APPENDIX J

GEOLOGICAL REPORT

Project Gemini
Chlorine Liquefaction Plant
Definitive Feasibility Study & Detailed Design

Geotechnical Investigation Report

Project Gemini
Chlorine Liquefaction Plant
Definitive Feasibility Study & Detailed Design

Geotechnical Investigation Report

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Acknowledgments

KBR acknowledges and respects the Traditional Custodians of the land on which it operates throughout Australia. We recognise their enduring connection to the land, waterways, cultural heritage, and communities. KBR also pays tribute to the wisdom and leadership of their Elders, both past and present.

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Limitations Statement

The sole purpose of this report and the associated services performed by Kellogg Brown & Root Pty Ltd (KBR) is to **provide geotechnical report (produced by Macquarie Geotech Pty Ltd) at IXOM Botany site** in accordance with the scope of services set out in the contract between KBR and **IXOM OPERATIONS Pty Ltd** ('the Client'). That scope of services was defined by the request of the Client, by the time and budgetary constraints imposed by the Client, and by the availability of access to the site.

KBR derived the data in this report primarily from **subcontractor's report and the report has been reviewed as per relevant Australian and International Standards.** The passage of time, manifestation of latent conditions or impacts of future events may require further exploration at the site and subsequent data analysis, and re-evaluation of the findings, observations and conclusions expressed in this report.

In preparing this report, KBR has relied upon and presumed accurate certain information (or absence thereof) relative to **subcontractor's report** provided by government officials and authorities, the Client and others identified herein. Except as otherwise stated in the report, KBR has not attempted to verify the accuracy or completeness of any such information.

The findings, observations and conclusions expressed by KBR in this report are not, and should not be considered, an opinion concerning **additional work outside of the scope of work**. No warranty or guarantee, whether express or implied, is made with respect to the data reported or to the findings, observations and conclusions expressed in this report. Further, such data, findings, observations, and conclusions are based solely upon **site conditions, information, drawings supplied by the client** in existence at the time of the investigation.

Revision History

Revision	Date	Comment	Signatures			
			Originated By	Checked By	Technical Approval	Project Approval
0	11/03/25	Issued for Use	Jack Chen	Mikkel Gade	Mahesh Dhargalkar	Mahesh Dhargalkar

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EXECUTIVE SUMMARY

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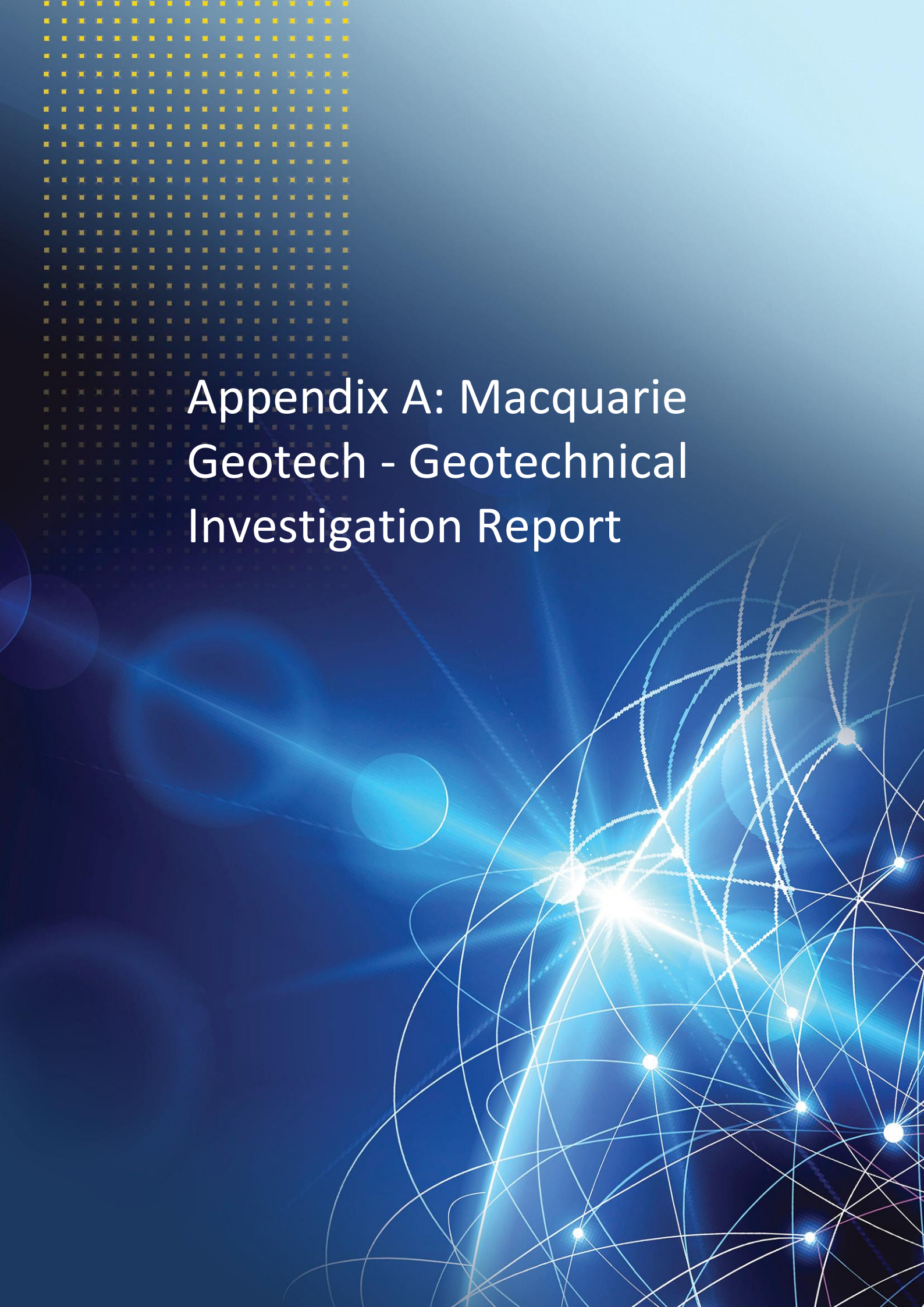
Executive Summary

As Macquarie Geotech is not ISO 9001 certified, this report is produced to attach geotechnical investigation report in the Appendix A below to assist with KBR Quality Control in issuing the document.

Appendix A: Macquarie Geotech - Geotechnical Investigation Report



MACQUARIE GEOTECH

Matraville Chlorine Liquefaction Plant

Job No.: G24469

IXOM Document No: PC.20301993-11-101

Submitted to:

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Matraville Chlorine Liquefaction Plant, NSW 2036

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MACQUARIE GEOTECH

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1 INTRODUCTION

At the request of Kellogg Brown & Root Pty Ltd (KBR). Macquarie Geotechnical (MG) has carried out a geotechnical investigation new Chlorine Liquefaction plant and relocation of the Hypo Tanker loading bay. It is understood from the project brief that geotechnical investigation is required.

The objective of the investigation is to provide a geotechnical investigation report.

The comments and opinions expressed in this report are based on the ground conditions encountered during the site work and on the results of tests carried out in the field and in the laboratory. There may, however, be special conditions prevailing on the site which have not been disclosed by this investigation and which have not been taken into account by this report.

2 PROPOSED DEVELOPMENT

It is understood that the proposed development will include the construction of a New Chlorine Liquefaction Plant in the place of an existing Sodium Hypochlorite (Hypo) Tanker Loading Bay. This Hypo Tanker Loading Bay is proposed to be relocated Northwest near the existing Sodium Hydroxide (caustic) Tanker Loading Bay. Figure 1 on the following page shows the proposed development plan provided by KBR.

Figure 1: Proposed Development Plan provided by KBR

3 SCOPE OF INVESTIGATION

The agreed scope of works are as follows:

- Undertake a brief desk study of the site to confirm the likely geological conditions of the site and to develop a geological model for the site.
- Undertake Before You Dig – Australia (BYDA) services search. Service locator provided by the client.
- Mobilisation of a one track/truck mounted rig. Drilling, logging and sampling of five boreholes to a depth of up to 6.45m as per Table 1. Additional boreholes were drilled due to obstruction.
- In-situ testing comprised of Dynamic Cone Penetrometer (DCP) and Standard Penetration Testing (SPT).

Table 1: Borehole Scope

Hole ID	Eastings (m)	Northings (m)	RL (AHD)	Depth (m)	Termination Reason
BH01	335626	6241259	12.00	6.00	Target Depth
BH02	335593	6241244	11.00	6.00	Target Depth
BH02a	335597	6241244	11.00	1.70	Criteria Satisfied
BH03	335586	6241257	11.00	6.00	Target Depth
BH04	335576	6241229	11.00	1.41	Possible concrete obstruction
BH04a	335574	6241225	10.00	6.00	Target Depth
BH05	335535	6241314	9.00	0.40	Concrete Obstruction
BH05a	335534	6241313	9.00	0.40	Concrete Obstruction
BH05b	335534	6241315	9.00	0.51	Concrete Obstruction
BH05c	335532	6241314	9.00	6.45	Target Depth

- Samples were taken at regular intervals and at every change of strata to allow for laboratory testing and returned to our NATA accredited laboratory in Sydney, NSW and Envirolab. Laboratory testing comprised the following:
    - Five Moisture Content tests
    - One Atterberg Limits and Linear Shrinkage tests.
    - Three California Bearing Ratio (CBR) tests.
    - Three Maximum Dry Density/Standard Compaction tests
    - Five Particle size distribution tests
    - Four Direct Shear Box Tests (non-cohesive)
    - One Direct Shear Box Test (cohesive)
    - Four Soil Particle Density Tests
    - Four Soil Aggressivity Tests
    - One Total Organic Content Test

4 SITE DESCRIPTION

The site is located in located within the south-western corner of the Botany Industrial Park (BIP), off Denison street in Banksmedow NSW 2019 (Lot 1101 DP1227173).

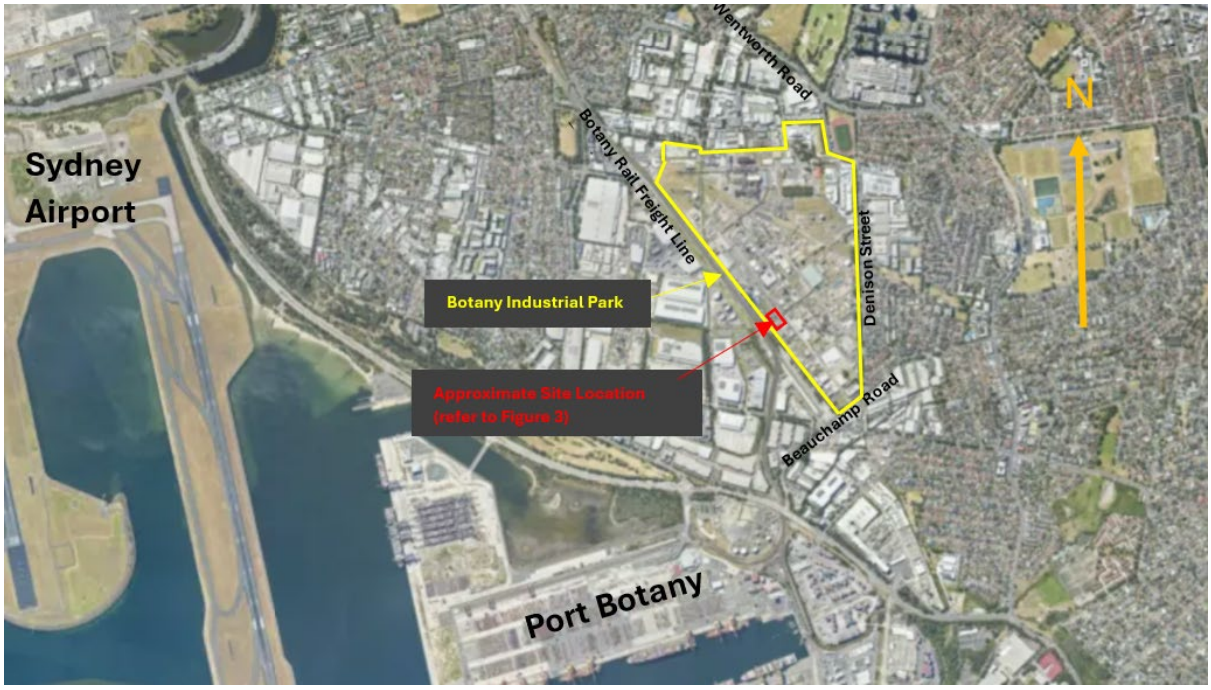

Figure 2: Approximate Site Location

The site covers two separate areas with a total approximate area of about 6500 m² (refer Figure 2)

The area of the site is relatively flat with a slight fall to the west of less than 1° ranging from in elevation 9.00 to 12.00 AHD. The site is occupied by loading bays and other chemical plant processing buildings predominantly located on hard standing and hard gravel fill layers with no vegetation or tree cover.

Historical imagery of the site indicates the plant has been operational since at least 1943 with significant structures present on site.

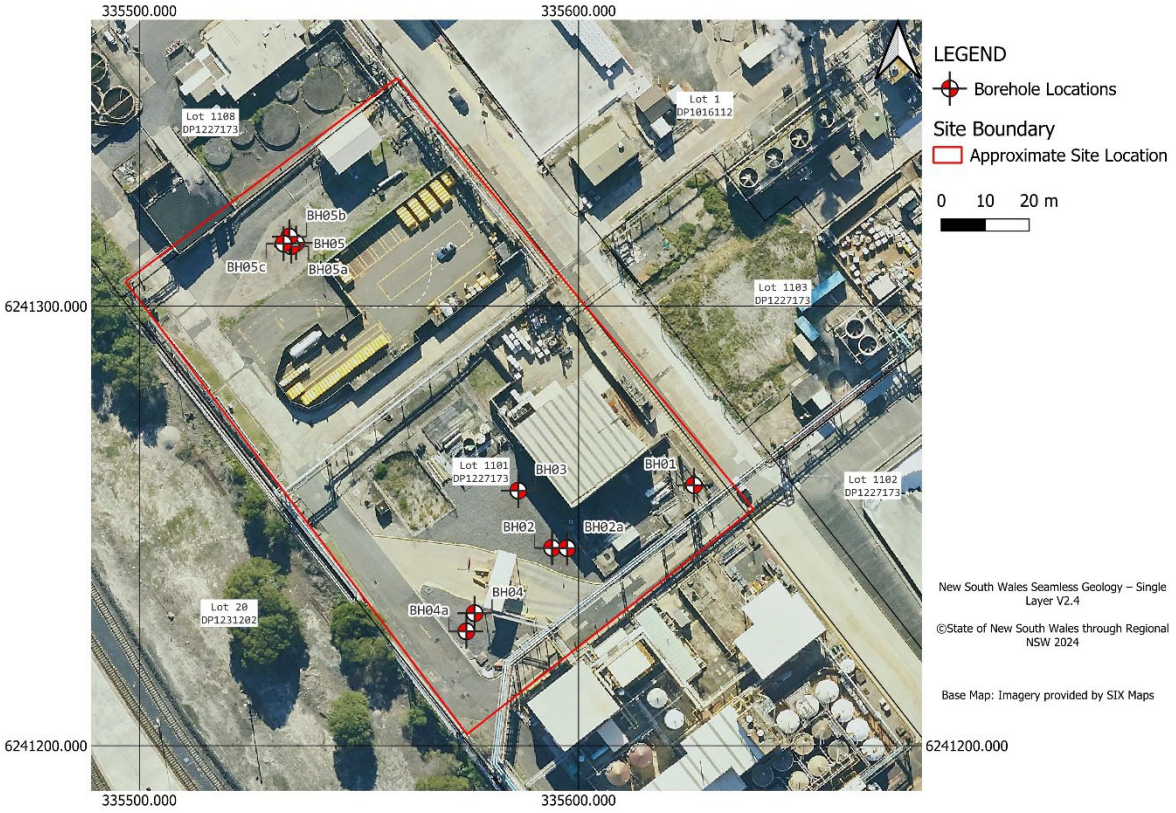

Figure 3: Site Location

5 DESK STUDY

A brief desk study was undertaken using readily available geological and geotechnical information and included the following:

- NSW Seamless Geological Map.
- Geology website – MinView.
- NSW Acid Sulfate Map.
- Published Literature.

