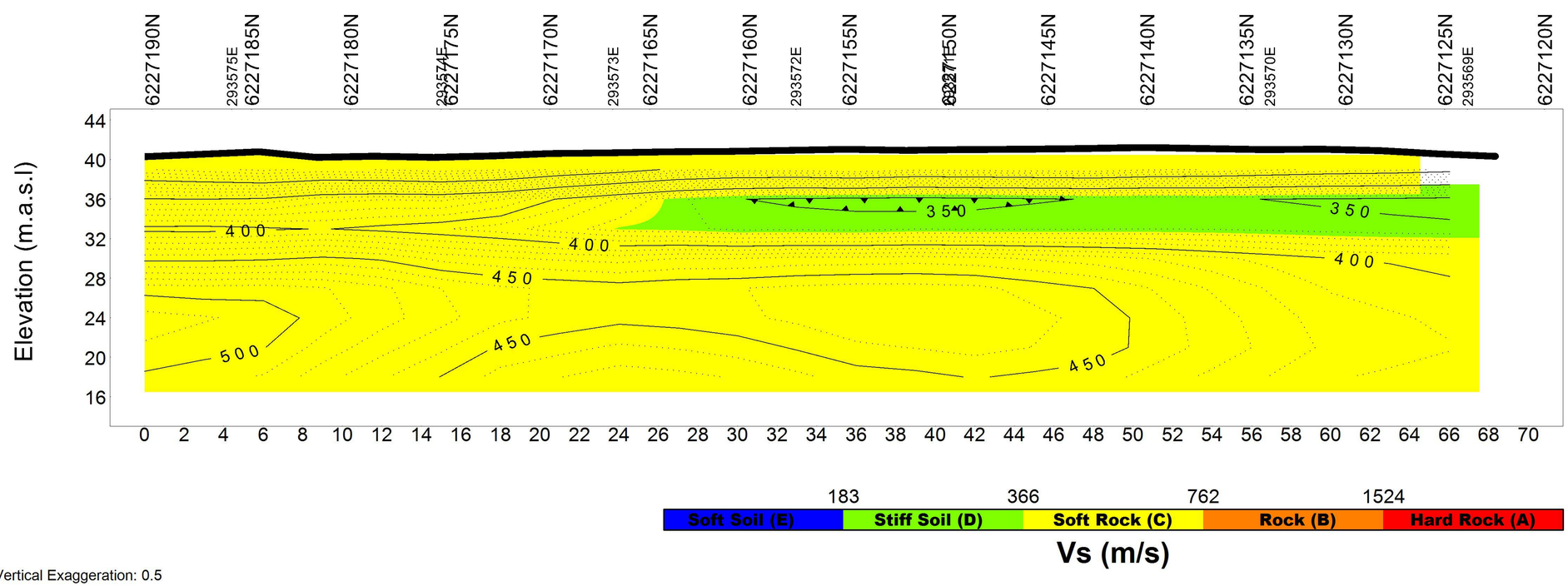
Figure 2c: Site BH06





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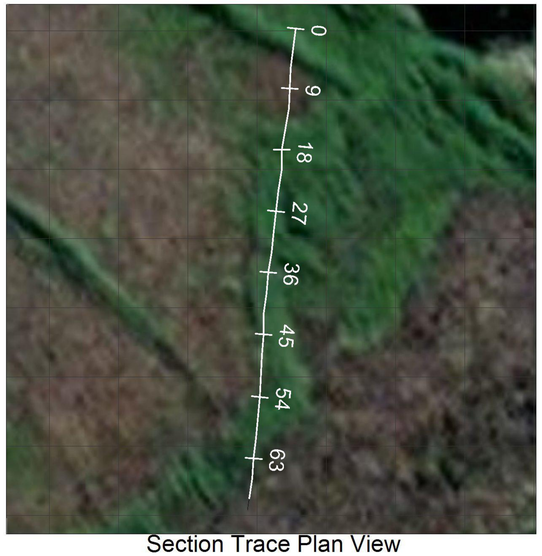

Section Trace Plan View

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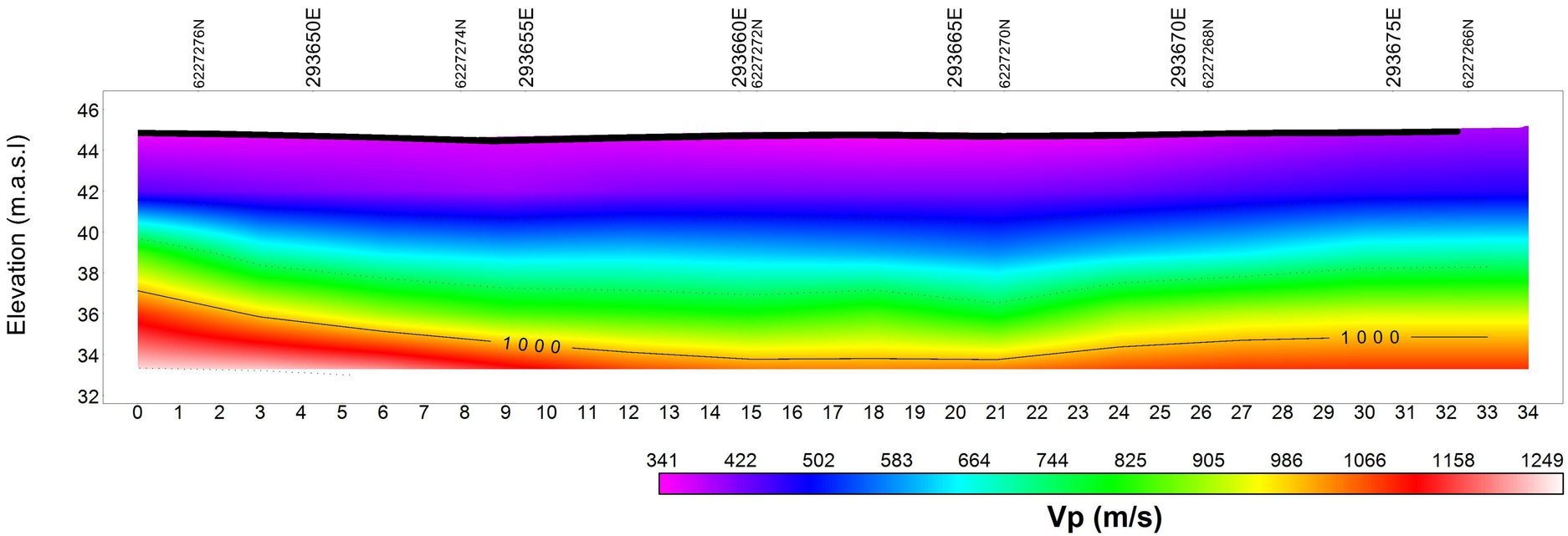
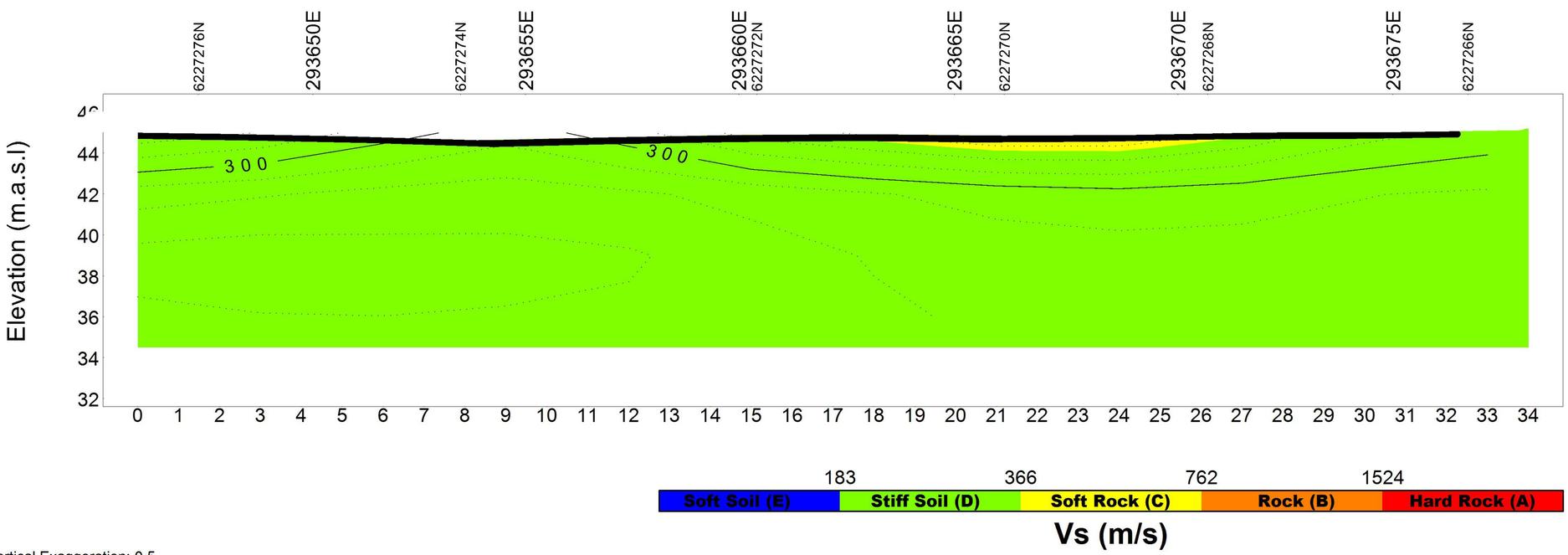
Figure 2d: Site 2





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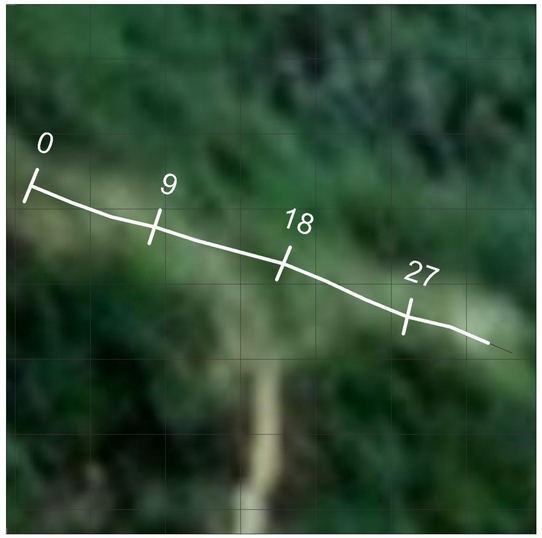

Section Trace Plan View

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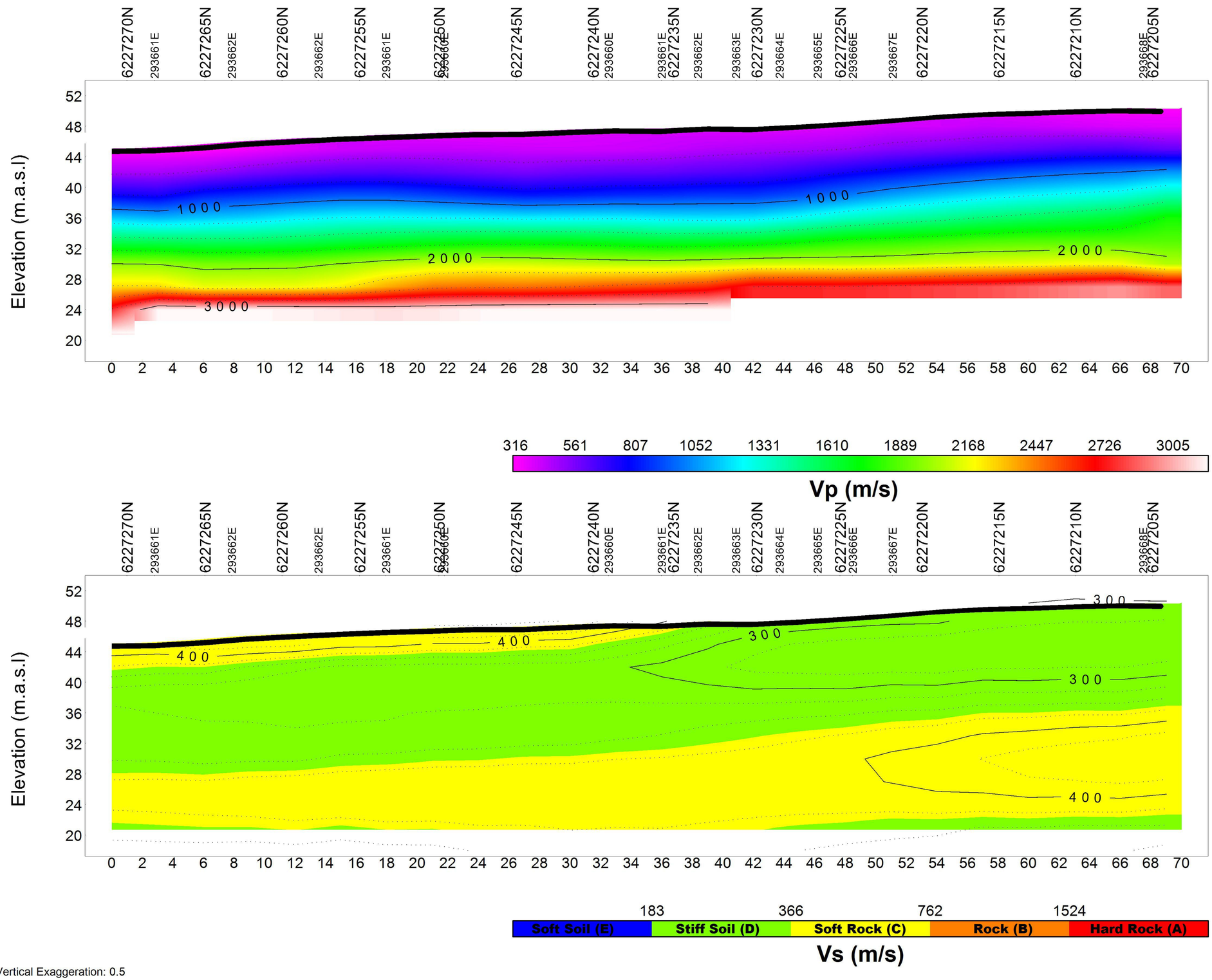
Figure 2e: Site 3