5.1 Regional Geology

The NSW Seamless Geological map is shown in Figure 4 below:

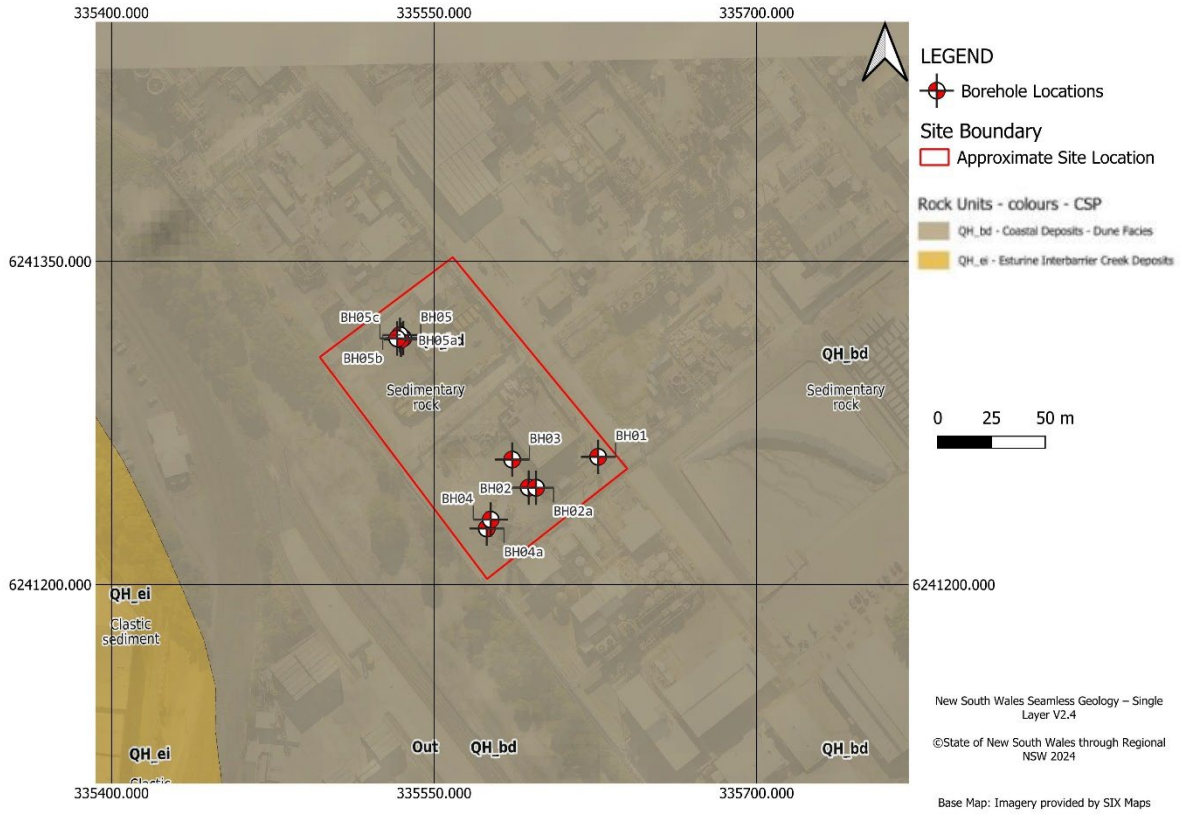

Figure 4: Seamless Geological Map Overlay

With reference to the Seamless Geological map in Figure 3, the site is underlain by the following:

Table 2: Summary of Geology

Geological Symbol	Stratigraphic Unit	Description
QH_bd	Coastal Deposits – Dune Facies	Marine-deposited and aeolian-reworked coastal sand dunes.
QH_ei	Estuarine interbarrier creek deposits	Fine- to medium-grained lithic-carbonate-quartz sand (marine-deposited), silt, clay, organic mud, gravel, shell material.

The site is generally underlain by coastal deposits including marine deposited and aeolian reworked sand dunes.

5.2 Groundwater Bores

There are various existing groundwater boreholes in the area. The closest recorded groundwater data is approximately 250m west of the site. This borehole indicates groundwater is approximately 8.40m below ground level. Other groundwater wells within the Botany Industrial Park have been drilled to 30 m to 35 m without encountering bedrock and groundwater at depths as shallow as 2 m. The logs, where the lithology was recorded, have predominantly been sands, however, include clay and peat layers ranging in thickness from 10 mm to 1.6 m.

One well (GW103437), located about 300 m south-west of the site, indicated sandstone at a depth of 20.7 m, however, other wells surrounding this well which we drilled up to 24.3 m to 29.9 m did not encounter sandstone bedrock.

Figure 3: Groundwater Borehole Data

5.3 Acid Sulphate Maps

Reference is made to the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Atlas of Australian Acid Sulphate Soils indicating extremely low to low risk of acid sulphate soils on site.

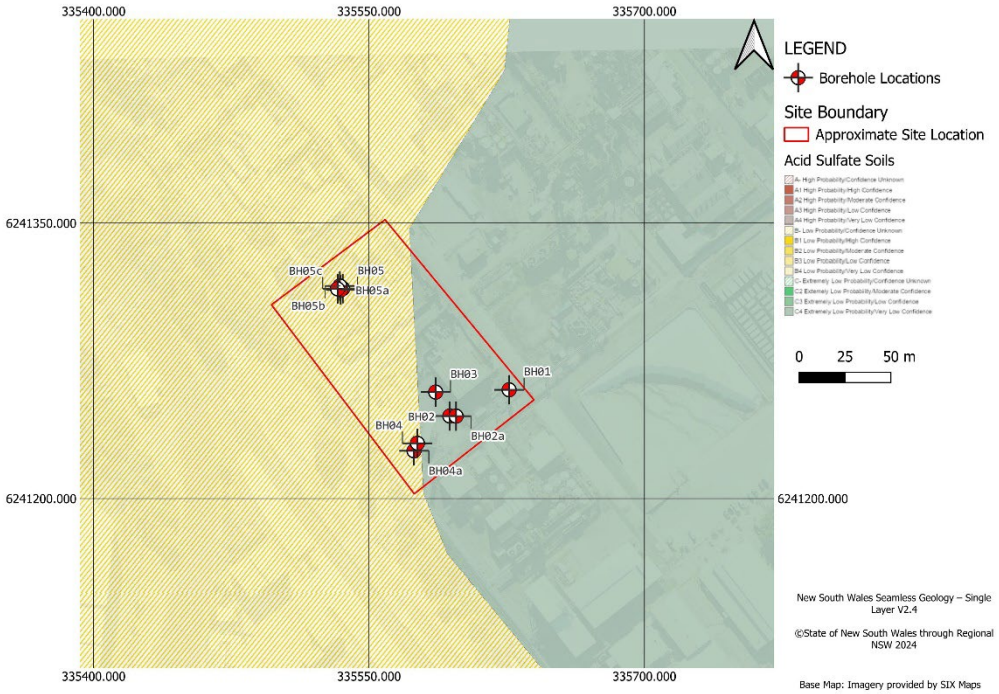

Figure 4: Acid Sulphate Map overlay

5.4 Published Information

Reference to the Sydney 1: 100 000 Geology Notes indicates that the Botany Bay is underlain by quaternary sediments up to 80 m thick that overlie an eroded bedrock surface (Hawkesbury Sandstone). The site is located in an area underlain by clean quartzose sand ("Marine Sand"). The "Marine Sand" together with other layers observed in the Marine Sand are described below;

- Marine Sand - up to 30 m thick and comprising clean, medium grained, well-sorted sand. It is shell free and 99 percent rounded quartz grains.
- Peat layers are often discontinuous, organic and typically occur in the upper part of the unit.
- Waterloo rock horizons which comprise indurated "sandrock" layers.

The depth to bedrock in the area is indicated as ranging from 15 m to 70 m depth. The greater depths to rock are associated with existing creek lines or drainage channels to the east and west.

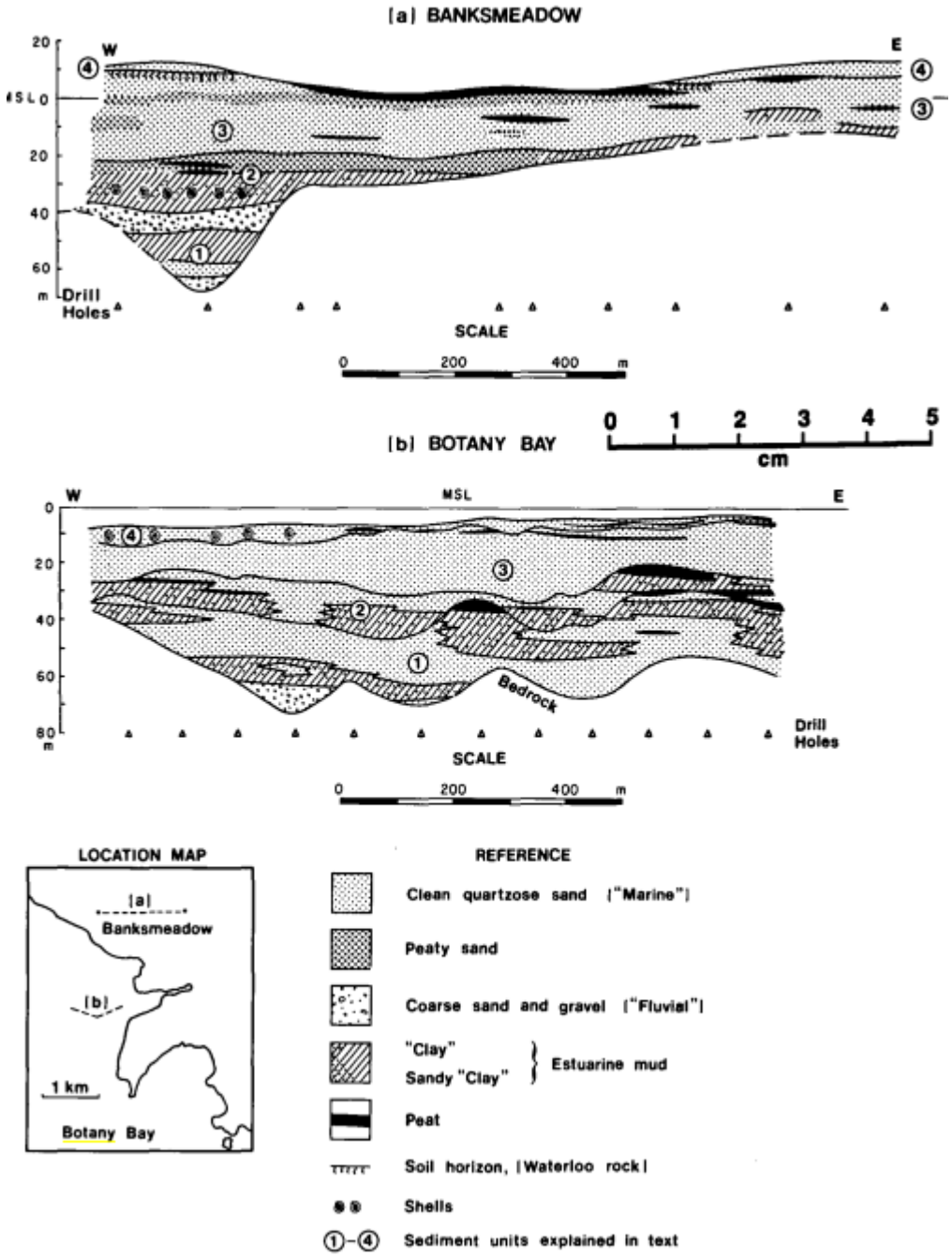

Figure 7: Excerpt of the Sydney 1:100 000 Geology Sheet 9130 Notes

Figure 8: Excerpt of the Sydney 1:100 000 Geology Sheet 9130 Notes (Contours indicate depth to rock)

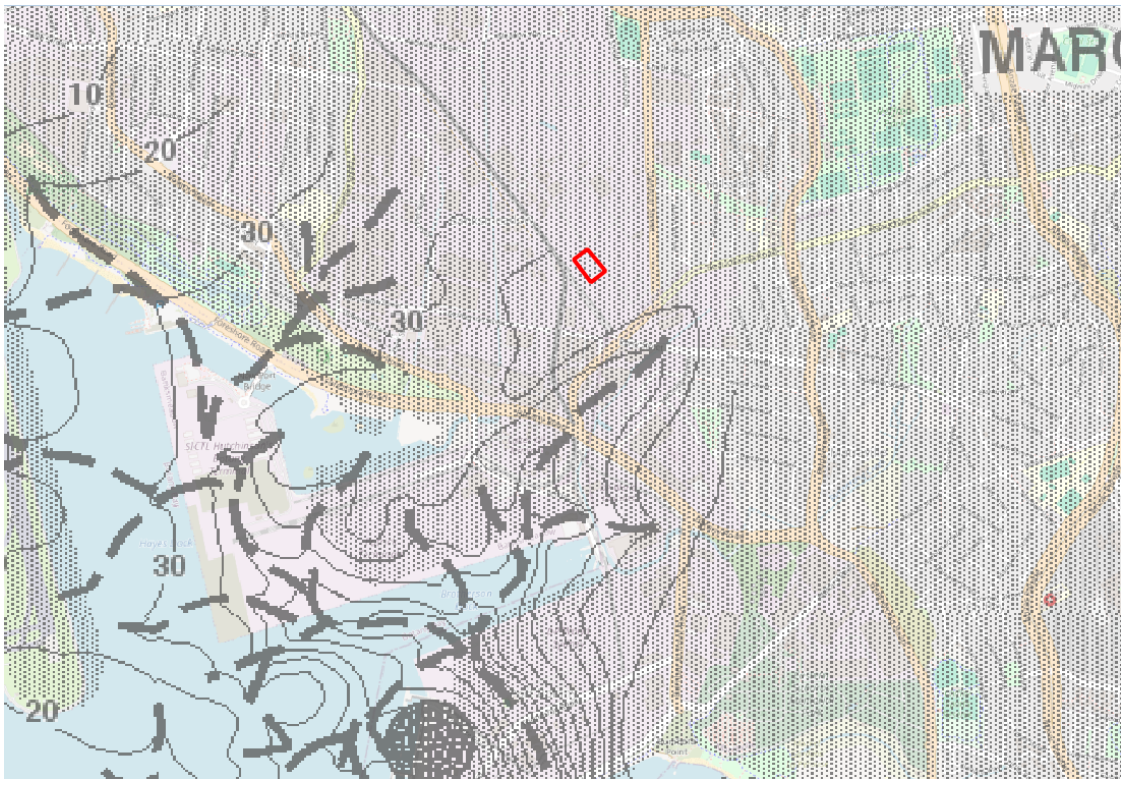

Figure 8: Excerpt of The Botany Basin; It's Bedrock Topography and Recent Geology History indicated depth to rock

6 FIELDWORK

Fieldwork was undertaken on 24 October 2024 to 6 November 2024 by a team of Drillers and Engineering Geologists from our Sydney office. The fieldwork was undertaken in accordance with the project proposal and the AS: 1726:2017 Geotechnical Site Investigation standard.

6.1.1 Service Location

Macquarie Geotechnical obtained underground services and utility plans through 'Dial Before You Dig (DBYD)' services. Service locating was conducted by the client.

6.1.2 GPS

All test locations were surveyed using a handheld GPS with co-ordinates recorded in the MGA Zone 56 format and elevations in Australian Height Datum (AHD).

6.1.3 Boreholes

The boreholes were drilled at locations nominated by Macquarie Geotechnical and are summarised in Table 1.

A Tracked Drill Rig was used to drill nine boreholes to depths of up to 6.00m utilising a 110mm diameter solid flight auger and 280mm bulk auger.

BH05c was initially cored by a concrete coring subcontractor to drill through the concrete layer found at 0.30m utilising a 305mm diameter corer. A Truck mounted drill rig was then used to drill one borehole to a depth of 6.45m utilising 110mm solid flight augers and 280mm bulk auger.

In-situ testing comprised of Dynamic Cone Penetrometer (DCP) and Standard Penetration Testing (SPT). The boreholes were backfilled with arisings/sand backfill and grout/cement mix for BH01 and BH05c which had concrete layers present. The borehole logs are presented in Appendix C.

6.2 Sampling

The sampling was undertaken in general accordance with AS:1289 1.2.1 and based on that defined in the proposal and considered the engineering requirements of the investigation and the nature of the materials encountered.

6.3 In-Situ Testing

In-situ testing as specified by our proposal was carried out in the exploratory holes in accordance with the techniques outlined in the relevant Australian Standards and Macquarie Geotech Quality procedures. The results are presented on the borehole hole logs in Appendix C.

6.4 Dynamic Cone Penetration Testing

Dynamic Cone Penetrometer (DCP) testing was carried out in the boreholes with techniques outlined in AS1289 6.3.2 in order to determine the relative density and consistency of the strata encountered. The numbers of blows per 100mm penetration were recorded.

6.5 Standard Penetration Testing

Standard Penetration Tests (SPT) were carried out in the boreholes with techniques outlined in AS1289.6.3.1 in order to determine the relative density and consistency of the strata encountered. The SPT "N" value (number of blows per 300mm penetration) or the blow count / penetration were recorded for each test.

6.6 Laboratory Testing

The samples were returned to Macquarie Geotechnical NATA accredited laboratory in Sydney and Envirolab in Sydney for further assessment and testing. The laboratory tests were carried out as per the laboratory test schedule indicated in the proposal.

A summary of the laboratory tests is provided in Table 3 below.

Table 3: Summary of Laboratory Tests

Laboratory Test	Quantity
Moisture Content (AS 1289.2.1.1)	5
Atterberg and Linear Shrinkage (AS 1289.3.1.1, 3.2.1, 3.3.1, 3.4.1)	1
Soil Particle Density (AS 1289.3.5.1)	4
Particle Size Distribution (AS 1289.3.6.1)	5
MDD - Dry density/moisture content relation of a soil using standard compactive effort) (AS 1289.5.1.1)	3
CBR - California Bearing Ratio of a soil – standard laboratory method for a remoulded specimen (4-day soak) (AS 1289.6.1.1)	3
Direct Shear - Non-cohesive - Peak only - 3 single stage (AS 1289.6.2.2) including MDD	4
Direct Shear - Cohesive - Peak only - 3 single stage (AS 1289.6.2.2) including MDD	1
Soil Aggressivity	4
Total Organic Content	1

7 SUB SURFACE CONDITIONS

7.1 Ground Conditions

The ground conditions observed in the boreholes are broadly summarised in Table 6 below. Detailed descriptions of the strata can be found within the borehole logs provided in Appendix C.

Table 4: Borehole Summary

Unit	Name	Depth to Top of Unit (m)	Maximum Thickness (m)	Material Description
1	Fill	0.0 m	1.5 m	Concrete and gravelly sand/sand fill – the soil appears variably compacted
2	Sand – Variably compacted sand	0.1 – 1.5 m	3.0 m	Sand with or trace silt trace gravel– medium dense but with some very loose and loose layers. Borehole 4a also includes a 0.5 m thick, soft to firm clay layer. Trace vegetation was encountered in some layers
3	Sand – loose to medium dense	3.6 –	>2.4 m	Sand – typically medium dense with some loose and dense layers

7.2 Groundwater

The comments on groundwater are based on the observations made at the time of the investigation. Groundwater was encountered at between 2.80mbgl to 5.30mbgl. It is possible that elevated groundwater levels may occur during wet periods or due to seasonal variation and should be considered as part of the design process.

Table 5: Summary of Groundwater Ingress during Drilling

Hole ID	Groundwater Level Observed (mBGL)	Hole Depth (m)	Date
BH01	5.30	6.00	25/10/2024
BH02	5.00	6.00	24/10/2024
BH03	3.90	6.00	24/10/2024
BH04a	5.00	6.00	24/10/2024
BH05c	2.80	6.45	06/11/2024

8 LABORATORY TEST RESULTS

The laboratory tests were carried out on the samples nominated by Macquarie Geotechnical. Summaries of test results are shown in Tables 7 to 13 below.

Table 6: Laboratory Test Results – Classification

Hole ID	Depth (m)	Atterberg Limits			Moisture Content (%)
		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	
01	1.0 – 1.5 1.5 – 2.2	-	-	-	4.3
01	2.6 – 5.5	-	-	-	9.6
02	3.75 – 4.0	-	-	-	17.7
4a	4.0 – 4.5	NO	NO	NP	29.6
5c	2.0 – 2.7	-	-	-	14.0

Table 7: Laboratory Test Results - California Bearing Ratio (CBR)

Hole ID	Depth (m)	California Bearing Ratio (CBR)				
		FMC (%)	MDD (t/m^3)	OMC (%)	CBR (%)	CBR Swell (%)
1	0.5 – 1.0 1.0 – 1.5 1.5 – 2.2	4.3	1.66	14.3	-	-
1	4.6 – 5.5 5.5 – 6.0	9.6	1.68	15.5	-	-
2a	0.1 – 1.2	-	1.68	14.0	25	0.0
2a	1.2 – 1.7	-	1.66	13.3	13	-0.1
5c	1.0 – 2.0	-	1.71	12.9	25	0.0
5c	2.0 – 2.7	14.0	-	-	-	-

Note: FMC = Field Moisture Content, MDD – Maximum Dry Density, OMC – Optimum Moisture Content, CBR = California Bearing Ratio

Table 10: Laboratory Test Results – Particle Size Distribution and Soil Density

Hole ID	Depth (m)	Soil Particle Density (g/cm^3)	Percent Passing (%)				
			0.3 mm	1.18 mm	2.36 mm	4.75 mm	19.0 mm
1	0.5 – 1.0 1.0 – 1.5 1.5 – 2.2	2.63	-	-	-	-	
2	3.75 – 4.0 4.0 – 4.5	2.58	38	98	98	99	100
04a	1.5 – 2.5	-	40	99	99	99	100
04a	4.0 – 4.5	-	46	98	99	100	100
05c	2.0 – 2.7	2.64	48	99	99	100	100
05c	3.0 – 3.5	2.47	48	96	97	98	100

Table 11: Laboratory Test Results – Soil Chemical Properties

Hole ID	Depth (m)	Soil Chemical Properties (SCP)				Total Organic Matter
		pH	SO_4 (mg/kg)	Cl (mg/kg)	EC (uS/cm)	mg/kg
BH01	0.15 – 0.50	8.2	21	<10	45	-
BH03	0.95 – 1.50	9	10	20	76	-
BH04a	0.10 – 0.50	8.7	30	<10	86	-
BH05c	0.70 – 1.15	8.4	20	210	190	-
BH05c	2.70 – 3.00	-	-	-	-	36 000

Note: SO_4 – Sulphate, Cl – Chloride, EC – Electrical Conductivity;

Table 12: Laboratory Test Results – Direct Shear Test Results

Hole ID	Depth (m)	Peak Values			Ultimate Values		
		Friction Angle °	Cohesion (kPa)	Correlation	Friction Angle °	Cohesion (kPa)	Correlation
BH1	1.0 - 2.25[1]	33.5	0.2	0.99	33.4	0.8	0.99
BH1	4.6 – 5.5 5.5 – 6.0	29.2	8.3	0.98	32.9	0.5	
BH02	2.5 – 3.0 3.0 – 3.5	32.7	2.8	0.99	33.8	0.6	0.99
BH03	1.5 – 2.55 2.5 – 3.5[1]	31.9	2.9	0.9968	32.1	0.8	0.9980
BH5c	3.0 – 3.5	37.3	3.2	0.99	37.4	0.0	0.99

Note: 1. Two Samples

9 GEOTECHNICAL ASSESSMENT

9.1 Geological Model

The site comprises a variable layer of fill (Unit 1) overlying Natural Sands (Unit 2) of variable consistency but including very loose sands and soft clay layers to 4.5 m depth. The variability of the natural sands of Unit 2 are consistent with the marine and aeolian depositional environments with clay layers possibly deposited in an estuarine environment. At other nearby locations, this surface layer has been observed to have a similar depositional sequence where a variable profile, with differing densities (for sand)/shear strength (for clay) over short distances. In addition this layer often includes discontinuous zones of loose sands and clay layers together with indurated (or cemented) layers, however, indurated layers were not encountered during the investigation on-site. The variability in the depositional profile may also be a result of erosion that has been overlain by subsequent marine and aeolian deposition together with estuarine deposits. The underlying sand (Unit 3) appears to consistently be medium dense with loose and dense layers.

The sandstone on-site is likely to be at a depth of greater than 25 m. Published information together with a groundwater well to the west that encountered sandstone bedrock at 20 m suggests that the rock level is falling to the east or south-east, towards an old creek line where the published information suggests the rock level ranges between 20 m and 50 m. Given that the rock it as approximately 20 m depth in a well to the west, the rock level appears to be dipping to the east, towards the creek line identified

Groundwater levels have been recorded at depths of 2.8 – 5.3 m. Water levels are expected to fluctuate with changing climatic conditions.

It is noted that this report has not included a contamination assessment. A contamination assessment is understood to be separately undertaken by JBS&G.

10 EXCAVATION AND STABILITY

10.1 Soil

Excavation in sandy soils should be achievable using standard conventional earthmoving equipment (e.g. excavators with a toothed bucket).

10.2 Temporary Excavation Support

All excavations deeper than 1 m or within soils will require either battering (or benching) or retention support due to the presence of very loose sands and uncontrolled fill in the upper portion of the profile. This is a shallower depth than specified by Safework "Code of Practice – Excavation Work" (2020) but is recommended due to the inherent variability of the fill and surface sands together with the risk of premature collapse of deeper excavations.

For temporary work battering or benching in the cohesive soils at effective slope angles of 2.5:1 H:V (or up to 22 degrees) in non-cohesive or granular soils (at least loose density) are considered appropriate for the site materials. Geotechnical inspection should be carried out for lower strength/density materials or where groundwater seepage is present to assess if flattening of these slopes is required.

10.3 Retaining Structures

Retaining walls up to 1 m in height may occur as part of the development. It is recommended that design be based on a unit weight of 18 $\mathrm{kN/m^3}$ and a triangular earth pressure distribution with an effective friction angle of 30° (effective cohesion of 0 kPa). These parameters assume adequate drainage is provided, level ground conditions are present at the crest of the wall and surcharge loads (including construction loads) are considered in the design. If localised deeper retaining walls up to 3 m are proposed then these design parameters are considered suitable for preliminary design, however, specific further advice will need to be sought regarding the construction of these walls.

Design of retaining structures should be carried out in accordance with AS4678 (2002) "Earth-Retaining Structures".

10.4 Drainage

Drainage should be installed at the top of the cuttings to divert surface water runoff from the excavation and cut face during rainfall events.

10.5 EARTHWORKS

10.5.1 Re-use of Site Material

From a geotechnical perspective, the majority of the site won soil material from the cuttings is considered suitable for use as general structural fill material on-site. If the material is proposed to be used as engineered fill within the permanent works then some blending of the material with coarser particle sizes may be required to comply with Specification grading requirements.

Careful extraction and stockpile management will be required to optimise the potential volume of site won materials. Where feasible, material should be trucked directly to the placement site to avoid double handling and associated time and cost implications.

The majority of the site won material from the rock cuttings (moderately weathered rock or stronger) is likely to be suitable for use as general fill and selected material zone fill providing it can be adequately broken down to a suitable size for re-use as fill. Screening and processing of the raw material will be required to comply with earthwork specification and design requirements.

10.5.2 Building Pad and Subgrade Preparation

Building pad and subgrade preparation for pavements will generally require the following;

- Test roll the exposed surface with at least six passes of a minimum 12 tonne smooth drum roller (or similar) without vibrations in the presence of a geotechnical professional. Any soft or loose layers identified should be removed and replaced;
- Boxed-out excavations are expected to experience some groundwater infiltration if moisture ingress into the excavation is allowed to occur. Notwithstanding this infiltration, water accumulation in the excavation will result in other associated problems such as sidewall collapse (upon draining through a rapid drawdown type failure mechanism). Management of this water ingress must occur due to the potential adverse effects on the integrity of the excavation. ;
- Place approved cohesive filling, where required, in layers not greater than 250 mm (vertical thickness placed loosely), with each layer compacted to a density ratio between 98 % and 102 % (Standard Compaction) or 100% within 300 mm of any subgrade levels of pavements. Moisture contents should be maintained within 2% dry and 1 % wet of Standard optimum moisture content (OMC). Where cohesionless materials are proposed then the sand should be compacted to a density index of at least 75%. ;
- New filling should be free of oversize particles (>75 mm) and deleterious material;
- Moisture conditioning of clay soils may be required if soils are saturated (e.g. air drying, blending with dryer material or lime stabilisation);
- New filling placed under structures to be placed under Level 1 testing conditions as defined in AS 3798–(2007) “Guidelines on Earthworks for Commercial and Residential Developments”. Level 2 testing is recommended for filling in other areas.

Vibrations could be generated due to the compaction process in vibratory mode. It is recommended that vibrations be limited to a peak particle velocity of 5 mm/sec and that vibration monitors be installed on sensitive adjacent structures to monitor vibrations during the construction process.

10.5.3 Fill Batters

Fill batters should be overfilled by at least 1 m and trimmed back to the design profile to ensure adequate edge compaction.

Slope angles of 1.5:1 (H:V) and 2:1 (H:V) are considered appropriate for compacted embankment fill materials in the temporary and permanent conditions respectively, up to a maximum height of 3 m

provided the embankment is constructed on a competent foundation with controlled fill soils/natural soils. Higher embankments may require specific stability consideration.

11 FOUNDATIONS

11.1 Site Classification

The classification of a site involves a number of geotechnical factors such as depth of bedrock, the nature and extent of subsurface soils and any specific problems (slope stability, soft soils, filling, reactivity, etc).

AS2870 specifically relates to construction of low rise residential dwellings and is not technically appropriate for industrial or commercial structures. Given the depth of filling on-site the site is assigned a "P" classification requiring design in accordance with engineering principles.

Notwithstanding the “P” classification, the natural site soils are expected to have shrink-swell movements consistent with a “S” classification, with shrink-swell movements less than 20 mm.

An appropriate footing system should be designed in accordance with the above code to accommodate these anticipated movements. The possibility of additional movements, due to abnormal moisture variations, should be minimised by proper "site management" procedures as provided on the attached sheet.

It should be noted that this assessment is based on site conditions being represented by the natural soil profile. Any change in conditions noted during development, including cut or fill should be referred to Macquarie Geotechnical for appropriate inspection and assessment.

11.2 Geotechnical Design Parameters

The geotechnical design parameters estimated for this site are provided in Table 13 on the following page.

Table 13: Estimated Geotechnical Engineering Parameters

Soil Description	Unit Weight (kN/m³)	Effective Stress Parameters		Undrained Shear Strength	Poisson's Value	Concrete to Soil Friction Angle δ (degrees)	Young's Modulus [1] (MPa)	Modulus of Subgrade Reaction (MN/m³) Ks
		ϕ' Degrees	c' (kPa)	Cu (kPa)				
Unity 1 - FILL	16	25	0	0	0.35	23	2	NA
Unit 2 – Variable Sand	17	28	0	0	0.35	23	7	5
Unit 3 – Medium Dense Sand	18	30	0	0	0.3	23	20	10

1. Layers are sensitive to vibration and Young's Modulus values can be affected by excessive and/or prolonged nearby vibration.

11.3 Foundation Types

Design of foundations should achieve uniform founding conditions throughout the structure. Given the presence of very loose sands in Unit 2, it is recommended that all structural loads be transferred to the medium dense sands of Unit 3. Consideration could be given to shallow footings, however, given the presence of very loose sands it is likely that testing of the base of at least some footings during construction will result identify unsuitable materials that will require significant deepening of the footings in order to limit the potential for excessive settlement. It is recommended that pile footings comprise either displacement piles (driven timber or concrete piles), continuous flight auger (CFA) piles or concrete screw piles due to the presence of collapsing ground conditions and the relatively high and fluctuating groundwater levels.

Noise and vibration may be associated with driven piles and will need to be considered by the designer due to potential disruption of adjacent facilities.

It is likely that a working platform will be required for any piling rigs operating on-site. The size of the working platform will be dependent on applied rig loads together with the subgrade condition during construction.

11.4 Shallow Foundations

Shallow footings could be considered provided each footing is tested during construction to confirm the suitability of the base of the footing to support the applied loads. Various shallow footing types are outlined in Table 14.

Table 14: Vertical Design Parameters for Shallow Foundations

Unit	Footing Type	Dimensions	Embedment Depth below ground surface (m)	Allowable End Bearing Pressure (kPa)
2	Pad Footing	1 m square	1 m	100
2	Strip Footing	0.5 m wide and at least 2 m long	1 m	100

These shallow footings are to be founded on consistent loose sands and are expected to have 10 – 20 mm of settlement upon load application.

It is imperative that the integrity of the ground conditions adjacent to each shallow footing be maintained. The stability of shallow footings can be compromised by any adjacent excavations (e.g. service trenches, other footings) resulting in bearing capacity failure. Any proposed excavations adjacent to shallow footings must be assessed by an experienced geotechnical engineer on a case-by-case basis.

11.5 Pile Foundations

Due to the weaker nature of the near surface soils, the anticipated loadings and the possibility of erosion of sediments, it is anticipated that the new structure will require support by pile foundations

Piles should be designed based on AS 2159-2009 'Piling – Design and Installation'. Account should also be taken of lateral loading on the piles (for example Broms 1965, Design of Laterally Loaded Piles).

The design ultimate geotechnical strength (Rd.ug) of a pile in compression can be approximated using the following relationship:

$R_{d.ug} = f_{m.s} A_s + f_b A_b$

Where: $f_{m.s}$ = average shaft friction for condition of full mobilisation (compression)

f_b = ultimate base pressure (compression)

A_s = shaft surface area of pile in contact with soil

A_b = base area of pile

The design geotechnical strength ($R_{d.g}$) is calculated as the design ultimate geotechnical strength ($R_{d.ug}$) multiplied by a geotechnical strength reduction factor (ϕ_g).

$R_{d.g} = R_{d.ug}\ \phi_g$

The geotechnical strength reduction factor is dependent on a risk assessment and any associated load testing of the installed piles.

It should be noted that a nominal length of 1.5 times the pile diameter (D) below the soil surface is normally ignored in the estimation of design ultimate geotechnical strength due to a potential gap (between pile and soil) that may occur within this depth due to cyclic loading and other factors.

Shaft friction (f_s) is calculated using the following equation(s) specific to the type of ground encountered:

$f_s = K_s\ \sigma_v'\ \tan\ \delta$ (for cohesionless soil)

$f_s = C_u\ \alpha$ (for cohesive soil)

Where: K_S = horizontal pressure coefficient

σ_v' = effective vertical stress (taking into account groundwater pressures)

δ = pile to soil friction angle

C_u = undrained shear strength

α = adhesion factor

End bearing (f_b) is calculated using the following equation(s) specific to the type of ground encountered:

$f_b = N_q\ \sigma_v'$ (for cohesionless soil)

Where: N_q = bearing capacity factor

Piles need to be embedded a minimum of 5 x diameter in order to generate the required bearing capacity factors.