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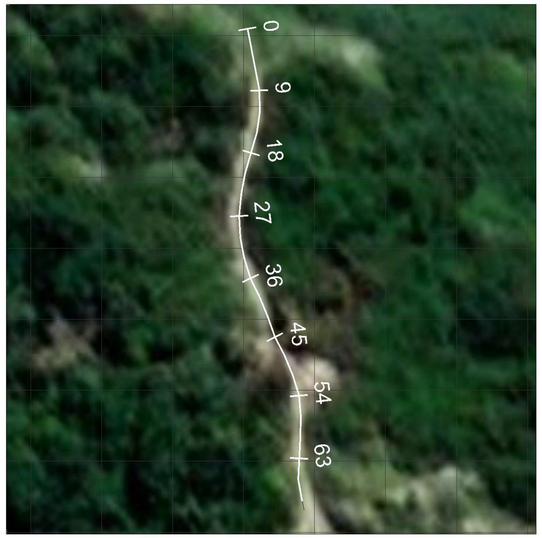

Section Trace Plan View

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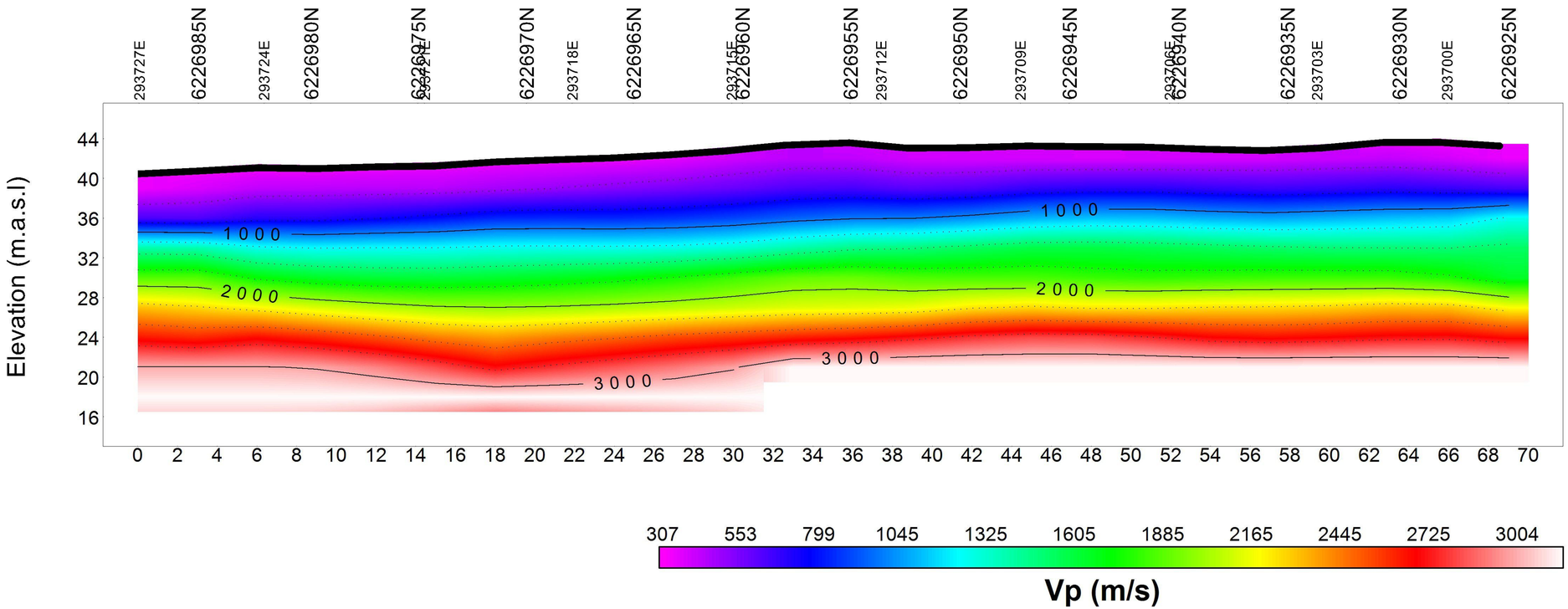
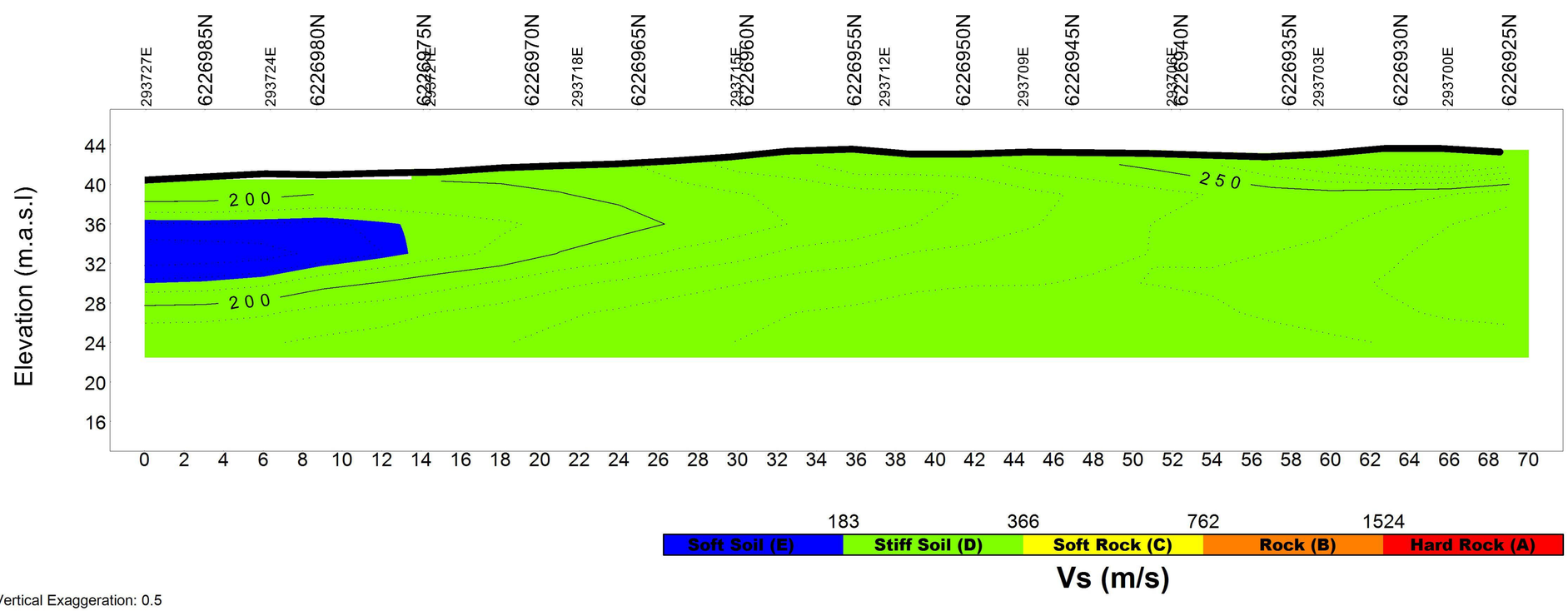
MASW & Seismic Refraction Surveys

Figure 2f: Site 5





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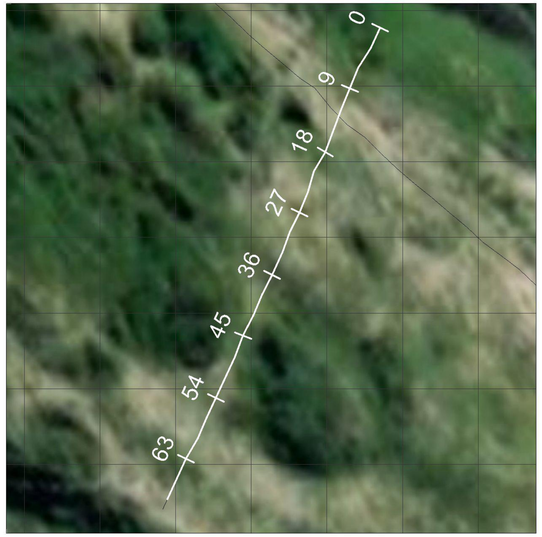

Section Trace Plan View

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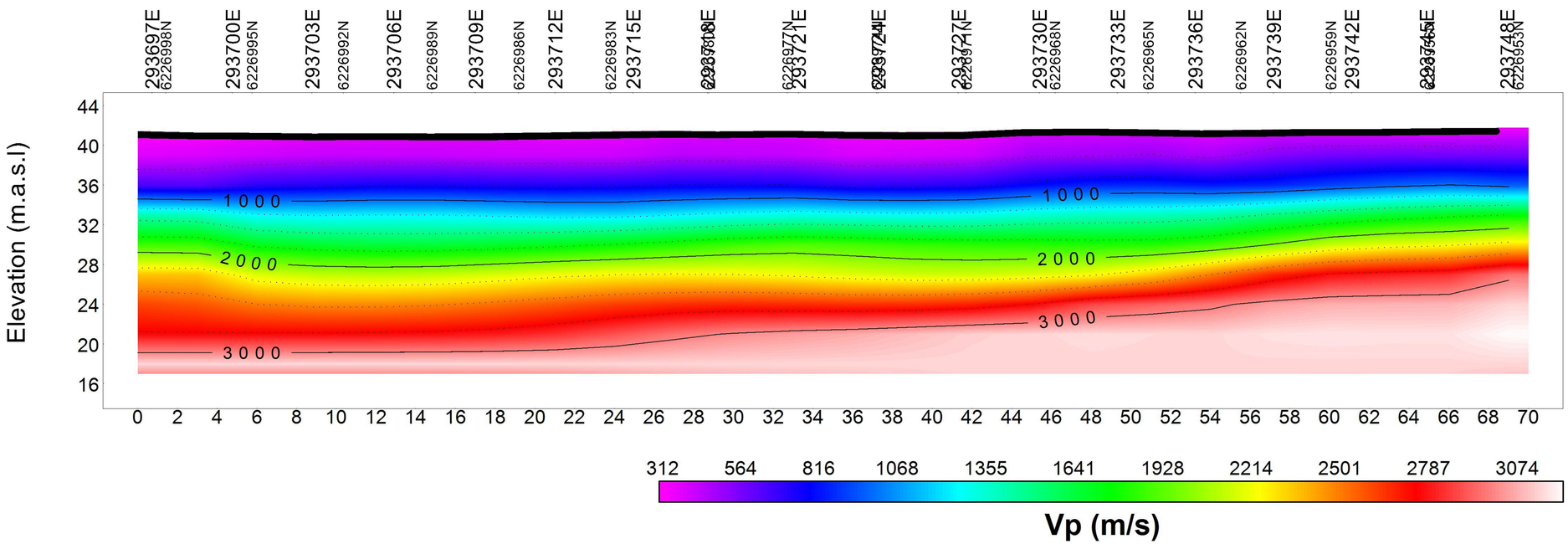
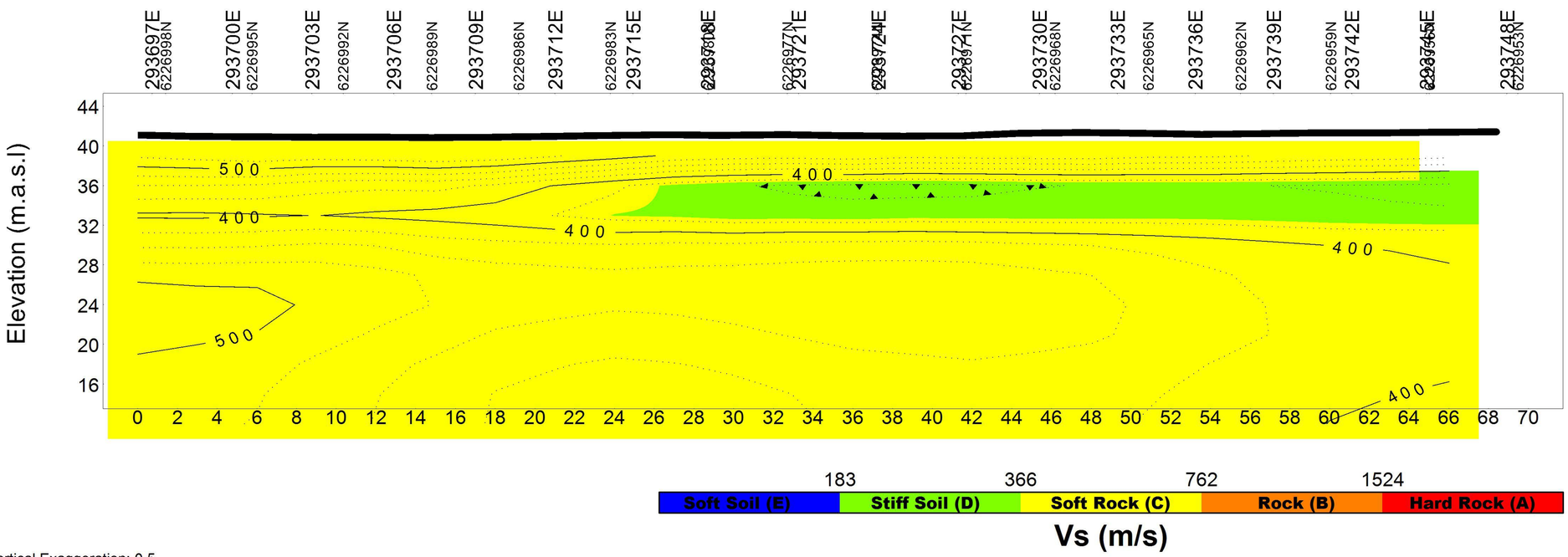
Figure 2g: Site 6