For tension piles, the pullout resistance would be wholly dependent on skin friction.

11.6 Pile Design Parameters

Based on our investigation, and our experience in this region, we recommend the following parameters in Table 13 have been estimated from SPT 'N' values.

Design parameters for vertical loadings of piled footings are provided in Table 15 on the following page. These parameters assume that the piled footings are constructed in accordance with industry's best practice.

Table 15: Vertical Design Parameters for Piled Foundations

Unit	Serviceability Values		Ultimate Values	
	Allowable End Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa)	Ultimate End Bearing Pressure (kPa)	Ultimate Shaft Adhesion (kPa)
2	NA	5	NA	15
3	400	20	1000	50

Higher values may be able to be adopted with additional cone penetration testing to a greater depth to confirm the geological profile.

Where uplift loads are to be considered then design should be based on 50% of the shaft adhesion values outlined in Table 15. Cone pullout failure should also be considered and designed in accordance with the method outlined in AS4678 "Earth Retaining Structures".

11.7 Geotechnical Strength Reduction Factor (AS2159)

The geotechnical strength reduction factor for pile design is defined in the Piling Code. Selection of the geotechnical strength reduction factor (ϕ_g) is based on a series of individual risk ratings (IRR) which are weighted and lead to an average risk rating (ARR). The individual risk ratings and final value of (ϕ_g) depend on the following factors:

- Site: the type, quantity and quality of testing.
- Design: design methods and parameter selection.
- Installation: construction control and monitoring.
- Pile testing regime.
- Redundancy.

Without clear details about the pile type, design method, testing regime and other construction factors it is not possible to calculate the appropriate (ϕ_g) value. Assuming no pile testing, limited specialist geotechnical supervision during construction, and the limited/basic investigation and testing, a ϕ_g value of 0.45 is considered appropriate.

11.8 Exposure Classification - Concrete

Reference is made to Table 6.4.2 (C) Exposure Classification for Concrete Piles AS2159 – 2009 'Piling – Design and Installation'. The soil condition is classified as 'Condition A' (Soils within groundwater). Given the minimum pH value of 6.5, the soils at this site are classified as mildly aggressive to steel and concrete.

11.9 Seismic Classification

In accordance with Part 4 of AS1170.4 – 2024, the site is assessed to have a Site Sub-Soil Class of "Ce". This is based on the expectation that the rock profile is less than 45 m depth.

12 PAVEMENT DESIGN PARAMETERS

Where sand fill is proposed as subgrade material, it is recommended that the design be based on a California bearing ratio of 10 %.

The subgrade should be formed in accordance with the methods outlined in Section 10.5.2.

Drainage should be incorporated into the design of the pavement hardstand, in both the short and long-term by the civil designer. Regular maintenance must be carried out on the drainage and pavement to extend the life of the pavement.

13 CONCLUSION

The findings of our report were based on our fieldwork, in-situ testing, laboratory testing and technical assessment for this site.

We trust the foregoing is sufficient for your present purposes, and if you have any questions, please contact the undersigned.

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BE (Civil) MEng Sc CPEng

Attached: Limitations of Geotechnical Site Investigation

References:

Australian Standard 1726 – 2017 Geotechnical Site Investigations
Australian Standard 3798 - 2007 Guidelines on Earthworks for Commercial and Residential Structures
Austroads 2024 – Guild to Pavement Technology Part 5: Pavement Evaluation and Treatment
Geological Survey of NSW: Department of Mineral Resources 1983 - "Geology of the Sydney 1:100 000 Sheet 9130"
Albani and Rickwood – 1998 "The Botany Basin; It's Bedrock Topography and Recent Geology History" in "Collected Case Studies in Engineering Geology, Hydrogeology and Environmental Geology, Geological Society of Australia.

LIMITATIONS OF GEOTECHNICAL SITE INVESTIGATION

Scope of Services

This report has been prepared for the Client in accordance with the Services Engagement Form (SEF), between the Client and Macquarie Geotechnical.

Reliance on Data

Macquarie Geotechnical has relied upon data and other information provided by the Client and other individuals. Macquarie Geotechnical has not verified the accuracy or completeness of the data, except as otherwise stated in the report. Recommendations in the report are based on the data.

Macquarie Geotechnical will not be liable in relation to incorrect recommendations should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed.

Geotechnical Investigation

Findings of Geotechnical Investigations are based extensively on judgment and experience. Geotechnical reports are prepared to meet the specific needs of individual clients. This report was prepared expressly for the Client and expressly for the Clients purposes.

This report is based on a subsurface investigation, which was designed for project-specific factors. Unless further geotechnical advice is obtained this report cannot be applied to an adjacent site nor can it be used when the nature of any proposed development is changed.

Limitations of Site investigation

As a result of the limited number of sub-surface excavations or boreholes there is the possibility that variations may occur between test locations. The investigation undertaken is an estimate of the general profile of the subsurface conditions. The data derived from the investigation and laboratory testing are extrapolated across the site to form a geological model. This geological model infers the subsurface conditions and their likely behavior with regard to the proposed development.

The actual conditions at the site might differ from those inferred to exist.

No subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

Time Dependence

This report is based on conditions, which existed at the time of subsurface exploration. Construction operations at or adjacent to the site, and natural events such as floods, or groundwater fluctuations, may also affect subsurface conditions, and thus the continuing adequacy of a geotechnical report.

Macquarie Geotechnical should be kept appraised of any such events and should be consulted for further geotechnical advice if any changes are noted.

Avoid Misinterpretation

A geotechnical engineer or engineering geologist should be retained to work with other design professionals explaining relevant geotechnical findings and in reviewing the adequacy of their plans and specifications relative to geotechnical issues.

No part of this report should be separated from the Final Report.

Sub-surface Logs

Sub-surface logs are developed by geoscientific professionals based upon their interpretation of field logs and laboratory evaluation of field samples. These logs should not under any circumstances be redrawn for inclusion in any drawings.

Geotechnical Involvement During Construction

During construction, excavation frequently exposes subsurface conditions. Geotechnical consultants should be retained through the construction stage, to identify variations if they are exposed.

Report for Benefit of Client

The report has been prepared for the benefit of the Client and no other party. Other parties should not rely upon the report or the accuracy or completeness of any recommendations and should make their own enquiries and obtain independent advice in relation to such matters.

Macquarie Geotechnical assumes no responsibility and will not be liable to any other person or organisations for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisations arising from matters dealt with or conclusions expressed in the report.

Other limitations

Macquarie Geotechnical will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

Other Information

For further information reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by the Institution of Engineers Australia, 1987.

Appendix A – Geotechnical Explanatory Notes

MACQUARIE GEOTECH

Geotechnical Explanatory Notes

Soil Description

In engineering terms soil includes every type of uncemented or partially cemented inorganic material found in the ground. In practice, if the material can be remoulded by hand in its field condition or in water it is described as a soil. The dominant soil constituent is given in capital letters, with secondary textures in lower case. The dominant feature is assessed from the Unified Soil Classification system and a soil symbol is used to define a soil layer as follows:

UNIFIED SOIL CLASSIFICATION

The appropriate symbols are selected on the result of visual examination, field tests and available laboratory tests, such as, sieve analysis, liquid limit and plasticity index.

USC Symbol	Description
GW	Well graded gravel
GP	Poorly graded gravel
GM	Silty gravel
GC	Clayey gravel
SW	Well graded sand
SP	Poorly graded sand
SM	Silty sand
SC	Clayey sand
ML	Silt of low plasticity
CL	Clay of low plasticity
OL	Organic soil of low plasticity
MH	Silt of high plasticity
CH	Clay of high plasticity
OH	Organic soil of high plasticity
Pt	Peaty Soil

MOISTURE CONDITION

Dry – Cohesive soils are friable or powdery
Cohesionless soil grains are free-running

Moist – Soil feels cool, darkened in colour
Cohesive soils can be moulded
Cohesionless soil grains tend to adhere

Wet – Cohesive soils usually weakened
Free water forms on hands when handling

For cohesive soils the following codes may also be used:

MC>PL Moisture Content greater than the Plastic Limit.
MC~PL Moisture Content near the Plastic Limit.
MC<PL Moisture Content less than the Plastic Limit.

PLASTICITY

The potential for soil to undergo change in volume with moisture change is assessed from its degree of plasticity. The classification of the degree of plasticity in terms of the Liquid Limit (LL) is as follows:

Description of Plasticity	LL (%)
Low	<35
Medium	35 to 50
High	>50

COHESIVE SOILS – CONSISTENCY

The consistency of a cohesive soil is defined by descriptive terminology such as very soft, soft, firm, stiff, very stiff and hard. These terms are assessed by the shear strength of the soil as observed visually, by the pocket penetrometer values and by resistance to deformation to hand moulding.

A Pocket Penetrometer may be used in the field or the laboratory to provide approximate assessment of unconfined compressive strength of cohesive soils. The values are recorded in kPa, as follows:

Strength	Symbol	Pocket Penetrometer Reading (kPa)
Very Soft	VS	< 25
Soft	S	20 to 50
Firm	F	50 to 100
Stiff	St	100 to 200
Very Stiff	VSt	200 to 400
Hard	H	> 400

MACQUARIE GEOTECH

COHESIONLESS SOILS – RELATIVE DENSITY

Relative density terms such as very loose, loose, medium, dense and very dense are used to describe silty and sandy material, and these are usually based on resistance to drilling penetration or the Standard Penetration Test (SPT) 'N' values. Other condition terms, such as friable, powdery or crumbly may also be used.

The Standard Penetration Test (SPT) is carried out in accordance with AS 1289, 6.3.1. For completed tests the number of blows required to drive the split spoon sampler 300 mm are recorded as the N value. For incomplete tests the number of blows and the penetration beyond the seating depth of 150 mm are recorded. If the 150 mm seating penetration is not achieved the number of blows to achieve the measured penetration is recorded. SPT correlations may be subject to corrections for overburden pressure and equipment type.

Term	Symbol	Density Index	N Value (blows/0.3 m)
Very Loose	VL	0 to 15	0 to 4
Loose	L	15 to 35	4 to 10
Medium Dense	MD	35 to 65	10 to 30
Dense	D	65 to 85	30 to 50
Very Dense	VD	>85	>50

COHESIONLESS SOILS PARTICLE SIZE DESCRIPTIVE TERMS

Name	Subdivision	Size
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	19 mm to 63 mm
	medium	6.7 mm to 19 mm
	fine	2.36 mm to 6.7 mm
Sand	coarse	600 μm to 2.36 mm
	medium	210 μm to 600 μm
	fine	75 μm to 210 μm

Rock Description

The rock is described with strength and weathering symbols as shown below. Other features such as bedding and dip angle are given.

ROCK QUALITY

The fracture spacing is shown where applicable and the Rock Quality Designation (RQD) or Total Core Recovery (TCR) is given where:

$$\text{RQD (\%)} = \frac{\text{Sum of Axial lengths of core > 100mm long}}{\text{total length considered}}$$

$$\text{TCR (\%)} = \frac{\text{length of core recovered}}{\text{length of core run}}$$

ROCK STRENGTH

Rock strength is described using AS1726 and ISRM – Commission on Standardisation of Laboratory and Field Tests, "Suggested method of determining the Uniaxial Compressive Strength of Rock materials and the Point Load Index", as follows:

Term	Symbol	Point Load Index $Is_{(50)}$ (MPa)
Very Low	VL	0.03 to 0.1
Low	L	0.1 to 0.3
Medium	M	0.3 to 1
High	H	1 to 3
Very High	VH	3 to 10
Extremely High	EH	>10

ROCK MATERIAL WEATHERING

Rock weathering is described using the following abbreviation and definitions used in AS1726:

Abbreviation	Term
RS	Residual soil
XW	Extremely weathered
DW	Distinctly weathered
HW	Highly weathered
MW	Moderately weathered
SW	Slightly weathered
FR	Fresh

MACQUARIE GEOTECH

DEFECT SPACING/BEDDING THICKNESS

Measured at right angles to defects of same set or bedding.

Term	Defect Spacing	Bedding
Extremely closely spaced	<6 mm	Thinly Laminated
	6 to 20 mm	Laminated
Very closely spaced	20 to 60 mm	Very Thin
Closely spaced	0.06 to 0.2 m	Thin
Moderately widely spaced	0.2 to 0.6 m	Medium
Widely spaced	0.6 to 2 m	Thick
Very widely spaced	>2 m	Very Thick

DEFECT DESCRIPTION

Type:	Description
B	Bedding
F	Fault
C	Cleavage
J	Joint
S	Shear Zone
D	Drill break

Planarity/Roughness:

Class	Description
I	rough or irregular, stepped
II	smooth, stepped
III	slickensided, stepped
IV	rough or irregular, undulating
V	smooth, undulating
VI	slickensided, undulating
VII	rough or irregular, planar
VIII	smooth, planar
IX	slickensided, planar

The inclination if defects are measured from perpendicular to the core axis.

WATER

Water level at date shown

Partial water loss

Water inflow

Complete water loss

Groundwater not observed: The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.

Groundwater not encountered: The borehole/test pit was dry soon after excavation, however groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

MACQUARIE GEOTECH

Graphic Symbols for Soils and Rocks

Typical symbols for soils and rocks are as follows. Combinations of these symbols may be used to indicated mixed materials such as clayey sand.

Soil Symbols

Main components

CLAY - CL

CLAY - CH

SAND

GRAVEL

BOULDERS / COBBLES

TOPSOIL

SILT

Minor Components

Clayey

Silty

Sandy

Gravelly

Other

FILL

BITUMEN

CONCRETE

Rock Symbols

Sedimentary Rocks

SANDSTONE

SILTSTONE

CLAYSTONE, MUDSTONE

SHALE

LAMINITE

ASPHALT

LIMESTONE

CONGLOMERATE

Igneous Rocks

GRANITE

BASALT

UNDIFFERENTIATED IGNEOUS

Metamorphic Rocks

SLATE, PHYLLITE, SCHIST

GNEISS

QUARTZITE

MACQUARIE GEOTECH

Engineering Classification of Shales and Sandstones in the Sydney Region – A Summary Guide

The Sydney Rock Class classification system is based on rock strength, defect spacing and allowable seams as set out below. All three factors must be satisfied.

CLASSIFICATION FOR SANDSTONE

Class	Uniaxial Compressive Strength (MPa)	Defect Spacing (mm)	Allowable Seams (%)
I	>24	>600	<1.5
II	>12	>600	<3
III	>7	>200	<5
IV	>2	>60	<10
V	>1	N.A.	N.A.

CLASSIFICATION FOR SHALE

Class	Uniaxial Compressive Strength (MPa)	Defect Spacing (mm)	Allowable Seams (%)
I	>16	>600	<2
II	>7	>200	<4
III	>2	>60	<8
IV	>1	>20	<25
V	>1	N.A.	N.A.

MACQUARIE GEOTECH

UNIAXIAL COMPRESSIVE STRENGTH (UCS)

For expedience in field/construction situations the uniaxial (unconfined) compressive strength of the rock is often inferred, or assessed using the point load strength index (Is_{50}) test (AS 4133.4.1 – 1993). For Sydney Basin sedimentary rocks the uniaxial compressive strength is typically about 20 x (Is_{50}) but the multiplier may range from about 10 to 30 depending on the rock type and characteristics. In the absence of UCS tests, the assigned Sydney Rock Class classification may therefore include rock strengths outside the nominated UCS range.

DEFECT SPACING

The terms relate to spacing of natural fractures in NMLC, NQ and HQ diamond drill cores and have the following definitions:

Defect Spacing (mm)	Terms Used to Describe Defect Spacing[1]
>2000	Very widely spaced
600 – 2000	Widely spaced
200 – 600	Moderately spaced
60 – 200	Closely spaced
20 – 60	Very closely spaced
<20	Extremely closely spaced

[1]After ISO/CD14689 and ISRM.

ALLOWABLE SEAMS

Seams include clay, fragmented, highly weathered or similar zones, usually sub-parallel to the loaded surface. The limits suggested in the tables relate to a defined zone of influence. For pad footings, the zone of influence is defined as 1.5 times the least footing dimension. For socketed footings, the zone includes the length of the socket plus a further depth equal to the width of the footing. For tunnel or excavation assessment purposes the defects are assessed over a length of core of similar characteristics.

Source: Based on Pells et al (1978), as revised by Pells et al (1998).
Pells, P.J.N, Mostyn, G. and Walker, B.F. – Foundations on Sandstone and Shale in the Sydney Region. Australian Geomechanics Journal, No 33 Part 3, December 1998.

MACQUARIE GEOTECH

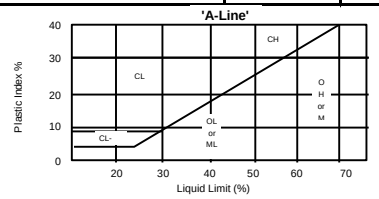
Summary of Soil Logging Procedures

Coarse Material: grain size - colour - particle shape - secondary components - minor constituents - moisture condition - relative density - origin - additional observations.

Fine Material: plasticity - colour - secondary components - minor constituents - moisture w.r.t. plasticity - consistency - origin - additional observations.

Guide to the Description, Identification and Classification of Soils

Major Divisions				SYMBOL	Typical Names
> 200mm		BOULDERS			
60 to 200mm		COBBLES			
COARSE GRAINED SOILS	More than 65% by dry mass less than 63mm is greater that 0.075mm	GRAVEL	More than 50% of coarse fraction > 2.36mm	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
				GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels.
		Gravelly Soils		GM	Silty gravels, gravel-sand-silt mixtures.
				GC	Clayey gravels, gravel-sand-clay mixtures
		SANDS	More than 50% of coarse fraction < 2.36mm	SW	Well-graded sands, gravelly sands, little or no fines.
				SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands.
		Sandy Soils		SM	Silty sands, sand-silt mixtures.
				SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	More than 35% by dry mass less than 60mm is less than 0.076mm	Liquid Limit < 50%		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts
				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays.
				OL	Organic silts and organic silty clays of low plasticity.
		Liquid Limit > 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
				CH	Inorganic clays of high plasticity, fat clays.
				OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS				Pt	Peat and other highly organic soils.



Grain sizes			
Gravel		Sand	
Coarse -	63 to 19mm	Coarse -	2.36 to 0.6mm
Medium -	19 to 6.7 mm	Medium -	0.6 to 0.21mm
Fine -	6.7 to 2.36mm	Fine -	0.21 to 0.075mm

GEOLOGICAL ORIGIN:-

Fill - artificial soils / deposits
Alluvial - soils deposited by the action of water
Aeolian - soils deposited by the action of wind
Topsoil - soils supporting plant life containing significant organic content
Residual - soils derived from insitu weathering of parent rock.
Colluvial - transported debris usually unsorted, loose and deposited

Field Identification of Fine Grained Soils - Silt or Clay?

Dry Strength - Allow the soil to dry completely and then test its strength by breaking and crumbling between the fingers.
High dry strength - Clays; Very slight dry strength - Silts.

Toughness Test - the soil is rolled by hand into a thread about 3mm in diameter. The thread is then folded and re-rolled repeatedly until it has dried sufficiently to break into lumps. In this condition inorganic clays are fairly stiff and tough while inorganic silts produce a weak and often soft thread which may be difficult to form and readily breaks and crumbles.

Dilatancy Test - Add sufficient water to the soil, held in the palm of the hand, to make it soft but not sticky. Shake horizontally, striking vigorously against the other hand several times. Dilatancy is indicated by the appearance of a shiny film on the surface of the soil. If the soil is then squeezed or pressed with the fingers, the surface becomes dull as the soil stiffens and eventually crumbles. These reactions are pronounced only for predominantly silt size material. Plastic clays give no reaction.

Descriptive Terms for Material Portions

COARSE GRAINED SOILS		FINE GRAINED SOILS	
% Fines	*Term/Modifier*	*% Coarse*	*Term/Modifier*
≤ 5	Omit, or use "trace"	≤ 15	Omit, or use "trace"
> 5, ≤ 12	"with clay/silt" as applicable	> 15, ≤ 30	"with sand/gravel" as applicable
> 12	Prefix soil as "silty/clayey"	> 30	Prefix as "sandy/gravelly"

Moisture Condition

for non-cohesive soils:

Dry -	runs freely through fingers.
Moist -	does not run freely but no free water visible on soil surface.
Wet -	free water visible on soil surface.

for cohesive soils:

MC > PL	Moisture content estimated to be greater than the plastic limit.
MC ~ PL	Moisture content estimated to be approximately equal to the plastic limit. The soil can be moulded
MC < PL	Moisture content estimated to be less than the plastic limit. The soil is hard and friable, or powdery.

The plastic limit (PL) is defined as the moisture content (percentage) at which the soil crumbles when rolled into threads of 3mm dia.

Consistency - For Clays & Silts

Description	*UCS(kPa)*	*Field guide to consistency*
Very soft	< 25	Exudes between the fingers when squeezed in hand
Soft	25 - 50	Can be moulded by light finger pressure
Firm	50 - 100	Can be moulded by strong finger pressure
Stiff	100 - 200	Cannot be moulded by fingers. Can be indented by thumb.
Very stiff	200 - 400	Can be indented by thumb nail
Hard	> 400	Can be indented with difficulty by thumb nail
Friable	-	Crumbles or powders when scraped by thumbnail

Relative Density for Gravels and Sands

Description	*SPT "N" Value*	*Density Index (ID) Range %*
Very loose	0 - 4	< 15
Loose	4 - 10	15 - 35
Medium dense	10 - 30	35 - 65
Dense	30 - 50	65 - 85
Very dense	> 50	> 85

MACQUARIE GEOTECH

Summary of Rock Logging Procedures

Description order: constituents - rock name - grain size - colour - weathering - strength - minor constituents - additional observations.
· minor constituents - moisture w.r.t. plasticity - consistency - origin - additional observations.

Definition - Sedimentary Rock

Conglomerate	more than 50% of the rock consists of gravel (>2mm) sized fragments
Sandstone	more than 50% of the rock consists of sand (0.06 to 2mm) sized grains
Siltstone	more than 50% of the rock consists of silt sized granular particles and the rock is not laminated
Claystone	more than 50% of the rock consists of clay or mica material and the rock is not laminated
Shale	more than 50% of the rock consists of clay or silt sized particles and the rock is laminated

Weathering

Residual Soil	RS	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a change in volume but the soil has not significantly transported.
Extremely Weathered	EW	Rock is weathered to such an extent that it has 'soil' properties; ie. it either disintegrates or can be remoulded, in water.
Distinctly Weathered	DW	**Highly Weathered (HW)** - Rock is wholly discoloured and rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals **Moderately Weathered (MW)** - The whole of the rock is discoloured, usually by iron staining and bleaching. Shows little or no change in rock strength.
Slightly Weathered	SW	Rock is slightly discoloured but shows little or no change of strength from fresh rock.
Fresh	FR	Rock shows no sign of decomposition or staining.

Stratification

thinly laminated	<6mm	medium bedded	0.2 - 0.6m
laminated	6 - 20mm	thickly bedded	0.6 - 2m
very thinly bedded	20 - 60mm	very thickly bedded	>2m
thinly bedded	60mm - 0.2m		

Discontinuities

order of description: depth - type - orientation - spacing - roughness / planarity - thickness - coating

	Type	Class	Roughness/Planarity	Class	Roughness/Planarity
B	Bedding	I	rough or irregular, stepped	VI	slickensided, undulating
F	Fault	II	smooth, stepped	VII	rough or irregular, planar
C	Cleavage	III	slickensided, stepped	VIII	smooth, planar
J	Joint	IV	rough or irregular, undulating	IX	slickensided, planar
S	Shear Zone	V	smooth, undulating		
D	Drill break				

Rock Strength

Term		Is (50)	Field Guide
		0.03	
Very low	VL		Material crumbles under firm blows with sharp end of pick; can be peeled with knive. Pieces up to 30mm thick can be broken by finger pressure.
		0.1	
Low	L		A piece of core 150 mm long x 50 mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
		0.3	
Medium	M		A piece of core 150 mm long x 50 mm dia. can be broken by hand with considerable difficulty. Readily scored with knife.
		1	
High	H		A piece of core 150 mm long x 50 mm dia. core cannot be broken by unaided hands, can be slightly scratched or scored with knife.
		3	
Very High	VH		A piece of core 150 mm long x 50 mm dia. May be broken readily with hand held hammer. Cannot be scratched with pen knife.
		10	
Extremely High	EH		A piece of core 150 mm long x 50 mm dia. Is difficult to break with hand held hammer. Rings when struck with a hammer.

* - rock strength defined by point load strength (Is 50) in direction normal to bedding

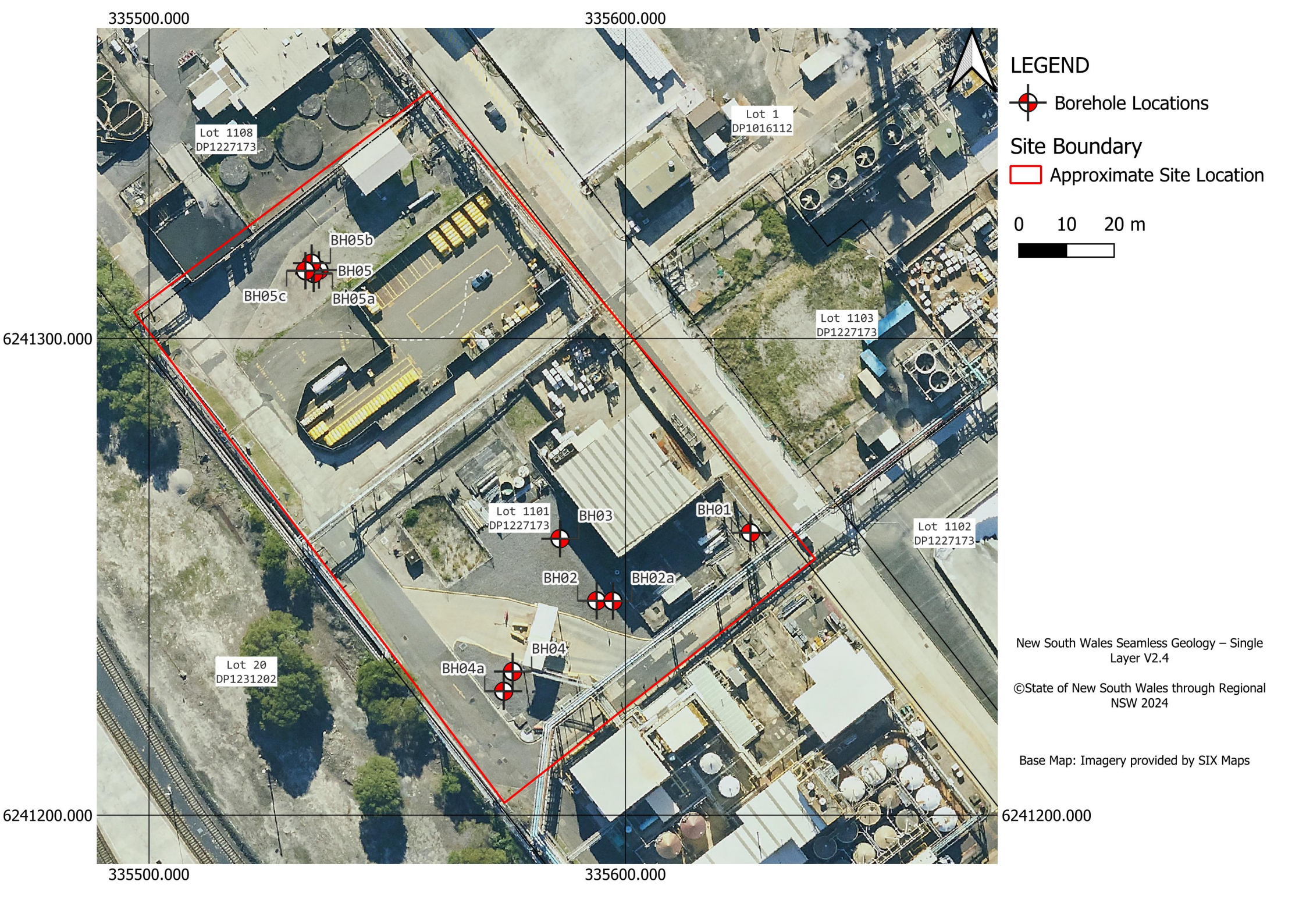
Degree of fracturing

fragmented	The core is comprised primarily of fragments of length less than 20mm, and mostly of width less than the core diameter
highly fractured	Core lengths are generally less than 20mm - 40mm with occasional fragments.
fractured	Core lengths are mainly 30mm - 100mm with occasional shorter and longer lengths
slightly fractured	Core lengths are generally 300mm - 1000mm with occasional longer sections and shorter sections of 100mm -- 300mm.
unbroken	The core does not contain any fracture.

- spacing of all types of natural fractures, but not artificial breaks, in cored bores.

The fracture spacing is shown where applicable and the Rock Quality Designation is given by: RQD (%) = sum of unbroken core pieces 100 mm or longer

Appendix B – Site Plan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335600.000
6241300.000
6241200.000
Lot 1108
DP1227173
Lot 1
DP1016112
Lot 1103
DP1227173
Lot 1101
DP1227173
Lot 1102
DP1227173
Lot 20
DP1231202
BH05b
BH05
BH05c
BH05a
BH03
BH01
BH02
BH02a
BH04
BH04a
LEGEND
Borehole Locations
Site Boundary
Approximate Site Location
0
10
20 m
New South Wales Seamless Geology – Single Layer V2.4
©State of New South Wales through Regional NSW 2024
Base Map: Imagery provided by SIX Maps

MACQUARIE GEOTECH

Appendix C – Borehole Logs

MACQUARIE GEOTECH

EXPLORATORY HOLE - GEOTECHNICAL LOG

ID: **BH01**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**
HOLE TYPE: **BH**
PROJECT LOCATION:
MacGeo PROJECT: **G24469**
CLIENT: **KBR**
PAGE: 1 of **1**

DATA QUALITY: REVISION: PRODUCTION CODE: **2502241754** SUITABILITY CODE:

POSITION: E: **335626.00** N: **6241259.00** **(MGA2020-56)** RL: **12.00** (AHD) DESIGN ELEMENT:

FIELD WORK: DATE: **25/10/24** LOGGED BY: **KR**

HOLE CONSTRUCTION: PLANT: **GEO305** DIP/AZIMUTH: **°/°** OPERATED BY: **IB**

METHOD / CASING	WATER OBS.	SAMPLE	DEPTH	INSITU TEST	ELEVATION / DEPTH	GRAPHIC LOG	INFERRED ORIGIN	GROUP SYMBOL	MATERIAL COMPOSITION	MOISTURE CONDITION	CONSIS. / REL. DENS.	ADDITIONAL OBSERVATIONS
AD/T	▶	D DIG.JAY	0.15		12.0 / 0.0		NA	NA	0.00 CONCRETE; aggregate up to 20mm	NA	NA	
			0.50						0.13 SAND trace gravel, trace silt; grey pale orange yellow; SAND is fine to coarse grained; gravel is fine to medium grained, sub-angular to angular			
		SPT SET.LIB B TAM.REM	0.95	SPT: 5,5,5 N=10	11.1.0		ALV and AEO	SP		M	L	
			1.00									
		B WAY.JOY	1.50									
		SPT JOB.ASH B PAD.SHE	1.95	SPT: 4,5,4 N=9	10.2.0							
		D SAM.SUP	2.20						2.20 SAND trace silt; pale-dark grey; SAND is fine to medium grained			
		SPT ELM.SUB	2.50	SPT: 1,3,3 N=6			ALV and AEO	SP		M	L	
		B WIN.JET	2.95		9.03.0							
			3.50									
		SPT RUM.ART	3.70	SPT: 3,5,6 N=11					3.63 SAND trace silt; dark brown orange; SAND is fine to medium grained			
		B PAL.COT	3.95		8.04.0		ALV and AEO	SP		M	MD	
			4.50									
		SPT DOG.DAN	4.60	SPT: 2,6,8 N=14					4.60 SAND trace silt; pale grey; SAND is fine to medium grained			
		B OWE.PAP	4.95		7.05.0		ALV and AEO	SP		M-W	MD	
			5.50									
		SPT THE.BOW B HAM.ASP	5.95	SPT: 2,7,9 N=16	6.06.0							
			6.00						Terminated at 6.00 m. Criteria Satisfied.			
					5.07.0							

VERSION CONTROL
HOLE ID: BH01
PRODUCTION CODE: 2502241754
PAGE ID: BH01{GDMS[LOG]_001}

Remarks:

MACQUARIE GEOTECH

EXPLORATORY HOLE - SAMPLE PHOTOS

ID: **BH01**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

PROJECT LOCATION:

CLIENT: **KBR**

HOLE TYPE:

MacGeo PROJECT: **G24469**

PAGE: **1** of **1**

VERSION CONTROL

HOLE ID: BH01

PRODUCTION CODE: 2502241754

PAGE ID: BH01{GDMS[SMP]_001}

BH01_0.00-0.13

BH01_0.5-0.95

BH01_1.5-1.95

BH01_2.5-2.95

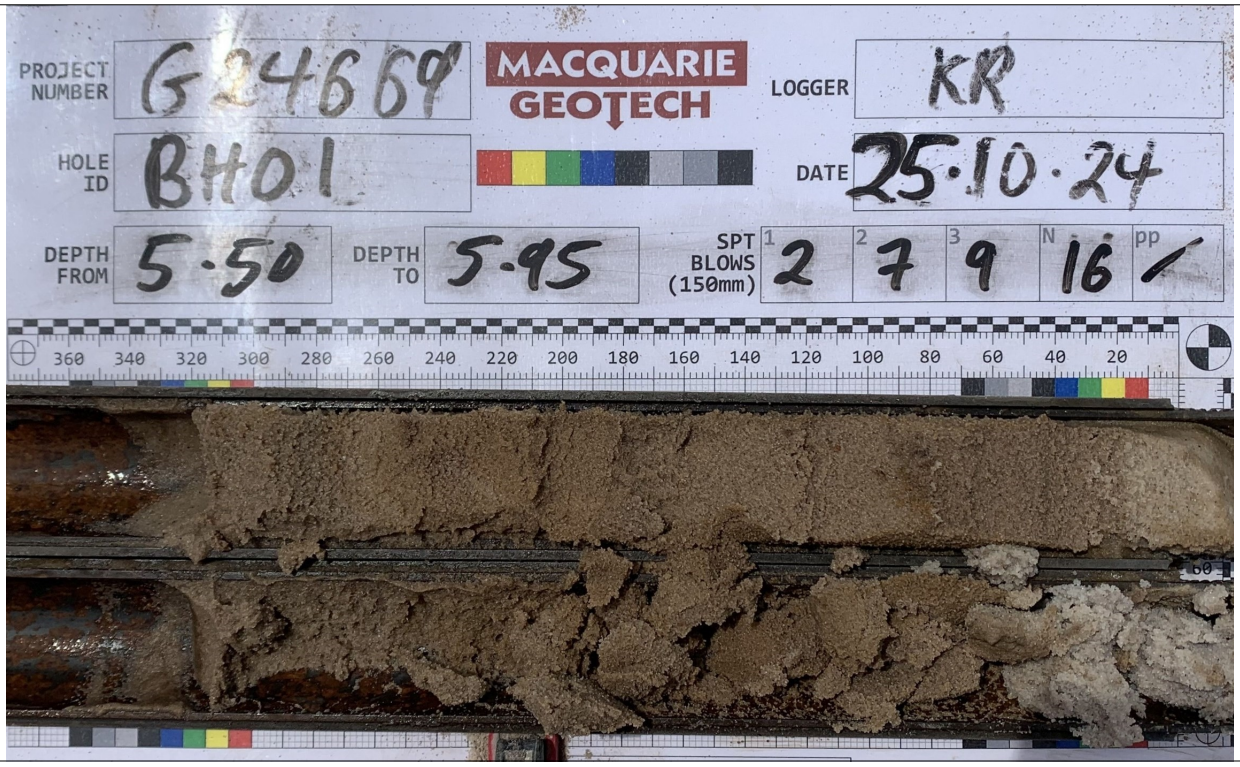
BH01_3.5-3.95

BH01_4.5-4.95

EXPLORATORY HOLE - MISCELLANEOUS PHOTOS ID: BH01

PROJECT NAME: Matraville Chlorine Liquefaction Plant
PROJECT LOCATION:
CLIENT: KBR

HOLE TYPE:
MacGeo PROJECT: G24469



BH01_5.5-5.95

VERSION CONTROL
HOLE ID: BH01
PRODUCTION CODE: 2502241806
PAGE ID: BH01{GDMS[MPH]_004}

MACQUARIE GEOTECH

EXPLORATORY HOLE - GEOTECHNICAL LOG

ID: **BH02**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

PROJECT LOCATION:

CLIENT: **KBR**

HOLE TYPE: **BH**

MacGeo PROJECT: **G24469**

PAGE: **1** of **1**

DATA QUALITY: REVISION: PRODUCTION CODE: **2502241754** SUITABILITY CODE:

POSITION: E: **335593.00** N: **6241244.00** **(MGA2020-56)** RL: **11.00** (AHD) DESIGN ELEMENT:

FIELD WORK: DATE: **24/10/24** LOGGED BY: **KR**

HOLE CONSTRUCTION: PLANT: **GEO305** DIP/AZIMUTH: **°/°** OPERATED BY: **IB**

METHOD / CASING	WATER OBS.	SAMPLE	DEPTH	INSITU TEST	ELEVATION / DEPTH	GRAPHIC LOG	INFERRED ORIGIN	GROUP SYMBOL	MATERIAL COMPOSITION	MOISTURE CONDITION	CONSIS. / REL. DENS.	DCP / VDEP	ADDITIONAL OBSERVATIONS
AD/T	▼	SPT FAY.OIL; B LED.CAP	0.10 – 0.95	SPT: 4,20,12 N=32	11.0 / 0.0 – 10.1 / 1.0		FIL	NA	0.00 FILL/GRAVEL with sand; grey; GRAVEL is fine to coarse, sub-rounded to sub-angular; sand is fine to coarse grained 0.10 FILL/SAND with gravel, trace silt; grey-brown; SAND is fine coarse grained; gravel is fine to coarse, sub-angular to angular	NA	NA	1, 3, 3, 4, 6, 10, 14, 11, 14, 10, 10, 11, 13, 13, 15	
		SPT ORE.TOY; B RAP.NEW	1.50 – 1.95	SPT: 5,10,11 N=21	9.0 / 2.0		ALV and AEO	SP	1.50 SAND trace silt; pale grey; SAND is fine to medium grained	M	MD		
		SPT LAG.MAS; B SIS.CAN; B BAY.DIM	2.50 – 3.00	SPT: 5,7,9 N=16	8.0 / 3.0								
		SPT TAR.SAE; B WAX.MET	3.50 – 3.95	SPT: 2,1,0 N=1	7.0 / 4.0		ALV and AEO	SC-SM	3.75 SAND with silt, trace gravel; black dark brown; SAND is fine to coarse grained; silt is medium plasticity ; gravel is fine to medium	M-W	VL		
		SPT COS.NIP; D EGG.OLD	4.00 – 4.45	SPT: 1,1,0 N=1									
		B MAC.PIC	4.50 – 5.00		6.0 / 5.0		ALV and AEO	SP-SM	4.50 Silty SAND; pale grey; SAND is medium to coarse grained	W	MD		
		SPT FIX.PAT	5.00 – 5.45	SPT: 5,9,12 N=21									
					5.0 / 6.0				Terminated at 6.00 m. Criteria Satisfied.				
					4.0 / 7.0								

VERSION CONTROL
HOLE ID: BH02
PRODUCTION CODE: 2502241754
PAGE ID: BH02{GDMS[LOG]_001}

Remarks:

MACQUARIE GEOTECH

EXPLORATORY HOLE - SAMPLE PHOTOS

ID: **BH02**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

HOLE TYPE:

PROJECT LOCATION:

MacGeo PROJECT: **G24469**

CLIENT: **KBR**

PAGE: **1** of **1**

VERSION CONTROL
HOLE ID: BH02
PRODUCTION CODE: 2502241754
PAGE ID: BH02{GDMS[SMP]_001}

MACQUARIE GEOTECH

EXPLORATORY HOLE - GEOTECHNICAL LOG

ID: **BH02a**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

HOLE TYPE: **BH**

PROJECT LOCATION:

MacGeo PROJECT: **G24469**

CLIENT: **KBR**

PAGE: **1** of **1**

DATA QUALITY: REVISION: PRODUCTION CODE: **2502241754** SUITABILITY CODE:

POSITION: E: **335597.00** N: **6241244.00** **(MGA2020-56)** RL: **11.00** (AHD) DESIGN ELEMENT:

FIELD WORK: DATE: **25/10/24** LOGGED BY: **KR**

HOLE CONSTRUCTION: PLANT: **GEO305** DIP/AZIMUTH: **°/°** OPERATED BY: **IB**

METHOD	CASING	WATER OBS.	SAMPLE	DEPTH	INSITU TEST	ELEVATION	DEPTH	GRAPHIC LOG	INFERRED ORIGIN	GROUP SYMBOL	MATERIAL COMPOSITION	MOISTURE CONDITION	CONSIS. / REL. DENS.	ADDITIONAL OBSERVATIONS
AD/T		Free groundwater not observed	B SAC.SAY	0.10		11.0	0.0		FIL	NA	0.00 FILL/GRAVEL; grey; fine to coarse, sub-rounded to sub-angular	NA	NA	
									FIL	NA	0.10 FILL/Gravelly SAND; grey; SAND is fine to coarse grained; Gravel is fine to medium grained, sub-angular to angular	NA	NA	
						10.0	1.0							
			B ANY.FOG	1.20					ALV and AEO	SP	1.20 SAND with silt; grey pale grey; SAND is fine to medium grained	D		
				1.70		9.0	2.0				Terminated at 1.70 m. Criteria Satisfied, Bulk Auger samples collected.			
						8.0	3.0							
						7.0	4.0							
						6.0	5.0							
						5.0	6.0							
						4.0	7.0							

VERSION CONTROL
HOLE ID: BH02a
PRODUCTION CODE: 2502241754
PAGE ID: BH02a{GDMS[LOG]_001}

Remarks:

MACQUARIE GEOTECH

EXPLORATORY HOLE - SAMPLE PHOTOS

ID: **BH02a**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

HOLE TYPE:

PROJECT LOCATION:

MacGeo PROJECT: **G24469**

CLIENT: **KBR**

PAGE: **1** of **1**

VERSION CONTROL

HOLE ID: BH02a

PRODUCTION CODE: 2502241754

PAGE ID: BH02a{GDMS[SMP]_001}

MACQUARIE GEOTECH

EXPLORATORY HOLE - MISCELLANEOUS PHOTOS ID: BH02

PROJECT NAME: Matraville Chlorine Liquefaction Plant
PROJECT LOCATION:
CLIENT: KBR

HOLE TYPE:
MacGeo PROJECT: G24469

BH02_0.5-0.95

BH02_1.5-1.95

BH02_2.5-2.95

BH02_3.5-3.95

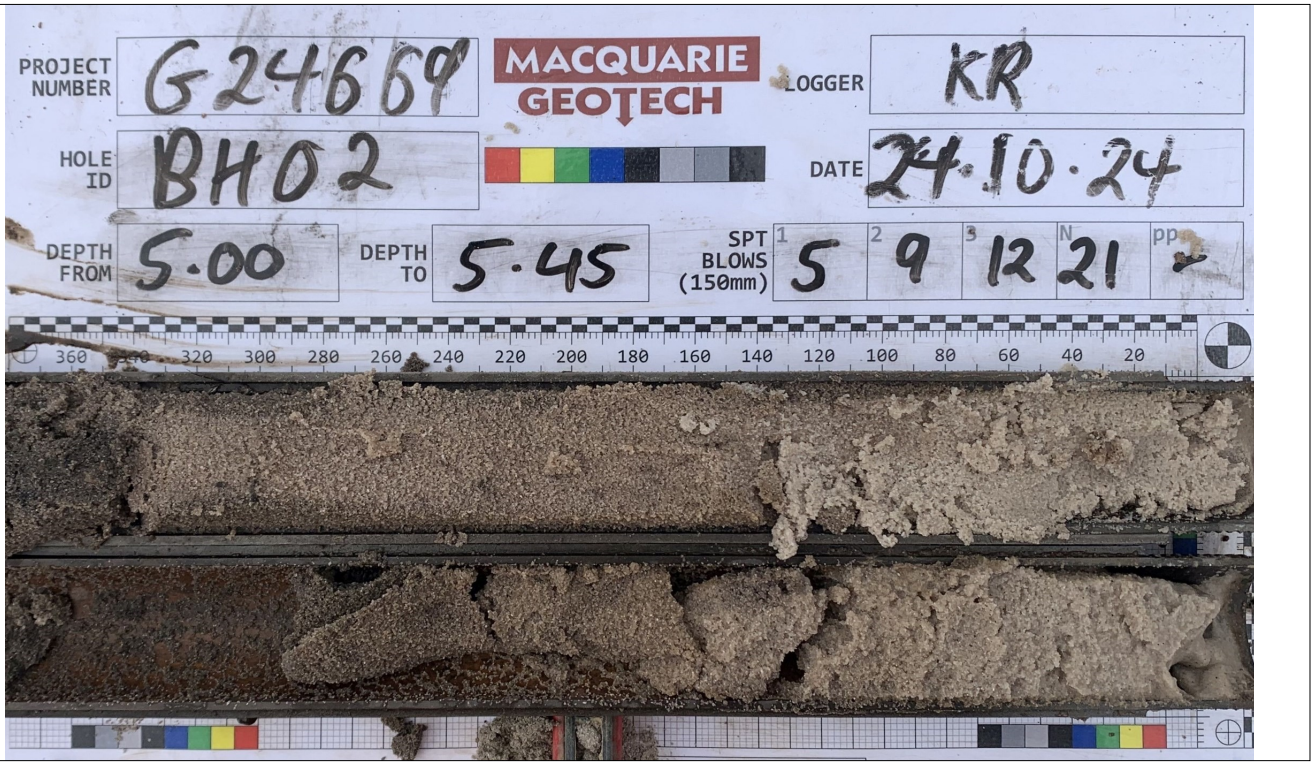
MACQUARIE GEOTECH

EXPLORATORY HOLE - MISCELLANEOUS PHOTOS ID: BH02

PROJECT NAME: Matraville Chlorine Liquefaction Plant
PROJECT LOCATION:
CLIENT: KBR

HOLE TYPE:
MacGeo PROJECT: G24469

BH02_4-4.45



BH02_5-5.45

MACQUARIE GEOTECH

EXPLORATORY HOLE - GEOTECHNICAL LOG

ID: **BH03**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

PROJECT LOCATION:

CLIENT: **KBR**

HOLE TYPE: **BH**

MacGeo PROJECT: **G24469**

PAGE: 1 of **1**

DATA QUALITY: REVISION: PRODUCTION CODE: **2502241754** SUITABILITY CODE:

POSITION: E: **335586.00** N: **6241257.00** **(MGA2020-56)** RL: **11.00** (AHD) DESIGN ELEMENT:

FIELD WORK: DATE: **24/10/24** LOGGED BY: **KR**

HOLE CONSTRUCTION: PLANT: **GEO305** DIP/AZIMUTH: **°/°** OPERATED BY: **IB**

METHOD / CASING	WATER OBS.	SAMPLE	DEPTH	INSITU TEST	ELEVATION / DEPTH	GRAPHIC LOG	INFERRED ORIGIN	GROUP SYMBOL	MATERIAL COMPOSITION	MOISTURE CONDITION	CONSIS. / REL. DENS.	DCP (5 10 15 20) / VDEP (2 4 6 8)	ADDITIONAL OBSERVATIONS
AD/T	▶	B OAK.FED	0.10		11.0 / 0.0		FIL	NA	0.00 FILL/GRAVEL with sand; grey; GRAVEL is fine to coarse, sub-angular to angular; sand is fine to coarse grained			1	
		SPT COW.RAT	0.50 0.57 0.58	SPT: 30/75 mm N=R			FIL	NA	0.10 FILL/Sandy GRAVEL trace clay; grey-dark grey; GRAVEL is fine to coarse, sub-angular to angular; Sand is fine to coarse grained			11 5 7 10 9	
									0.57 FILL/CONCRETE; grey; aggregate up to 15mm	NA	NA	6 13	
					10.1 / 1.0		FIL	NA				25	
		SPT COX.TOT	1.50	SPT: 1,1,1 N=2					1.40 SAND with silt; pale grey mottled yellow-orange; SAND is fine to medium grained		VL		
		B OLE.OFT	1.95		9.0 / 2.0								
		SPT WOW.TEN	2.50	SPT: 4,5,5 N=10			ALV and AEO	SP	*2.50-2.95: trace pockets of dark brown silt*	M			
		B INN.LAG	2.95		8.0 / 3.0						L		
		SPT FAY.SIS	3.50	SPT: 4,4,3 N=7					*3.50-3.95: trace pockets of black and dark brown silt*				
	▶		3.90 3.95		7.0 / 4.0		ALV and AEO	OL	3.90 Clayey SAND; black dark brown; SAND is fine to coarse grained; Clay is medium plasticity	W	MD		
		D SIP.SIS	4.50										
		SPT PEP.OWN	4.60	SPT: 1,5,9 N=14					4.60 SAND with silt; grey-brown; SAND is fine to medium grained				
		B JAR.GIG	4.95 5.00	SPT: 1,4,6 N=10	6.0 / 5.0		ALV and AEO	SP		W	L-MD		
		SPT APE.HUH	5.45 5.50										
		D EMU.PUB	5.95 6.00		5.0 / 6.0				Terminated at 6.00 m. Criteria Satisfied.				
					4.0 / 7.0								

VERSION CONTROL
HOLE ID: BH03
PRODUCTION CODE: 2502241754
PAGE ID: BH03{GDMS[LOG]_001}

Remarks:

MACQUARIE GEOTECH

EXPLORATORY HOLE - SAMPLE PHOTOS

ID: **BH03**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

PROJECT LOCATION:

CLIENT: **KBR**

HOLE TYPE:

MacGeo PROJECT: **G24469**

PAGE: **1** of **1**

VERSION CONTROL
HOLE ID: BH03
PRODUCTION CODE: 2502241754
PAGE ID: BH03{GDMS[SMP]_001}

EXPLORATORY HOLE - MISCELLANEOUS PHOTOS ID: BH03

PROJECT NAME: Matraville Chlorine Liquefaction Plant
PROJECT LOCATION:
CLIENT: KBR