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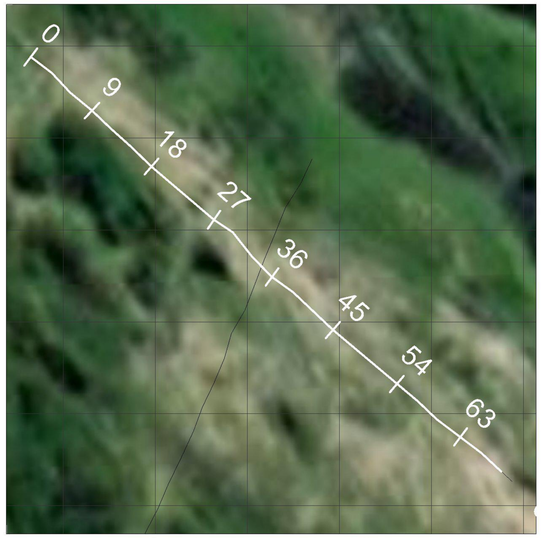

Section Trace Plan View

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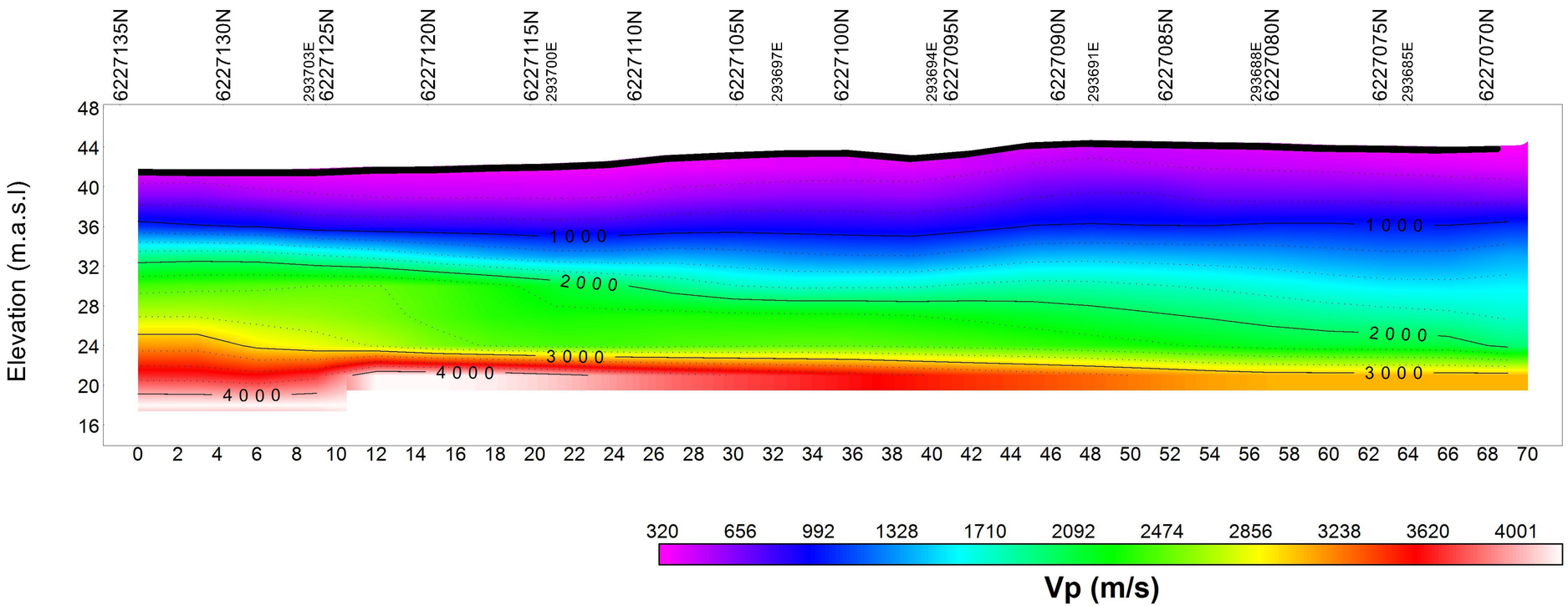
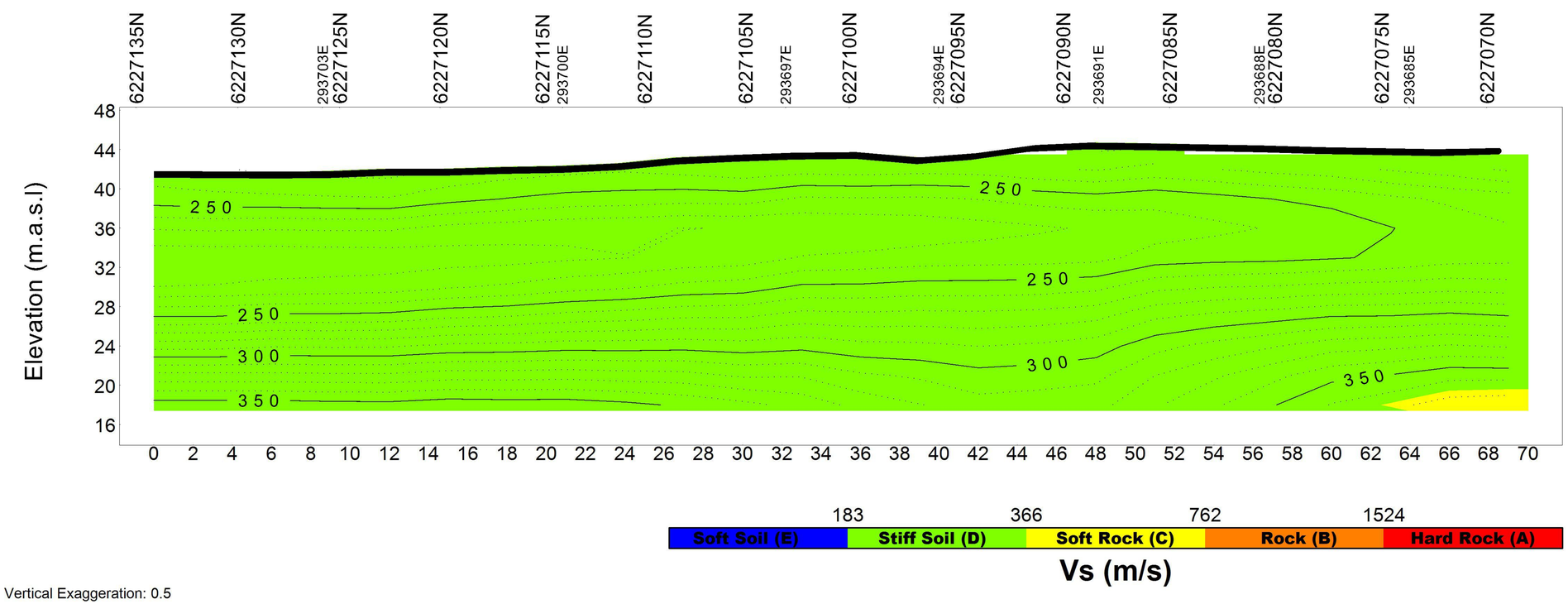
MACASSAR WWTW

MASW & Seismic Refraction Surveys

Figure 2h: Site 7





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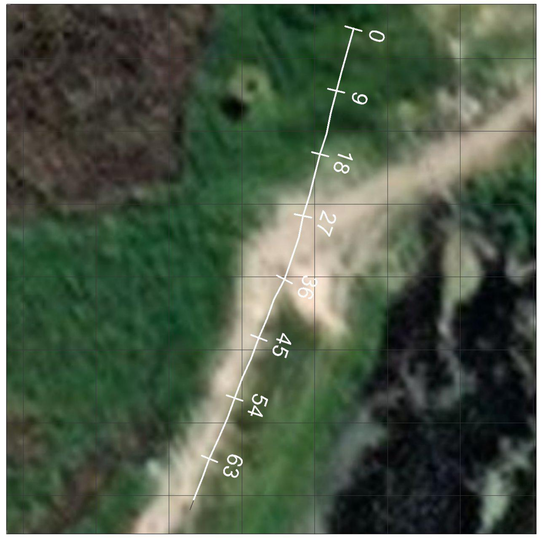

Section Trace Plan View

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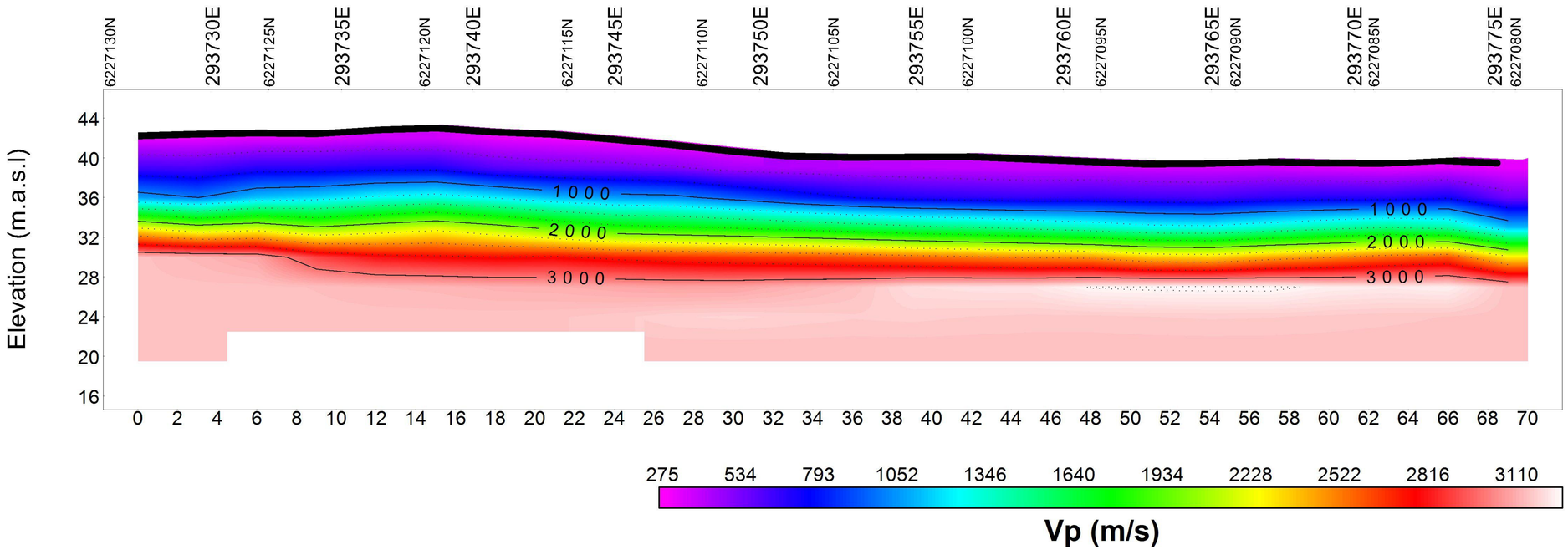
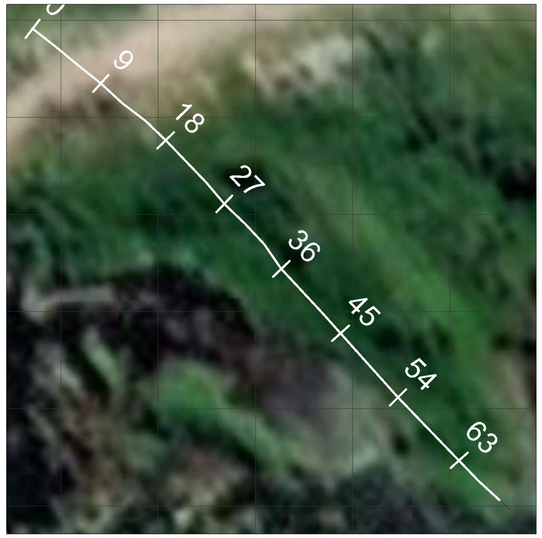
MACASSAR WWTW