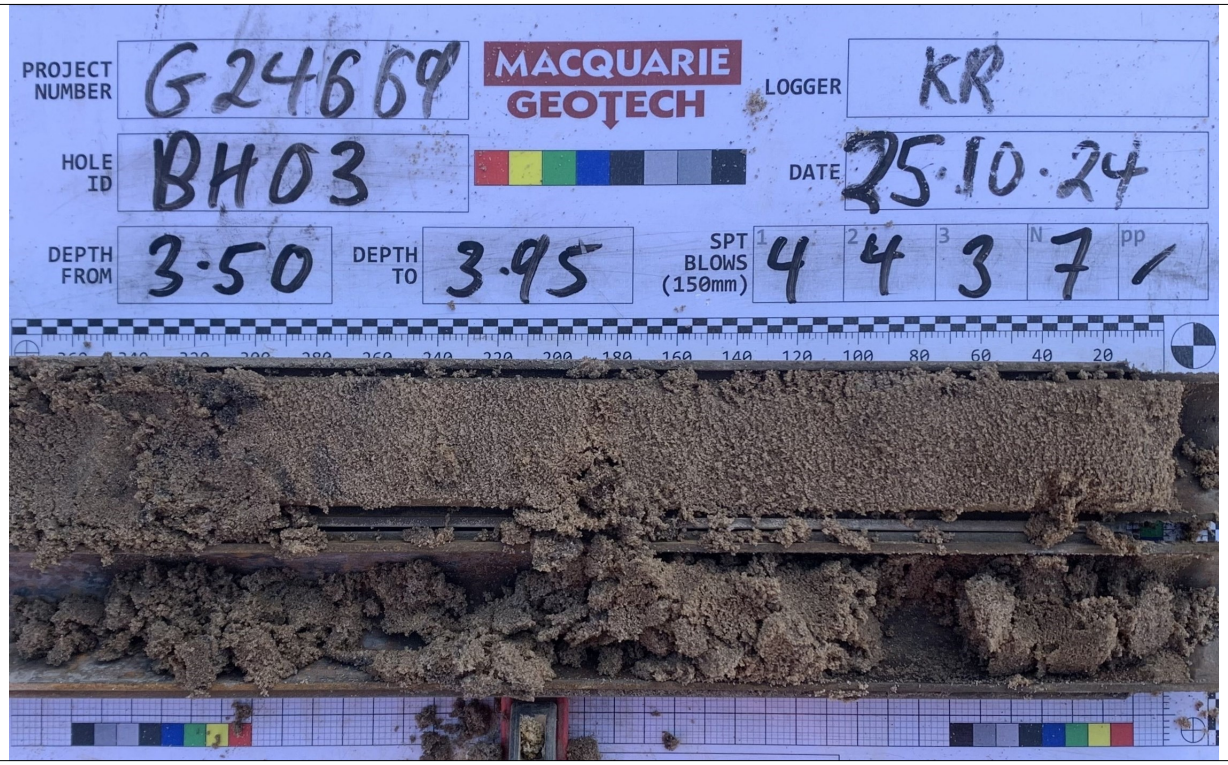
HOLE TYPE:
MacGeo PROJECT: G24469

BH03_0.5-0.57

BH03_1.5-1.95

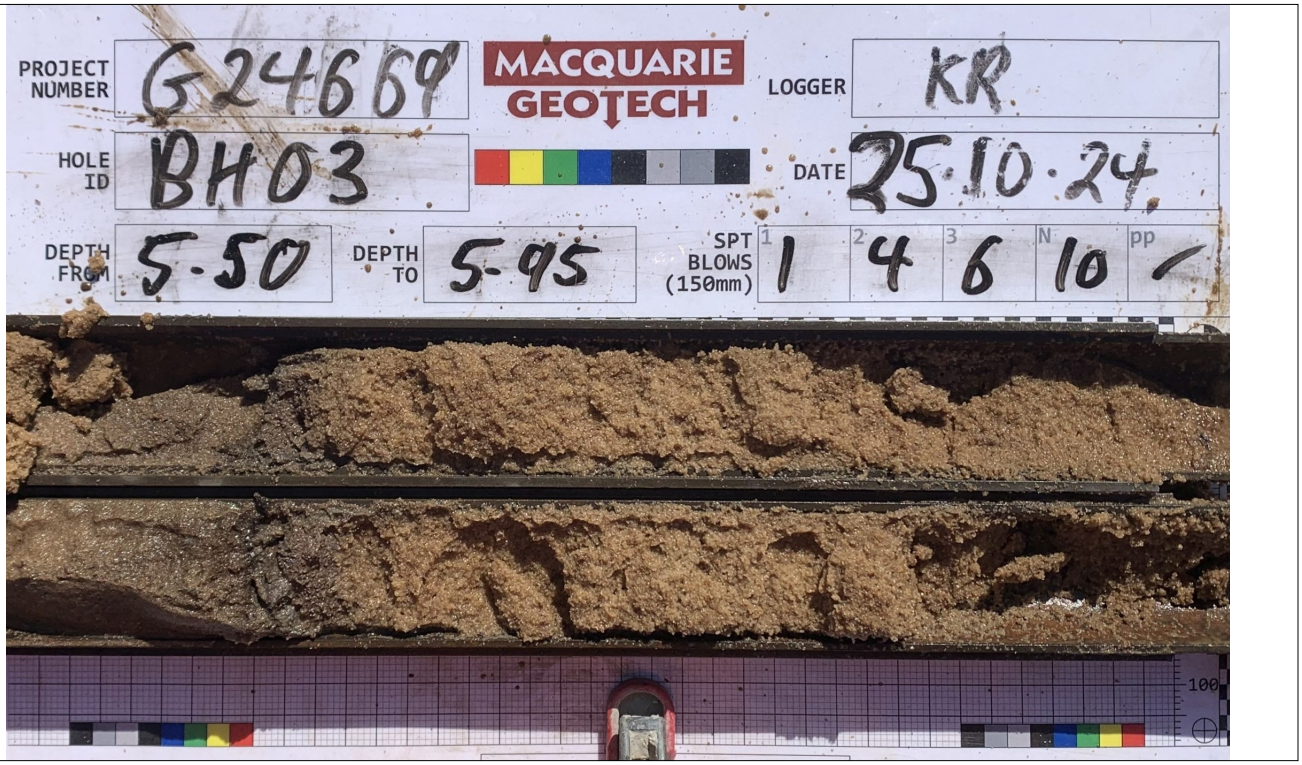
VERSION CONTROL
HOLE ID: BH03
PRODUCTION CODE: 2502241807
PAGE ID: BH03{GDMS[MPH]_001}

BH03_2.5-2.95



BH03_3.5-3.95

BH03_4.5-4.95



BH03_5.5-5.95

EXPLORATORY HOLE - GEOTECHNICAL LOG

ID: **BH04**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**
HOLE TYPE: **BH**
PROJECT LOCATION:
MacGeo PROJECT: **G24469**
CLIENT: **KBR**
PAGE: **1** of **1**

DATA QUALITY: REVISION: PRODUCTION CODE: **2502241754** SUITABILITY CODE:

POSITION: E: **335576.00** N: **6241229.00** **(MGA2020-56)** RL: **11.00** (AHD) DESIGN ELEMENT:

FIELD WORK: DATE: **24/10/24** LOGGED BY: **KR**

HOLE CONSTRUCTION: PLANT: **GEO305** DIP/AZIMUTH: **°/°** OPERATED BY: **IB**

METHOD	CASING	WATER OBS.	SAMPLE	DEPTH	INSITU TEST	ELEVATION / DEPTH	GRAPHIC LOG	INFERRED ORIGIN	GROUP SYMBOL	MATERIAL COMPOSITION	MOISTURE CONDITION	CONSIS. / REL. DENS.	DCP / VDEP	ADDITIONAL OBSERVATIONS
AD/T	140 mm	Free groundwater not observed	D NEB.LES	0.10		11.0 / 0.0		FIL	NA	0.00 FILL/GRAVEL with sand; grey-red; 0.10 GRAVEL is fine coarse, angular; sand is fine to coarse grained			1	0.10m: 10mm thick plastic sheeting
				0.50						FILL/SAND with gravel, trace silt; grey-brown black; SAND is fine to coarse grained; gravel is fine to coarse, sub-angular to angular			4 4 3 3 3	
			SPT JAW.THY D SOD.LAB		SPT: 5,5,11 N=16			FIL	NA		NA	NA	8 4 2	
				0.95 1.00		10.1.0							7 11	
			B LIT.BAT	1.40				ALV and AEO	SP	1.40 SAND trace silt; pale grey; SAND is fine to medium grained			7 10 9 8	
						9.02.0				Terminated at 1.41 m. Possible concrete obstruction .				
						8.03.0								
						7.04.0								
						6.05.0								
						5.06.0								
						4.07.0								

DCP 5 10 15 20 / 2 4 6 8 — VDEP

VERSION CONTROL
HOLE ID: BH04
PRODUCTION CODE: 2502241754
PAGE ID: BH04{GDMS[LOG]_001}

Remarks:

MACQUARIE GEOTECH

EXPLORATORY HOLE - SAMPLE PHOTOS

ID: **BH04**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

HOLE TYPE:

PROJECT LOCATION:

MacGeo PROJECT: **G24469**

CLIENT: **KBR**

PAGE: **1** of **1**

VERSION CONTROL
HOLE ID: BH04
PRODUCTION CODE: 2502241754
PAGE ID: BH04{GDMS[SMP]_001}

MACQUARIE GEOTECH

EXPLORATORY HOLE - GEOTECHNICAL LOG

ID: **BH04a**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

HOLE TYPE: **BH**

PROJECT LOCATION:

MacGeo PROJECT: **G24469**

CLIENT: **KBR**

PAGE: 1 of 1

DATA QUALITY: REVISION: PRODUCTION CODE: **2502241754** SUITABILITY CODE:

POSITION: E: **335574.00** N: **6241225.00** **(MGA2020-56)** RL: **10.00** (AHD) DESIGN ELEMENT:

FIELD WORK: DATE: **24/10/24** LOGGED BY: **KR**

HOLE CONSTRUCTION: PLANT: **GEO305** DIP/AZIMUTH: **°/°** OPERATED BY: **IB**

METHOD / CASING	WATER OBS.	SAMPLE	DEPTH	INSITU TEST	ELEVATION / DEPTH	GRAPHIC LOG	INFERRED ORIGIN	GROUP SYMBOL	MATERIAL COMPOSITION	MOISTURE CONDITION	CONSIS. / REL. DENS.	ADDITIONAL OBSERVATIONS
AD/T	▶	D JOG.RAM	0.10		10.0 / 0.0		FIL	NA	0.00 FILL/GRAVEL with sand; grey; GRAVEL is fine to coarse, angular to sub-angular; sand is fine to coarse grained	NA	NA	
			0.10				FIL	NA	FILL/SAND with gravel, with silt; grey brown; SAND is fine to coarse grained; gravel is fine to coarse, angular to subangular	NA	NA	
		SPT OUR.GAG	0.50	SPT: 3,7,18 N=25								
			0.95		9.01.0		FIL	NA	0.85 FILL/CONCRETE; grey red brown; aggregate up to 15mm; aggregate up to 15mm	NA	NA	
			1.00									
		D SAC.KIN	1.50						1.50 SAND trace silt, trace gravel; pale grey; SAND is fine to medium grained; gravel is fine			
		SPT PAP.AID		SPT: 4,6,8 N=14								
		B IGG.WET	1.95		8.02.0		ALV and AEO	SP	*2.50-2.95: trace pockets of black silt*	M	L-MD	
			2.50									
		SPT WEE.WET		SPT: 3,4,6 N=10								
			2.95		7.03.0							
			3.00									
		D NAY.LEG	3.50						3.50 SAND trace silt; grey; SAND is fine to medium grained			
		SPT SAW.CAT		SPT: 4,5,6 N=11			ALV and AEO	SP	*3.50-3.95: trace gravel subangular fine to medium.*	M	MD	
			3.95		6.04.0							
			4.00				ALV	CI	4.00 Sandy Silty CLAY; black; CLAY is medium plasticity; Sand is fine to medium grained; Hydrocarbon Odour	w<PL	S-F	
		B PSI.DIS	4.50						4.50 Silty SAND; grey dark grey; SAND is fine to medium grained			
		U HIS.CUB										
			4.90						*4.90-5.00: oily sheen observed on the SPT sample.*			
		SPT DOE.COS	5.00	SPT: 3,5,7 N=12	5.05.0		ALV and AEO	SM		M-W	MD	
			5.35									
		B PUT.NOW										
			6.00		4.06.0				Terminated at 6.00 m. Criteria Satisfied.			
					3.07.0							

VERSION CONTROL
HOLE ID: BH04a
PRODUCTION CODE: 2502241754
PAGE ID: BH04a{GDMS[LOG]_001}

Remarks:

MACQUARIE GEOTECH

EXPLORATORY HOLE - SAMPLE PHOTOS

ID: **BH04a**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

HOLE TYPE:

PROJECT LOCATION:

MacGeo PROJECT: **G24469**

CLIENT: **KBR**

PAGE: **1** of **1**

VERSION CONTROL

HOLE ID: BH04a

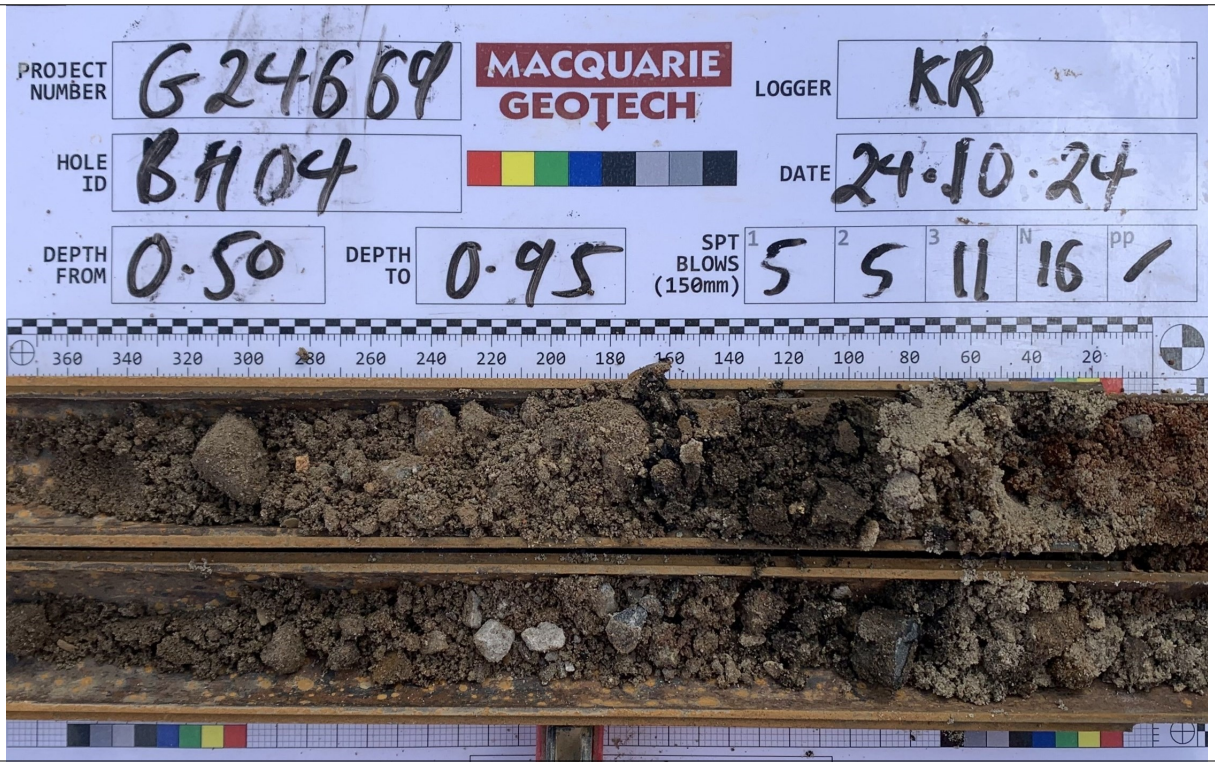
PRODUCTION CODE: 2502241754

PAGE ID: BH04a{GDMS[SMP]_001}

EXPLORATORY HOLE - MISCELLANEOUS PHOTOS ID: BH04

PROJECT NAME: Matraville Chlorine Liquefaction Plant
PROJECT LOCATION:
CLIENT: KBR