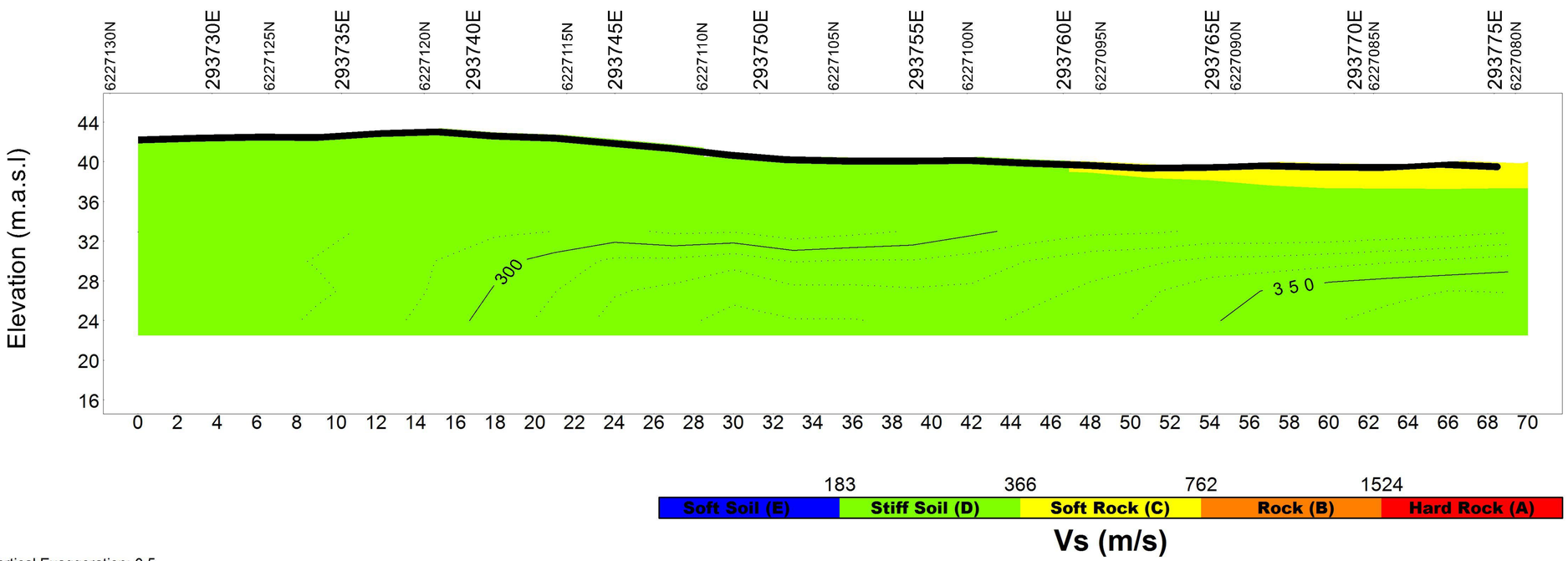
MASW & Seismic Refraction Surveys

Figure 2i: Site 10





Section Trace Plan View



Vertical Exaggeration: 0.5

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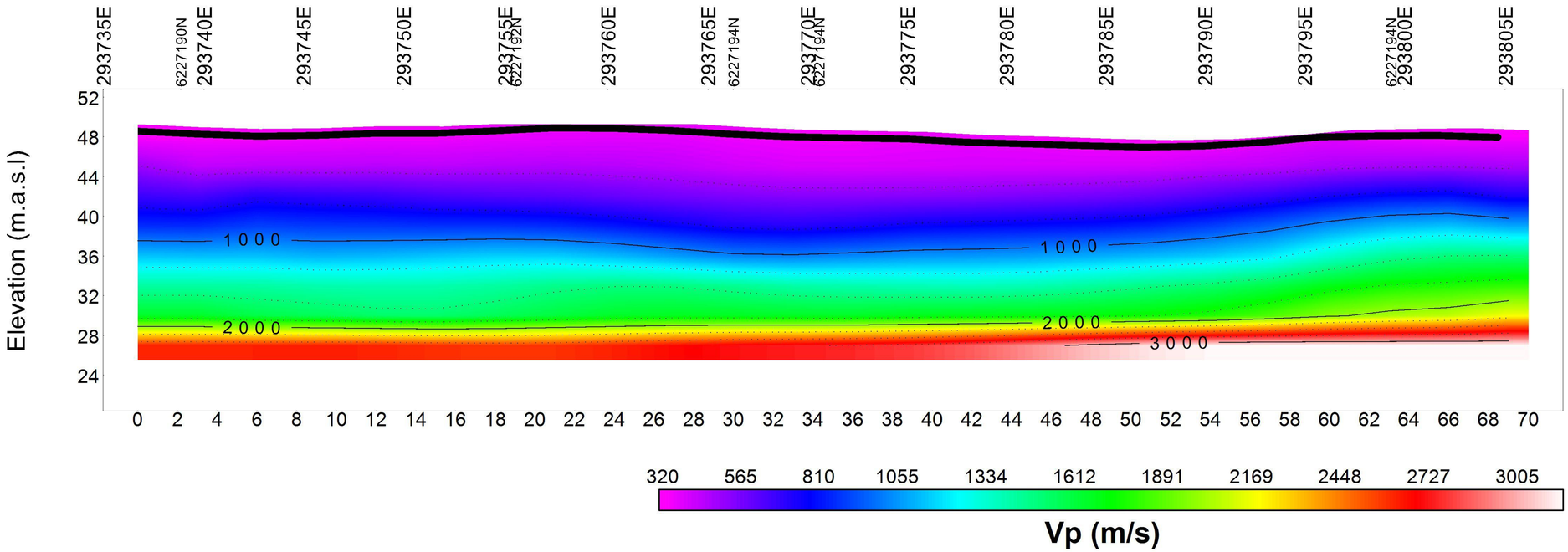
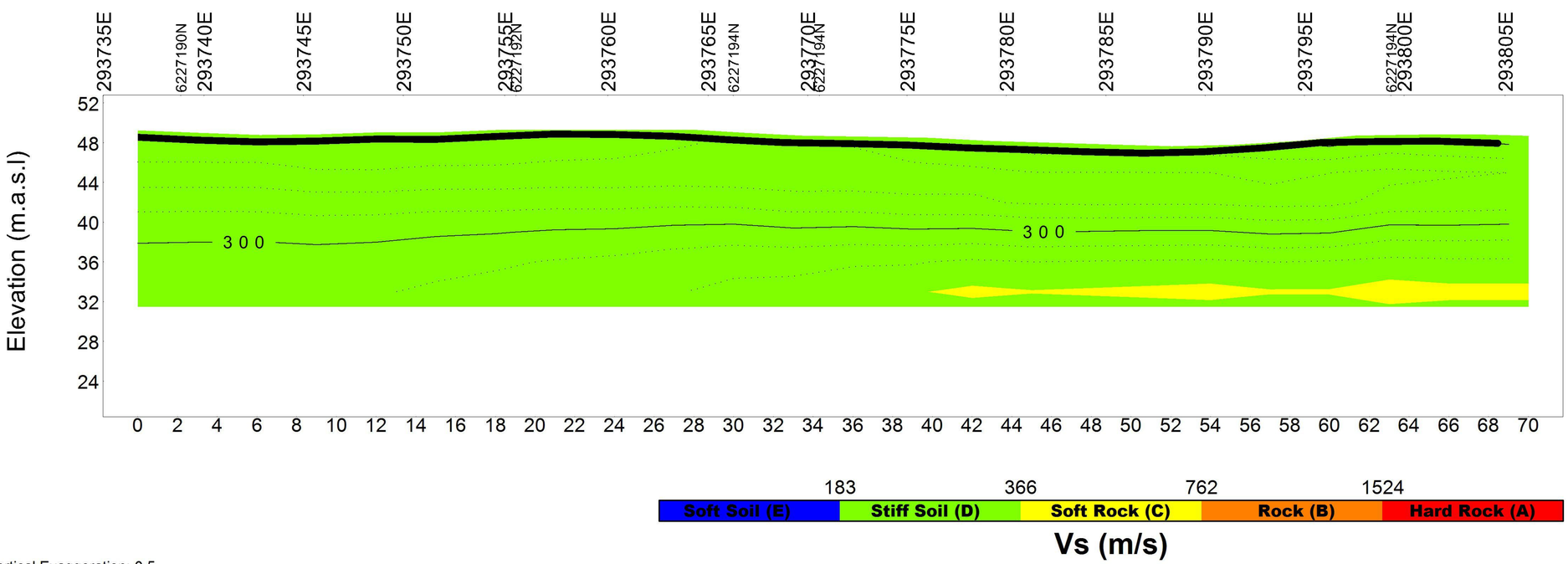
MASW & Seismic Refraction Surveys

Figure 2j: Site 11





Vertical Exaggeration: 0.5

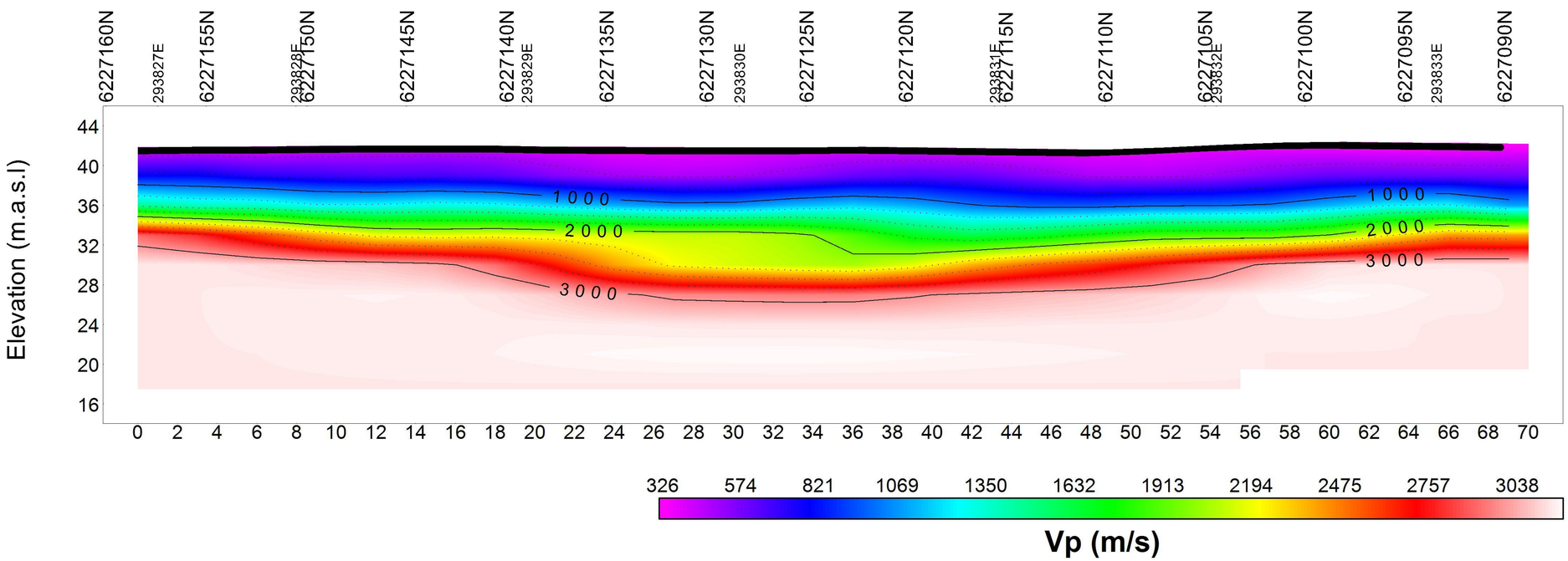
Section Trace Plan View

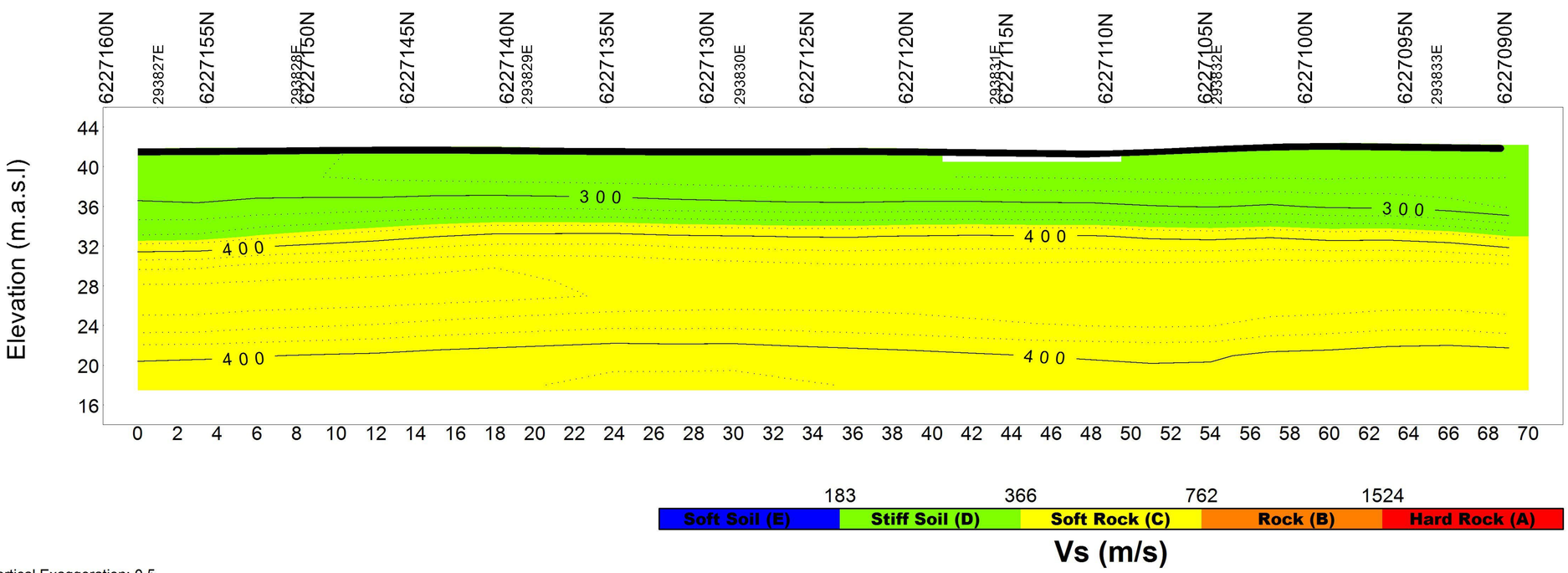
GCS Geotechnical Engineering

MACASSAR WWTW

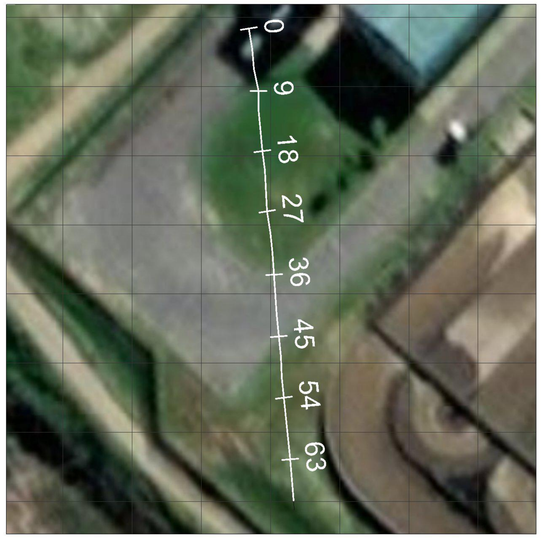
MASW & Seismic Refraction Surveys

Figure 2k: Site 11 (Plant)





Vertical Exaggeration: 0.5



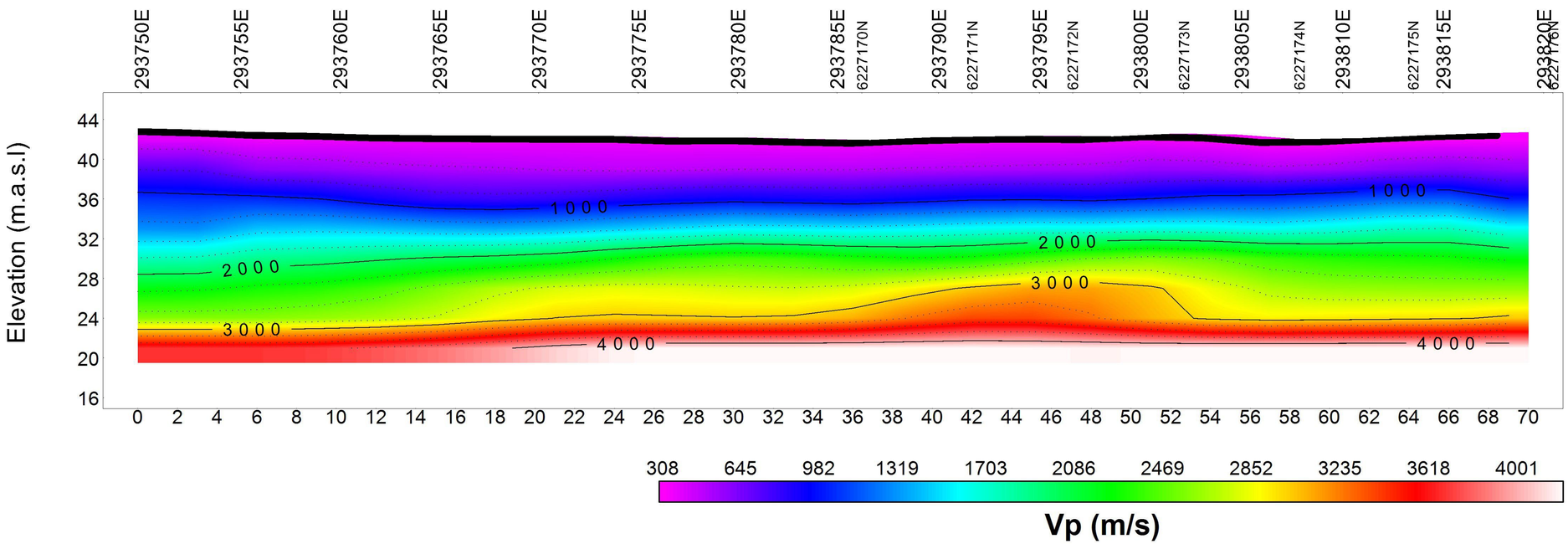
Section Trace Plan View

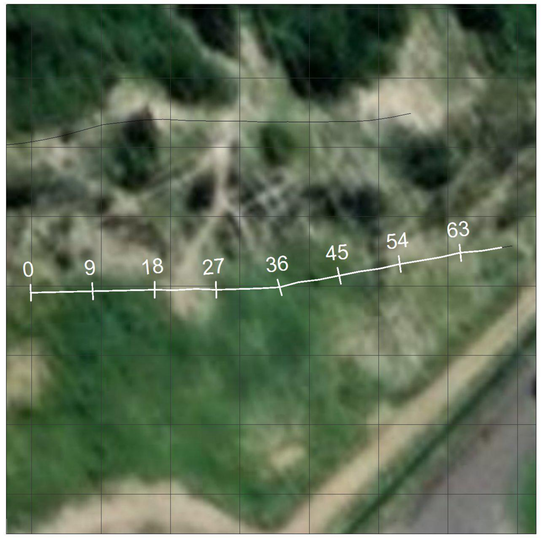
GCS Geotechnical Engineering

MACASSAR WWTW

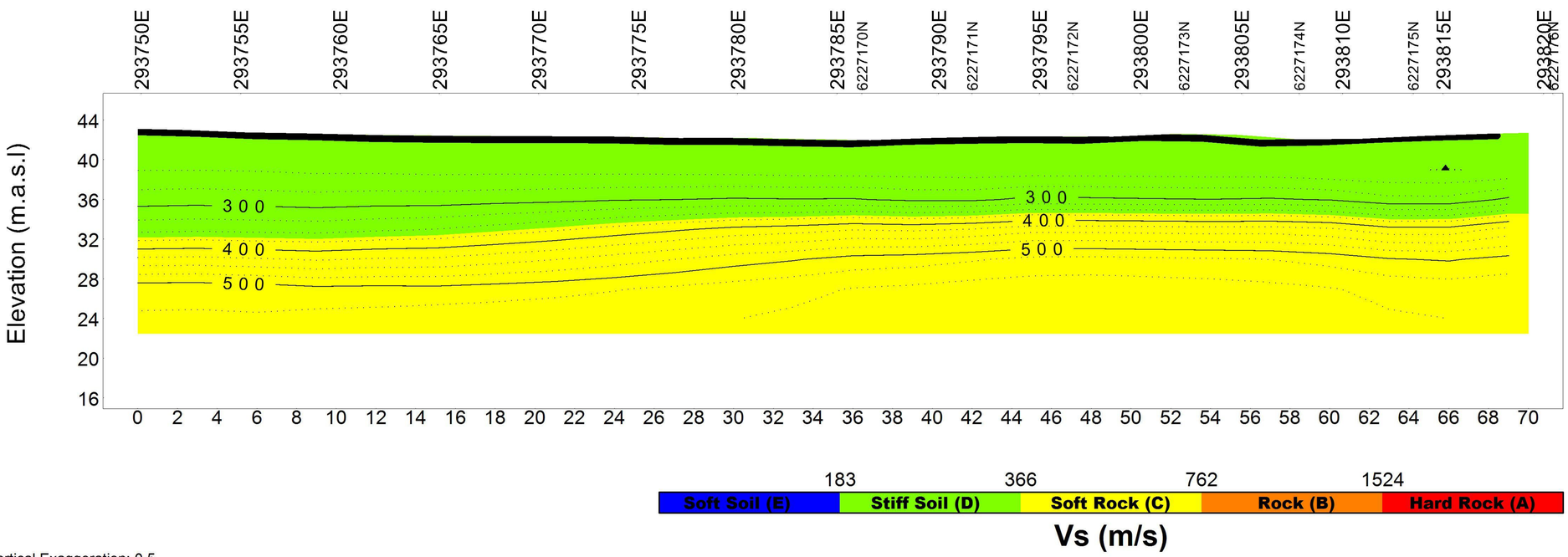
MASW & Seismic Refraction Surveys

Figure 2I: Site 12





Section Trace Plan View



Vertical Exaggeration: 0.5

GCS Geotechnical Engineering

MACASSAR WWTW

MASW & Seismic Refraction Surveys

APPENDIX G

Exploratory Hole Location Plan (Kantley & Templer, 2018)

KANTEY & TEMPLER
CONSULTING ENGINEERS

CLIENT
aurecon

PROJECT
MACASSAR WASTEWATER REUSE PLANT

TITLE
EXPLORATORY HOLE LOCATION PLAN

Scale: 1:2000

Drawing No. 15583GG-01

Rev.

Y:\DWG-G\15583G Maczssar Wastewater Reuse Plant\Working\15583GG-01 Macassar Wastewater Resuse Plan Exploratory Hole Location Plan A3.dwg 15/02/2018 10:57 Shirley Mossop

APPENDIX H

Settlement Calculations

MACASSAR REVISED SETTLEMENTS
DATED 19 OCT 2023
DESIGNER: NINO WELLAND

Return p/s

L/B	E (Mpa)	Rigidity	bearing (kPa)	Depth (mbfgl)	Settlement (mm)	Compaction depth (mbfl)
6x8	10		150	1.5	45-50	3
6x8	17		150	1.5	25-30	0

MACASSAR REVISED SETTLEMENTS
DATED 19 OCT 2023
DESIGNER: NINO WELLAND

SCREW LIFT

L/B	E (Mpa)	Rigidity	bearing (kPa)	Depth (mbfgl)	Settlement (mm)	Compaction depth (mbfl)
3x3	10	0.88	150	3	15-20	0
3.5x3.5	10	0.88	150	3	20-25	0
3x5	10	0.88	150	3	20-25	0
5x5	10	0.88	150	3	30-35	1
6.7x6.7	10	0.88	150	3	40-45	2
11.6x13.9	10	0.88	150	3	60-65	6
14.3x7.7	10	0.88	150	3	50-55	6
14.3x9.0	10	0.88	150	3	70-75	6
3x3	13	0.88	150	3	15-20	0
3.5x3.5	13	0.88	150	3	15-20	0
3x5	13	0.88	150	3	15-20	0
5x5	13	0.88	150	3	25-30	0
6.7x6.7	13	0.88	150	3	25-30	0
11.6x13.9	13	0.88	150	3	45-50	0
14.3x7.7	13	0.88	150	3	30-35	1
14.3x9.0	13	0.88	150	3	35-40	1.5

MACASSAR REVISED SETTLEMENTS
DATED 19 OCT 2023
DESIGNER: NINO WELLAND

BIOREACTOR

L/B	E (Mpa)	Rigidity	bearing (kPa)	Depth (mbfgl)	Settlement (mm)	Compaction depth (mbfl)
9X109	10	2.12	150-175	4.5	100-130	8 to 10
9X120	10	2.2	150-175	4.5	100-130	8 to 10
12X40	10	1.5	100-150	4.5	30-100	0-8
12X120	10	1.5	100-150	4.5	30-100	0-8
15X40	10	1.3	80-125	4.5	0-70	0-7
9X109	15	2.12	150-175	4.5	65-90	8 to 10
9X120	15	2.2	150-175	4.5	65-90	8 to 10
12X40	15	1.5	100-150	4.5	20-70	0-8
12X120	15	1.5	100-150	4.5	20-70	0-8
15X40	15	1.3	80-125	4.5	0-45	0-5

MACASSAR REVISED SETTLEMENTS
DATED 19 OCT 2023
DESIGNER: NINO WELLAND

SLUDGE SILOS & DEWATERING BUILDING

L/B	E (Mpa)	Rigidity	bearing (kPa)	Depth (mbfgl)	Settlement (mm)	Compaction depth (mbfl)
9x13	10	1	110	2.5	35-40	2
9x13	10	1	150	2.5	55-60	4.5
9x13	17-19	1	110	2.5	20-25	0
9x13	17-19	1	150	2.5	30-40	1 to 3

MACASSAR REVISED SETTLEMENTS
DATED 19 OCT 2023
DESIGNER: NINO WELLAND

UV CHANNEL

L/B	E (Mpa)	Rigidity	bearing (kPa)	Depth (mbfgl)	Settlement (mm)	Compaction depth (mbfl)
7X12	10	1.1	150	1	80-85	7
7X12	10	1.1	150	3	55-60	4.5
7x12	17	1.1	150	1	45-50	5.5
7x12	17	1.1	150	3	30-35	1

MACASSAR REVISED SETTLEMENTS
DATED 19 OCT 2023
DESIGNER: NINO WELLAND

SECONDARY SETTLING TANKS (1-10)

L/B	E (Mpa)	Rigidity	bearing (kPa)	Depth (mbfgl)	Settlement (mm)	Compaction depth (mbfl)
2.8x126	10	3	150	4.7	50-55	2.5
2.8x126	17.5	3	150	4.7	30-35	1

MACASSAR REVISED SETTLEMENTS
DATED 19 OCT 2023
DESIGNER: NINO WELLAND

PST SPLITTERS

L/B	E (Mpa)	Rigidity	bearing (kPa)	Depth (mbfgl)	Settlement (mm)	Compaction depth (mbfl)
12x12	10		150	5.3	25 to 30	0
12x12	10		200	5.3	50 to 55	4
12x12	14		150	5.3	20 to 25	0
12x12	14		200	5.3	35 to 40	2.5

MACASSAR REVISED SETTLEMENTS
DATED 19 OCT 2023
DESIGNER: NINO WELLAND

PRIMARY SLUDGE SCREENING STATION

L/B	E (Mpa)	Rigidity	bearing (kPa)	Depth (mbfgl)	Settlement (mm)	Compaction depth (mbfl)
11x11	10		150	2.8	45 to 50	3.5
11x11	13		150	2.8	30 to 35	1.5

MACASSAR REVISED SETTLEMENTS
DATED 19 OCT 2023
DESIGNER: NINO WELLAND

RAS RETURN CHANNEL

L/B	E (Mpa)	Rigidity	bearing (kPa)	Depth (mbfgl)	Settlement (mm)	Compaction depth (mbfl)
4.5x460	10		150	1.5	65-70	4.5
4.5x460	13		150	1.5	35-40	2.5

MACASSAR REVISED SETTLEMENTS
DATED 19 OCT 2023
DESIGNER: NINO WELLAND

SERVICE WATER P/S

L/B	E (Mpa)	Rigidity	bearing (kPa)	Depth (mbfgl)	Settlement (mm)	Compaction depth (mbfl)
10x15	10		150	2.5	50-55	3.5
10x15	14		150	2.5	35-40	2

MACASSAR REVISED SETTLEMENTS
DATED 19 OCT 2023
DESIGNER: NINO WELLAND

SCUM P/S

L/B	E (Mpa)	Rigidity	bearing (kPa)	Depth (mbfgl)	Settlement (mm)	Compaction depth (mbfl)
6x8	10		150	3	40-45	2.5
6x8	17		150	3	20-25	0

FIGURE 1

Site Plan – Test Pit Positions

MACASSAR WWTW - TEST PIT SITE PLAN

Legend

Test Pits

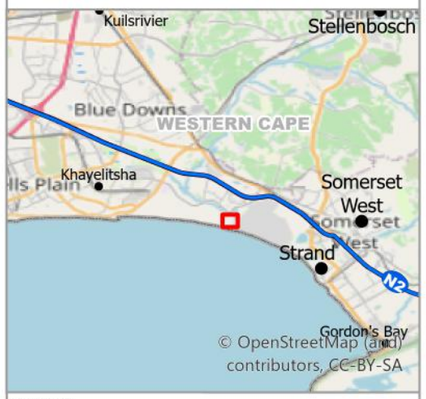
- DTP
- STP

Road Network

- Street

Rivers and Streams

- Non-Perennial
- Perennial



Data Sources:
Esri World Imagery Basemap

0 75 150 Meters

SCALE: 1:3 500

FIGURE NO.: -		MAP NUMBER:	22-1172-01
DRAWN BY:	N MBOKAZI GIS CONSULTANT	REVIEWED BY:	N WELLAND PROJECT MANAGER
DATUM: WGS84 PROJECTION: GEOGRAPHIC		DATE:	30 MAY 2023
PROJECT:	MACASSAR WWTW		
CLIENT:	ZUTARI		

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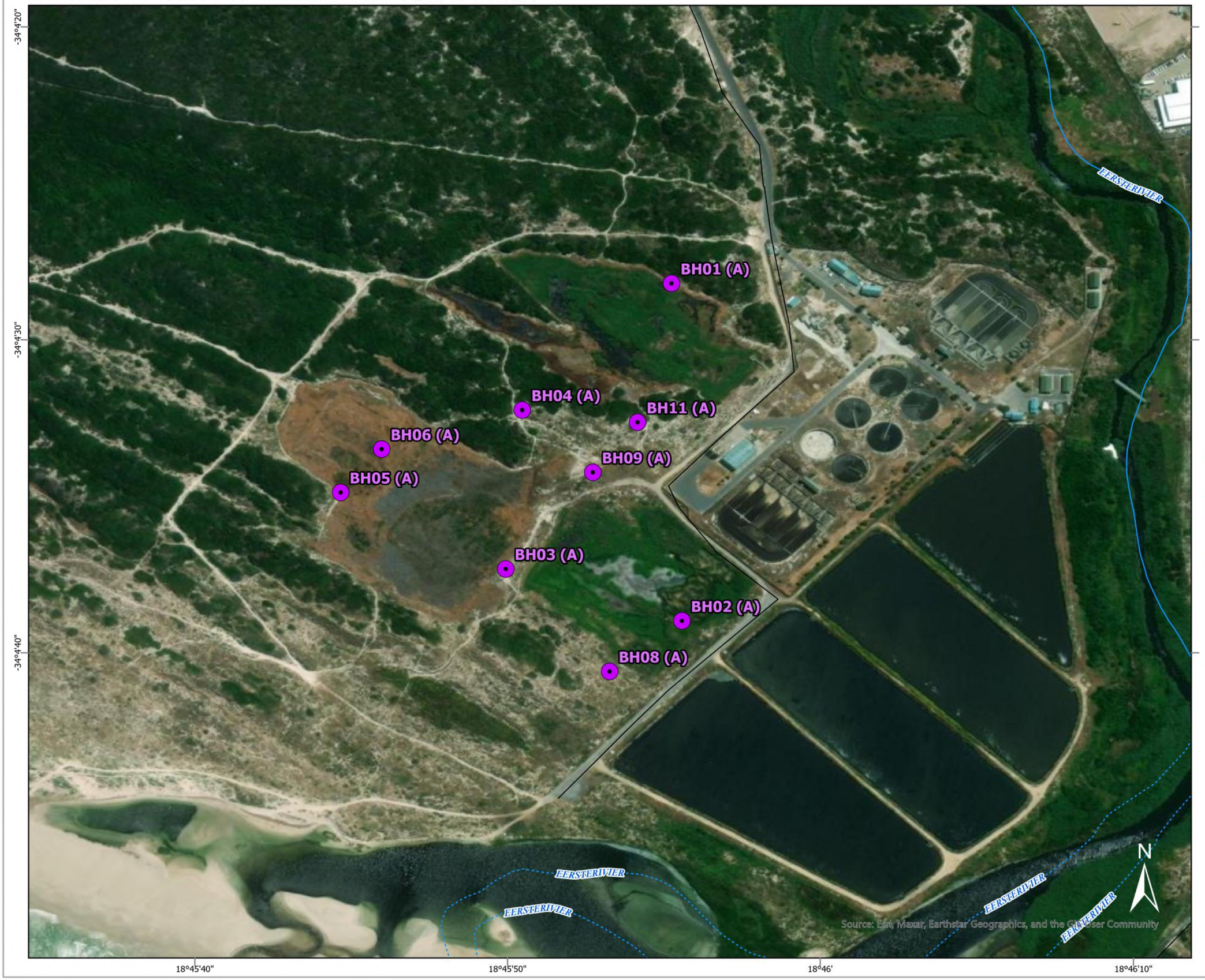
FIGURE 2:

Site Plan – Rotary Cored Borehole Positions

MACASSAR WWTW - BOREHOLE SITE PLAN



Legend

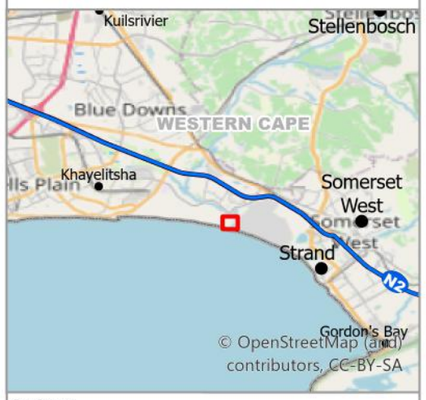
- Borehole

Road Network

- Street

Rivers and Streams

- Non-Perennial
- Perennial



Data Sources:
Esri World Imagery Basemap

0 75 150 Meters

SCALE: 1:3 500

FIGURE NO.: -		MAP NUMBER:	22-1172-02
DRAWN BY:	N MBOKAZI GIS CONSULTANT	REVIEWED BY:	N WELLAND PROJECT MANAGER
DATUM:	WGS84	DATE:	30 MAY 2023
PROJECTION:	GEOGRAPHIC		
PROJECT:	MACASSAR WWTW		
CLIENT:	ZUTARI		

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FIGURE 3:

Site Plan – Geophysical Survey Positions

MACASSAR WWTW - GEOPHYSICS SITE PLAN

Legend

Geophysics

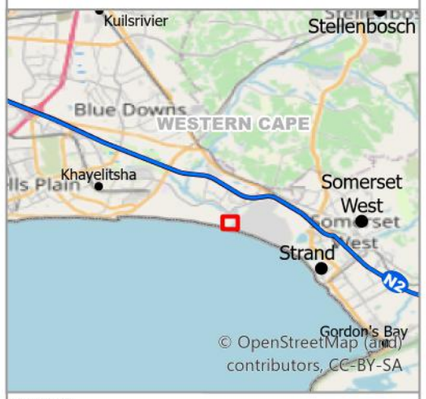
- BH
- SRT
- MASW

Road Network

- Street

Rivers and Streams

- Non-Perennial
- Perennial



Data Sources:
Esri World Imagery Basemap

0 75 150 Meters

SCALE: 1:3 500

FIGURE NO.: -	MAP NUMBER: 22-1172-03
DRAWN BY: N MBOKAZI GIS CONSULTANT	REVIEWED BY: N WELLAND PROJECT MANAGER
DATUM: WGS84 PROJECTION: GEOGRAPHIC	DATE: 30 MAY 2023
PROJECT: MACASSAR WWTW CLIENT: ZUTARI	

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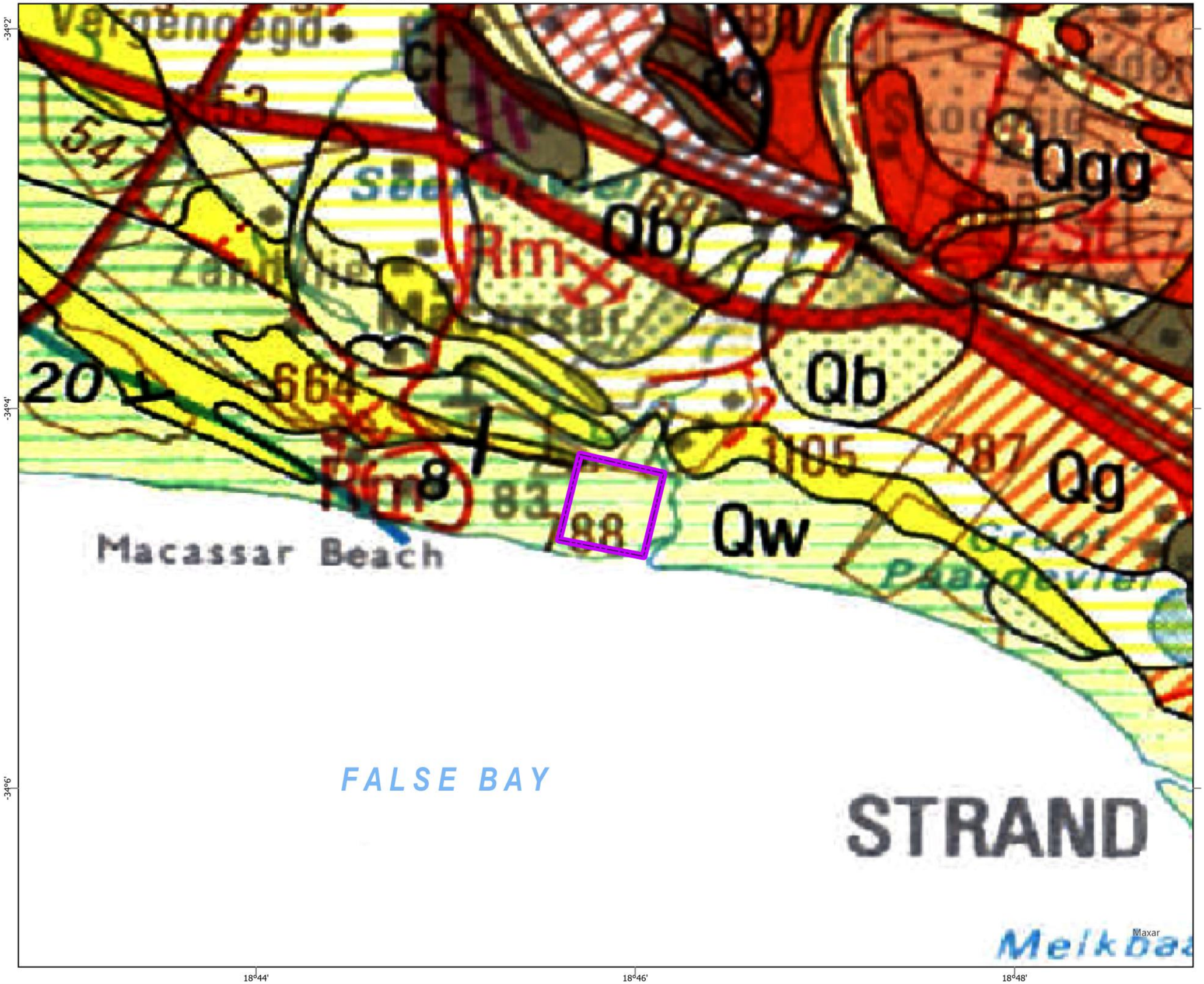
FIGURE 4:

Geological Plan

MACASSAR WWTW - GEOLOGY MAP

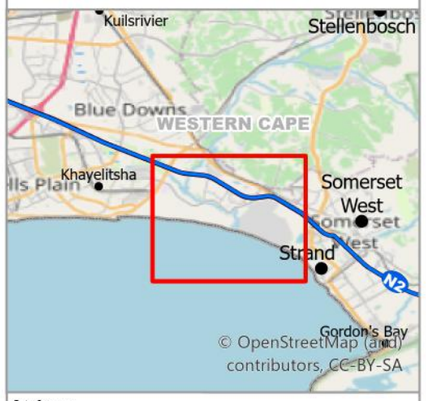


Legend

Site Location

LITHOLOGY

	Alluvium
Qw	Unconsolidated white sands with comminuted shell, pebbles and shells locally along the beach
Qb	Brackish, calcareous soil
Qg	Loam and sandy loam
Qs	Light-grey to pale-red sandy soil
Qgg	Gravelly clay/loam soil
Ct/Ca	Trachyte
Nt	Greywacke, phyllite and quartzitic sandstone; interbedded lava and tuff
N-Ck	Granite: mainly coarse-grained porphyritic



Data Sources:
Council for Geoscience, 1:250 000 Geological Series 3318

0 0.5 1 Kilometers

SCALE: 1:35 000

FIGURE NO.: -	MAP NUMBER: 22-1172-04
DRAWN BY: N MBOKAZI GIS CONSULTANT	REVIEWED BY: N WELLAND PROJECT MANAGER
DATUM: WGS84 PROJECTION: GEOGRAPHIC	DATE: 30 MAY 2023
PROJECT: MACASSAR WWTW CLIENT: ZUTARI	

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FIGURE 5:

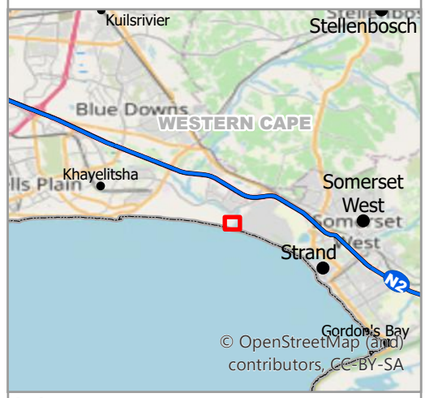
Geological Cross-Sections

MACASSAR WWTW - SITE LAYOUT PLAN

Legend

Rivers and Streams

- Non-Perennial
- Perennial



Data Sources:
ESRI World Imagery Basemap
Site Plan provided by specialist

0 75 150 Meters

SCALE: 1:3 450

FIGURE NO.: -	MAP NUMBER: 22-1172-09
DRAWN BY: N MBOKAZI GIS CONSULTANT	REVIEWED BY: N WELLAND PROJECT MANAGER
DATUM: WGS84 PROJECTION: GEOGRAPHIC	DATE: 20 OCTOBER 2023
PROJECT: MACASSAR WWTW CLIENT: ZUTARI	

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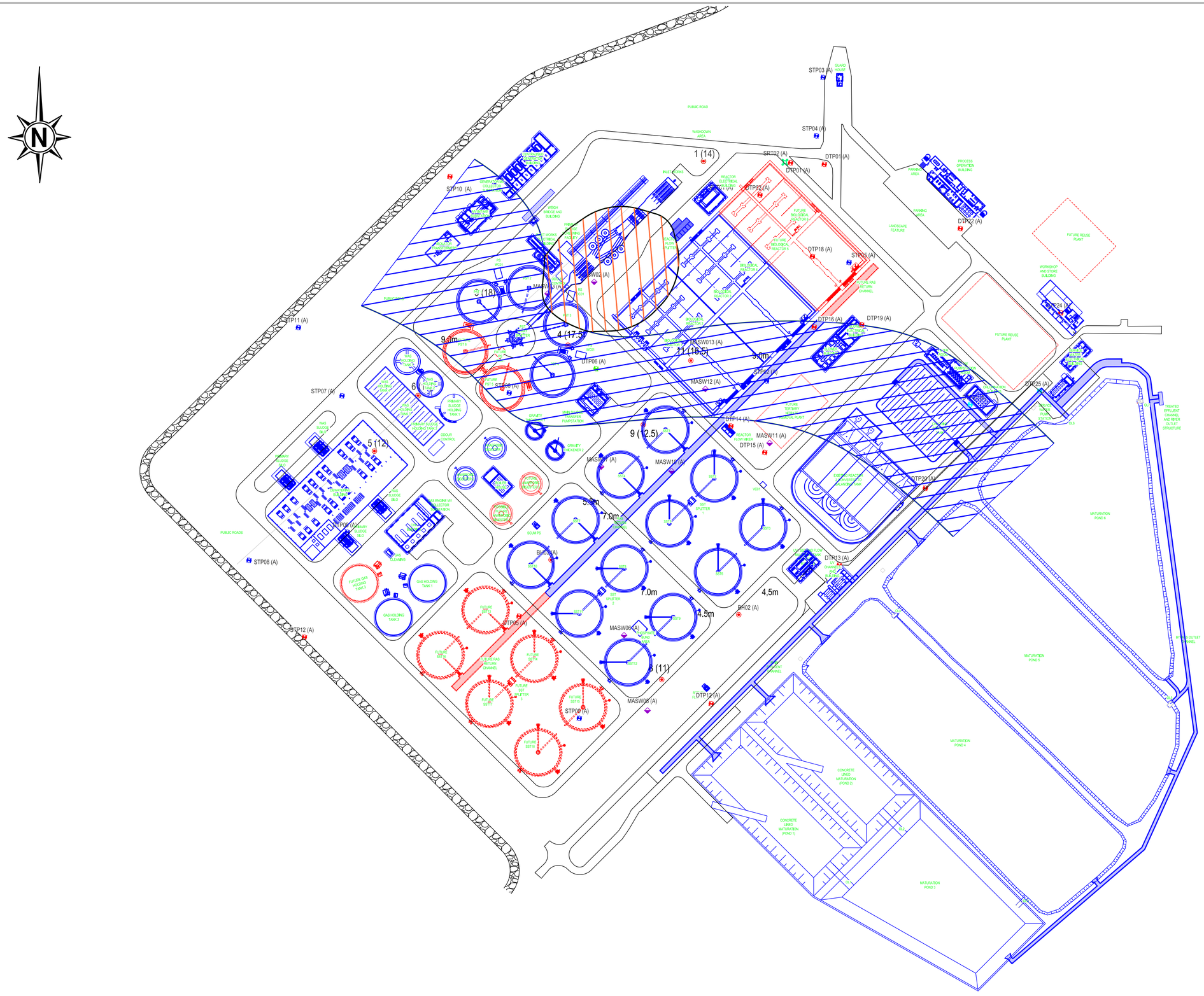
FIGURE 6

Depth to Bedrock



0.5m 0m 0.5m 1m 1.5m 2m
GRAPHIC SCALE

LEGENDS

- BEDROCK 5 - 10 mbgl
- BEDROCK 10 - 15 mbgl
- BEDROCK 15 - 20 mbgl
- 8 (11) BH No AND DEPTH TO TO BEDROCK IN mbgl

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CONSULTING ENGINEER — N. WELLAND — JUL 2023 DATE

CLIENT — DATE

CLIENT

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PROJECT

CONTRACT NO. 340C/2018/19
MACASSAR WASTEWATER TREATMENT WORKS

DRAWING DESCRIPTION

MACASSAR WASTEWATER TREATMENT WORKS
DEPTH TO BEDROCK

SCALE 1:1500
ORIGINAL DWG SIZE A1

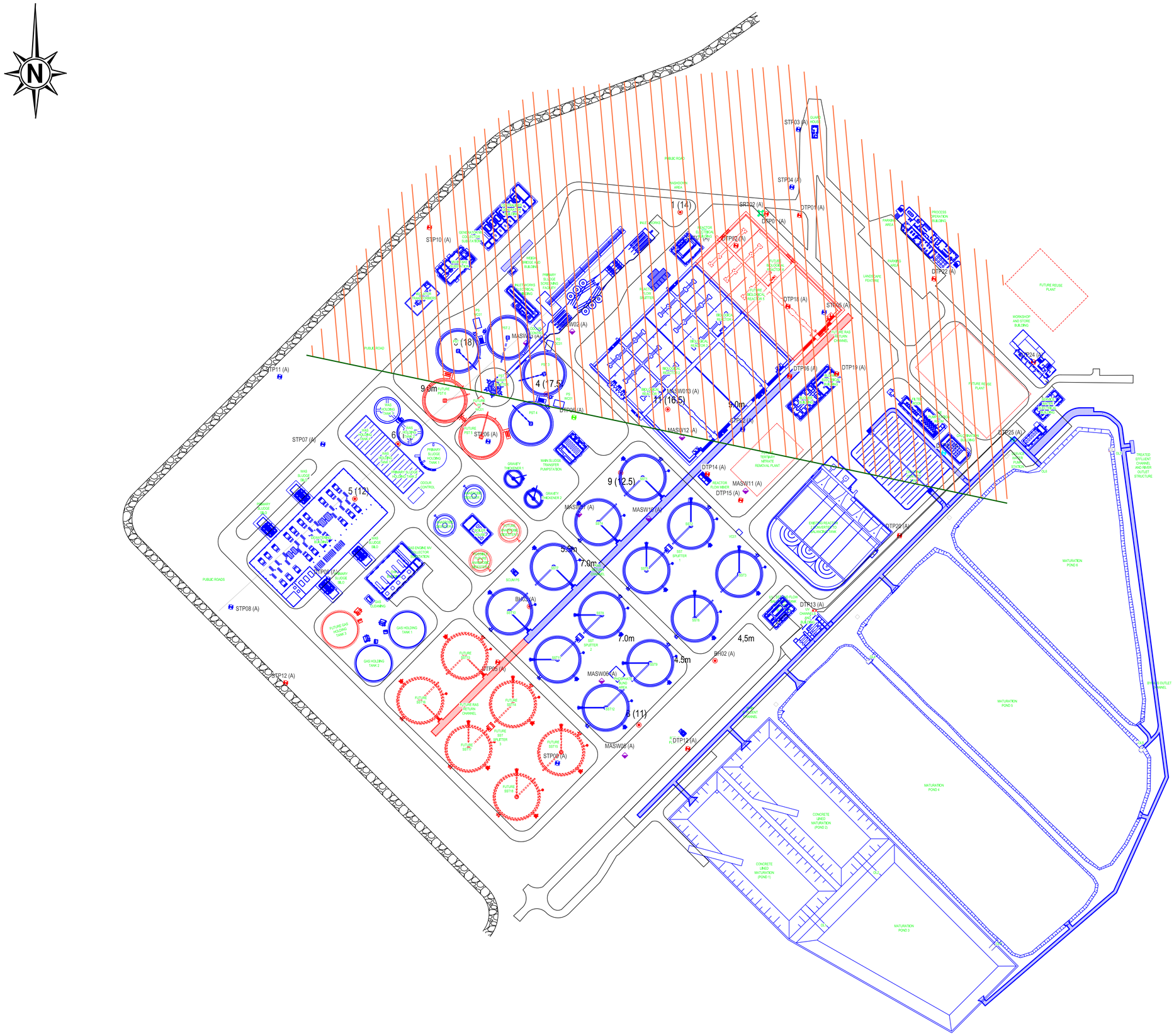
DATE OCT 2023

DRAWING NUMBER

FIGURE 6

FIGURE 7

Variation in E Modulus



0.5m 0m 0.5m 1m 1.5m 2m
GRAPHIC SCALE

LEGENDS

- E MODULUS 10 - 15 mPa
- E MODULUS 15 - 20 mPa
- 8 (17) BH No AND AVE E MODULUS FROM SPT

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CLIENT		DATE

CLIENT

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PROJECT

CONTRACT NO. 340C/2018/19
MACASSAR WASTEWATER TREATMENT WORKS

DRAWING DESCRIPTION

MACASSAR WASTEWATER TREATMENT WORKS
VARIATION IN E MODULUS

SCALE	DATE
1:1500	OCT 2023

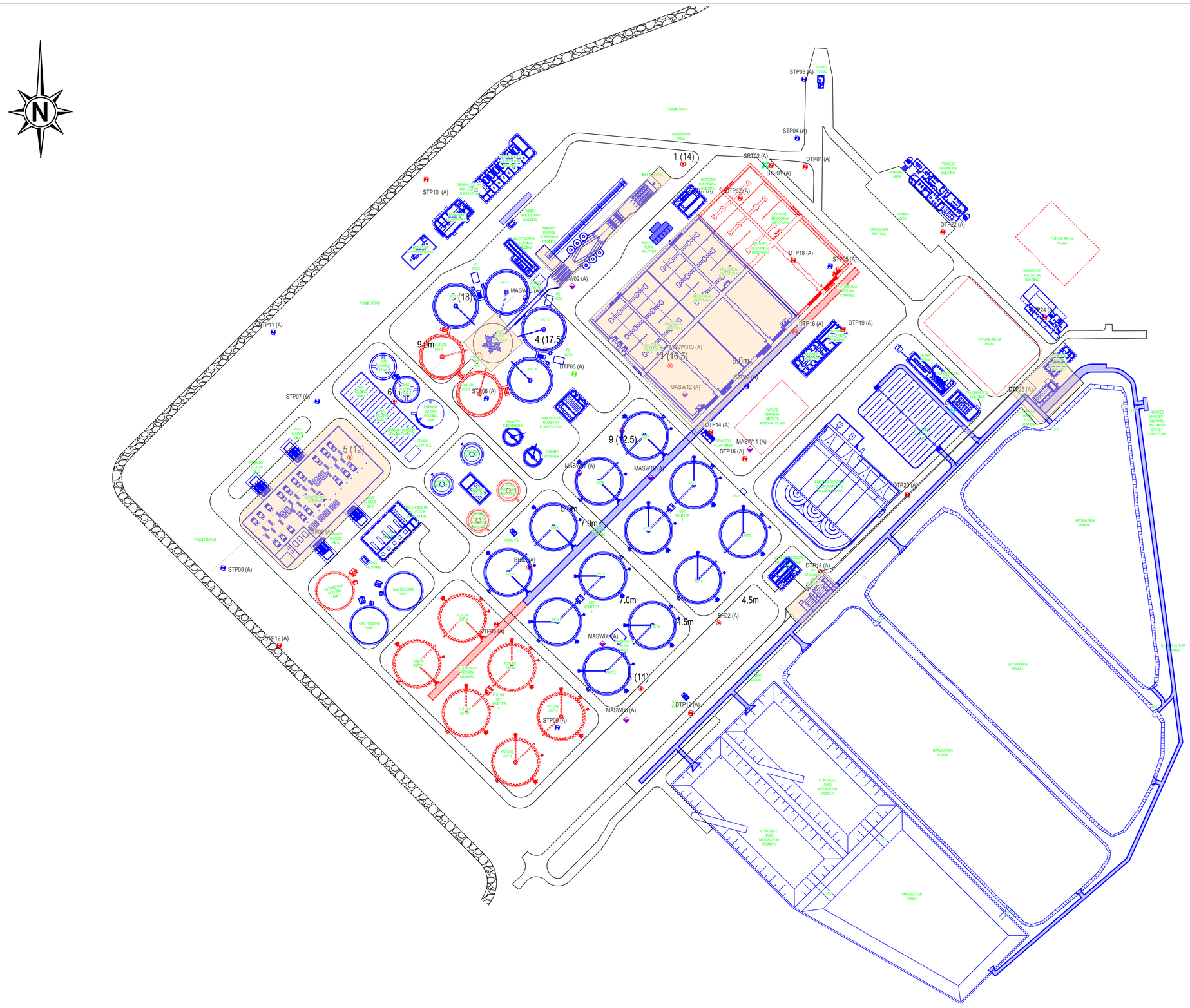
ORIGINAL DWG SIZE A1

DRAWING NUMBER

FIGURE 7

FIGURE 8

Deep Compaction (worst case scenario)



0.5m 0m 0.5m 1m 1.5m 2m
GRAPHIC SCALE

LEGENDS

DEEP COMPACTION (3 - 10 mbfl)

CONVENTIONAL COMPACTION (0 - 3 mbfl)

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CLIENT — DATE

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PROJECT

CONTRACT NO. 340C/2018/19
MACASSAR WASTEWATER TREATMENT WORKS

DRAWING DESCRIPTION

MACASSAR WASTEWATER TREATMENT WORKS
DEEP COMPACTION :
WORST CASE SCENARIO
(E = 10 mPa)

SCALE 1:1500
ORIGINAL DWG SIZE A1

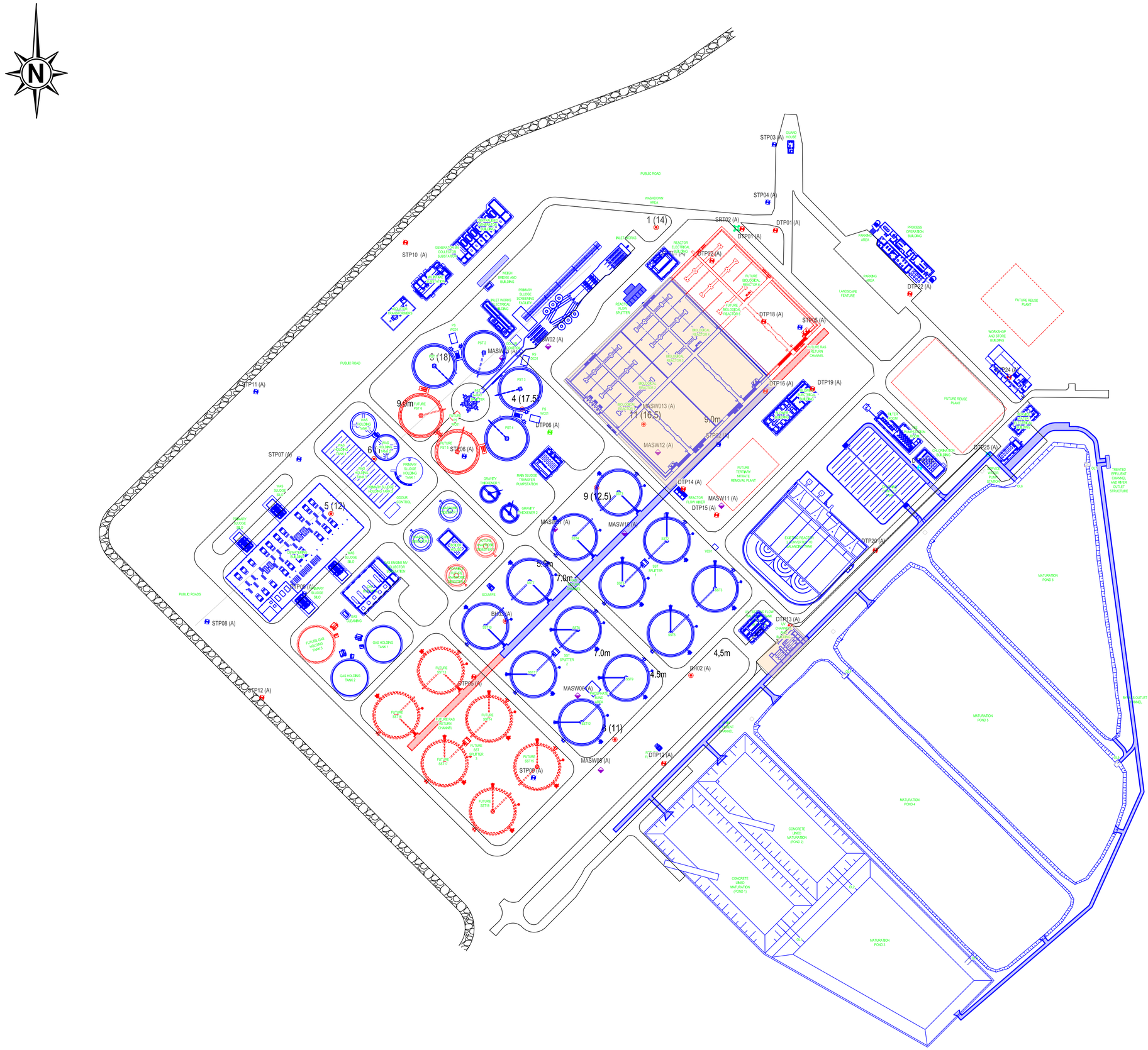
DATE OCT 2023

DRAWING NUMBER

FIGURE 8

FIGURE 9

Deep Compaction (best case scenario)



0.5m 0m 0.5m 1m 1.5m 2m
GRAPHIC SCALE

LEGENDS

DEEP COMPACTION (2 - 8 mbfl)

CONVENTIONAL COMPACTION (0 - 3 mbfl)

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All dimensions to be checked on site before any work is put in hand. Refer any discrepancies to the engineer.

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DETAIL DESIGN

AMENDMENT

NO.	DATE	CHECKED	DONE BY	DESCRIPTION
2	31/10/2023		H.G.	REVISED LAYOUT PLAN

GCS Geotechnical Engineering

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DESIGNED	DRAWN	CHECKED
N.A.	H.G.	H.H.

CONSULTING ENGINEER	N. WELLAND	JUL 2023 DATE
CLIENT		DATE

CLIENT

ZUTARI
IMPACT. ENGINEERED.

PROJECT

CONTRACT NO. 340C/2018/19
MACASSAR WASTEWATER TREATMENT WORKS

DRAWING DESCRIPTION

MACASSAR WASTEWATER TREATMENT WORKS
DEEP COMPACTION :
BEST CASE SCENARIO
(E = 13 - 20 mPa)

SCALE	DATE
1:1500	OCT 2023

ORIGINAL DWG SIZE A1

DRAWING NUMBER

FIGURE 9