HOLE TYPE:
MacGeo PROJECT: G24469
PAGE: 1 of 1



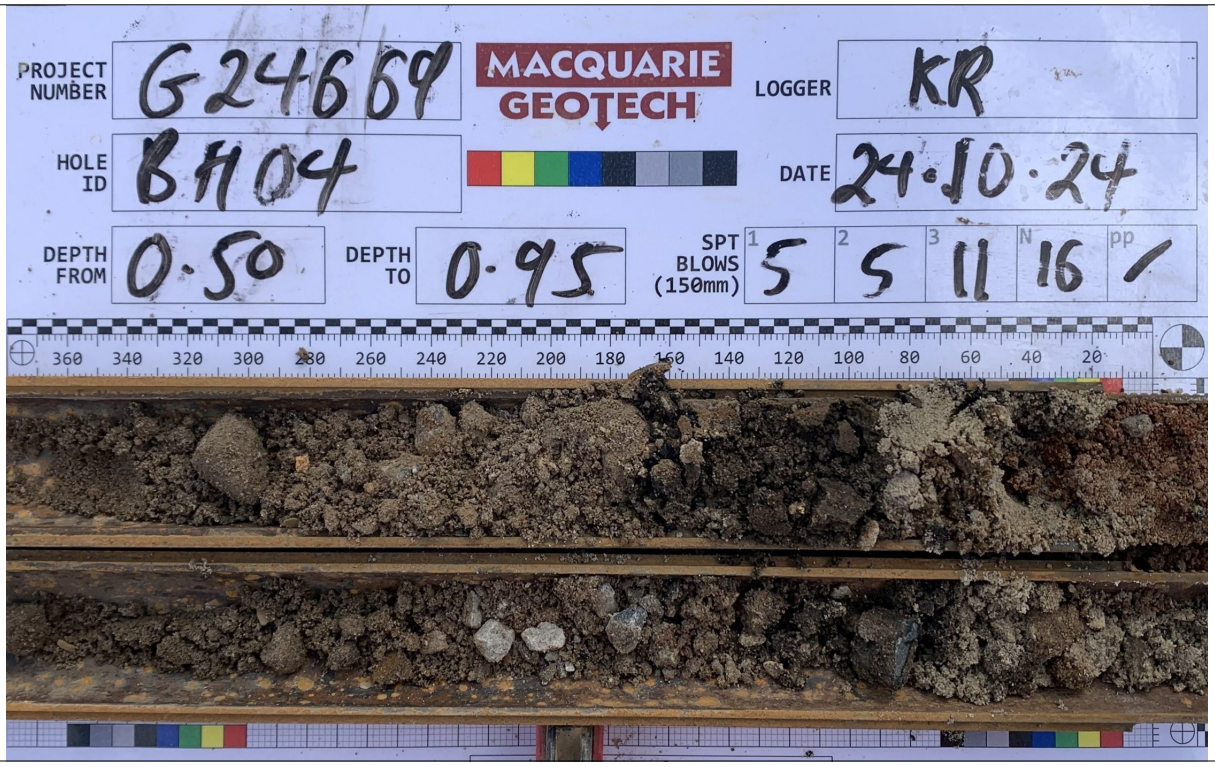
BH04_0.5-0.95

VERSION CONTROL
HOLE ID: BH04
PRODUCTION CODE: 2502241807
PAGE ID: BH04{GDMS[MPH]_001}

EXPLORATORY HOLE - MISCELLANEOUS PHOTOS ID: BH04a

PROJECT NAME: Matraville Chlorine Liquefaction Plant
PROJECT LOCATION:
CLIENT: KBR

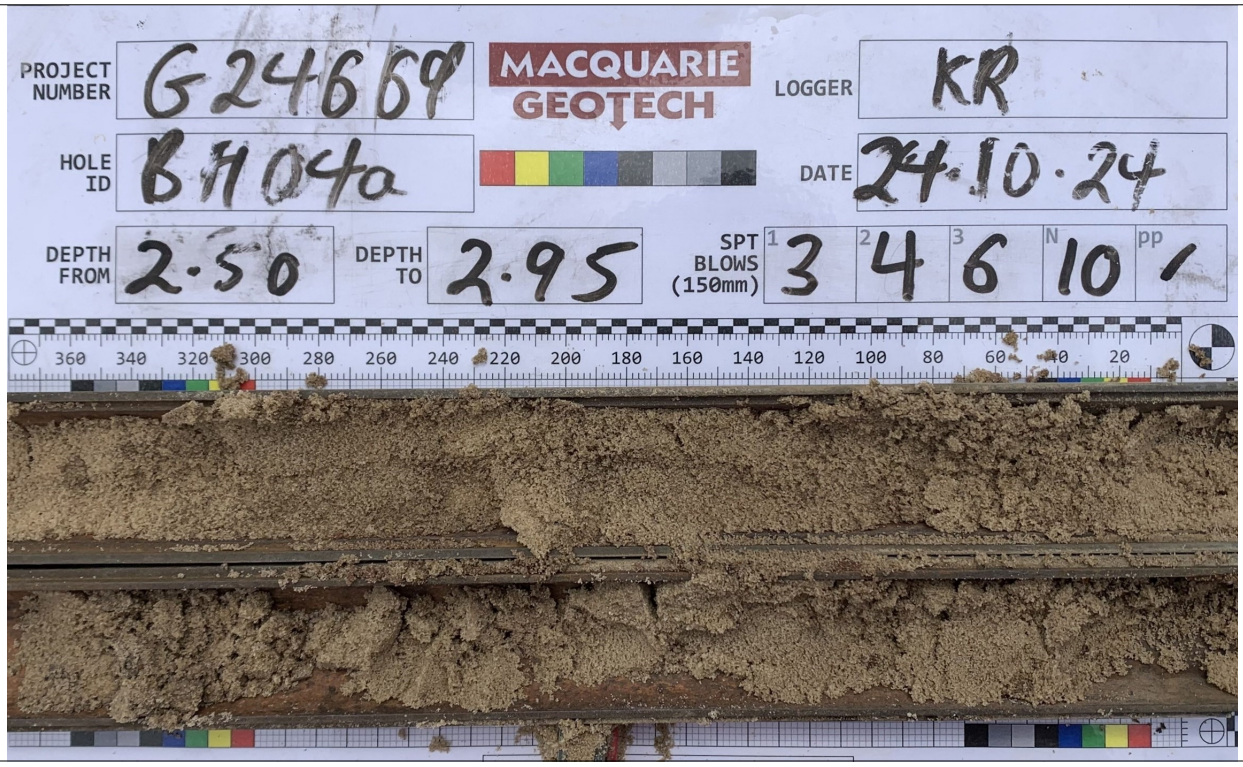
HOLE TYPE:
MacGeo PROJECT: G24469



BH04a_0.5-0.95

BH04a_1.5-1.95

VERSION CONTROL
HOLE ID: BH04a
PRODUCTION CODE: 2502241807
PAGE ID: BH04a{GDMS[MPH]_001}



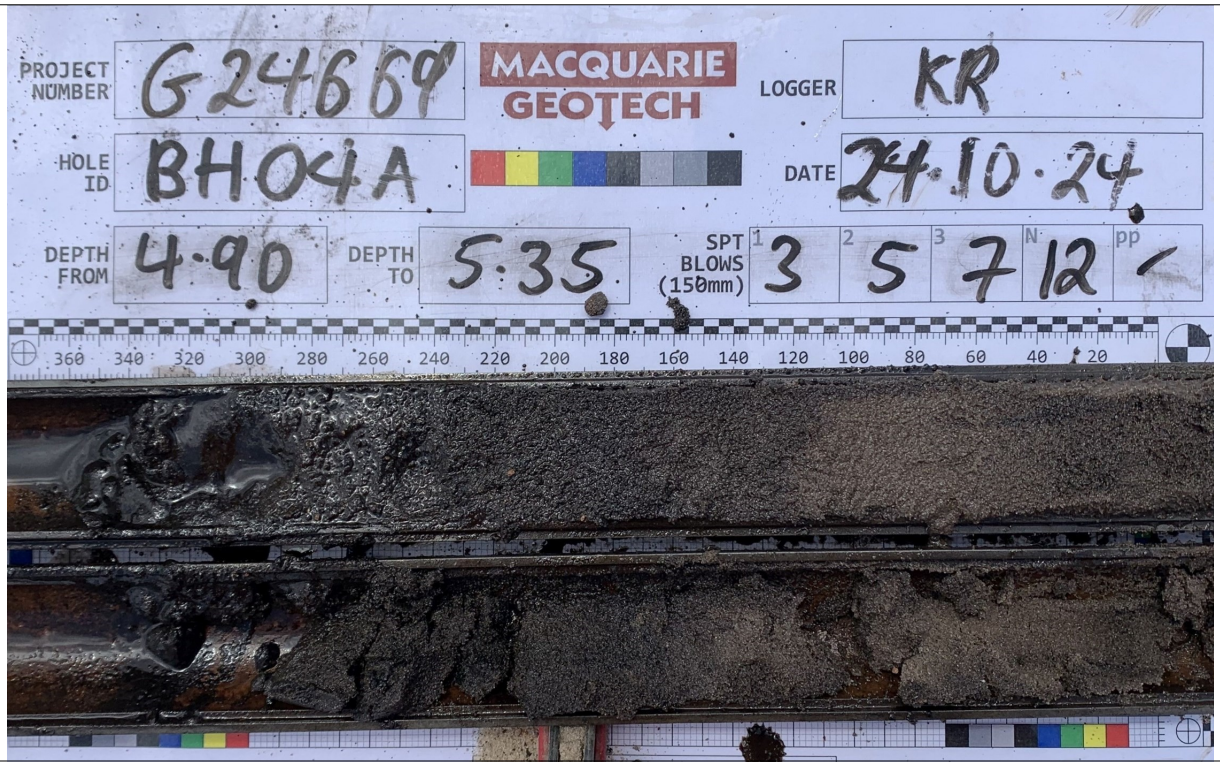
BH04a_2.5-2.95

BH04a_3.5-3.95

EXPLORATORY HOLE - MISCELLANEOUS PHOTOS ID: BH04a

PROJECT NAME: Matraville Chlorine Liquefaction Plant
PROJECT LOCATION:
CLIENT: KBR

HOLE TYPE:
MacGeo PROJECT: G24469



BH04a_4.9-5.35

VERSION CONTROL
HOLE ID: BH04a
PRODUCTION CODE: 2502241807
PAGE ID: BH04a{GDMS[MPH]_003}

EXPLORATORY HOLE - GEOTECHNICAL LOG

ID: **BH05**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**
HOLE TYPE: **BH**
PROJECT LOCATION:
MacGeo PROJECT: **G24469**
CLIENT: **KBR**
PAGE: **1** of **1**

DATA QUALITY: REVISION: PRODUCTION CODE: **2502241754** SUITABILITY CODE:

POSITION: E: **335535.00** N: **6241314.00** **(MGA2020-56)** RL: **9.00** (AHD) DESIGN ELEMENT:

FIELD WORK: DATE: **25/10/24** LOGGED BY: **KR**

HOLE CONSTRUCTION: PLANT: **GEO305** DIP/AZIMUTH: **°/°** OPERATED BY: **IB**

METHOD	CASING	WATER OBS.	SAMPLE	DEPTH	INSITU TEST	ELEVATION / DEPTH	GRAPHIC LOG	INFERRED ORIGIN	GROUP SYMBOL	MATERIAL COMPOSITION	MOISTURE CONDITION	CONSIS. / REL. DENS.	DCP / VDEP	ADDITIONAL OBSERVATIONS
AD/T		Free groundwater not observed				9.0 0.0		FIL	NA	0.00 FILL/Sandy GRAVEL with silt; grey; GRAVEL is fine to coarse, angular to sub-angular; Sand is fine to coarse grained.	NA	NA	25 25	
										Terminated at 0.40 m. Concrete Obstruction.				
						8.01.0								
						7.02.0								
						6.03.0								
						5.04.0								
						4.05.0								
						3.06.0								
						2.07.0								

DCP 5 10 15 20
VDEP 2 4 6 8

Remarks:

VERSION CONTROL
HOLE ID: BH05
PRODUCTION CODE: 2502241754
PAGE ID: BH05{GDMS[LOG]_001}

MACQUARIE GEOTECH

EXPLORATORY HOLE - SAMPLE PHOTOS

ID: **BH05**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

PROJECT LOCATION:

CLIENT: **KBR**

HOLE TYPE:

MacGeo PROJECT: **G24469**

PAGE: **1** of **1**

VERSION CONTROL

HOLE ID: BH05

PRODUCTION CODE: 2502241754

PAGE ID: BH05{GDMS[SMP]_001}

MACQUARIE GEOTECH

EXPLORATORY HOLE - GEOTECHNICAL LOG

ID: **BH05a**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

HOLE TYPE: **BH**

PROJECT LOCATION:

MacGeo PROJECT: **G24469**

CLIENT: **KBR**

PAGE: **1** of **1**

DATA QUALITY: REVISION: PRODUCTION CODE: **2502241754** SUITABILITY CODE:

POSITION: E: **335534.00** N: **6241313.00** **(MGA2020-56)** RL: **9.00** (AHD) DESIGN ELEMENT:

FIELD WORK: DATE: **25/10/24** LOGGED BY: **KR**

HOLE CONSTRUCTION: PLANT: **GEO305** DIP/AZIMUTH: **°/°** OPERATED BY: **IB**

METHOD	CASING	WATER OBS.	SAMPLE	DEPTH	INSITU TEST	ELEVATION	DEPTH	GRAPHIC LOG	INFERRED ORIGIN	GROUP SYMBOL	MATERIAL COMPOSITION	MOISTURE CONDITION	CONSIS. / REL. DENS.	ADDITIONAL OBSERVATIONS
AD/T		Free groundwater not observed				9.0	0.0		FIL	NA	0.00 FILL/Sandy GRAVEL with silt; grey; GRAVEL is fine to coarse, angular to sub-angular; Sand is fine to coarse grained	NA	NA	
											Terminated at 0.40 m. Concrete Obstruction .			
							8.0							
							1.0							
							7.0							
							2.0							
							6.0							
							3.0							
							5.0							
							4.0							
							5.0							
							4.0							
							3.0							
							6.0							
							2.0							
							7.0							

VERSION CONTROL
HOLE ID: BH05a
PRODUCTION CODE: 2502241754
PAGE ID: BH05a{GDMS[LOG]_001}

Remarks:

MACQUARIE GEOTECH

EXPLORATORY HOLE - SAMPLE PHOTOS

ID: **BH05a**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

HOLE TYPE:

PROJECT LOCATION:

MacGeo PROJECT: **G24469**

CLIENT: **KBR**

PAGE: **1** of **1**

VERSION CONTROL
HOLE ID: BH05a
PRODUCTION CODE: 2502241754
PAGE ID: BH05a{GDMS[SMP]_001}

MACQUARIE GEOTECH

EXPLORATORY HOLE - GEOTECHNICAL LOG

ID: **BH05b**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

HOLE TYPE: **BH**

PROJECT LOCATION:

MacGeo PROJECT: **G24469**

CLIENT: **KBR**

PAGE: **1** of **1**

DATA QUALITY: REVISION: PRODUCTION CODE: **2502241754** SUITABILITY CODE:

POSITION: E: **335534.00** N: **6241315.00** **(MGA2020-56)** RL: **9.00** (AHD) DESIGN ELEMENT:

FIELD WORK: DATE: **25/10/24** LOGGED BY: **KR**

HOLE CONSTRUCTION: PLANT: **GEO305** DIP/AZIMUTH: **°/°** OPERATED BY: **IB**

METHOD / CASING	WATER OBS.	SAMPLE	DEPTH	INSITU TEST	ELEVATION / DEPTH	GRAPHIC LOG	INFERRED ORIGIN	GROUP SYMBOL	MATERIAL COMPOSITION	MOISTURE CONDITION	CONSIS. / REL. DENS.	ADDITIONAL OBSERVATIONS
AD/T	Free groundwater not observed		0.50 0.51	SPT: 30/5 mm HB N=R	9.0 0.0		FIL		0.00 FILL/Sandy GRAVEL; dark grey.; GRAVEL is fine to coarse, sub-angular to angular; Sand is fine to coarse grained. Terminated at 0.51 m. Concrete Obstruction .	NA	NA	

8.01.0

7.02.0

6.03.0

5.04.0

4.05.0

3.06.0

2.07.0

VERSION CONTROL
HOLE ID: BH05b
PRODUCTION CODE: 2502241754
PAGE ID: BH05b{GDMS[LOG]_001}

Remarks:

MACQUARIE GEOTECH

EXPLORATORY HOLE - SAMPLE PHOTOS

ID: **BH05b**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

HOLE TYPE:

PROJECT LOCATION:

MacGeo PROJECT: **G24469**

CLIENT: **KBR**

PAGE: **1** of **1**

VERSION CONTROL
HOLE ID: BH05b
PRODUCTION CODE: 2502241754
PAGE ID: BH05b{GDMS[SMP]_001}

MACQUARIE GEOTECH

EXPLORATORY HOLE - GEOTECHNICAL LOG

ID: **BH05c**

PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

HOLE TYPE: **BH**

PROJECT LOCATION:

MacGeo PROJECT: **G24469**

CLIENT: **KBR**

PAGE: **1** of **1**

DATA QUALITY: REVISION: PRODUCTION CODE: **2502241754** SUITABILITY CODE:

POSITION: E: **335532.00** N: **6241314.00** **(MGA2020-56)** RL: **9.00** (AHD) DESIGN ELEMENT:

FIELD WORK: DATE: **06/11/24** LOGGED BY: **KR**

HOLE CONSTRUCTION: PLANT: **Drill Techniques Truck Rig/ Concrete Coring** DIP/AZIMUTH: **°/°** OPERATED BY: **TK/GW**

METHOD	CASING	WATER OBS.	SAMPLE	DEPTH	INSITU TEST	ELEVATION	DEPTH	GRAPHIC LOG	INFERRED ORIGIN	GROUP SYMBOL	MATERIAL COMPOSITION	MOISTURE CONDITION	CONSIS. / REL. DENS.	ADDITIONAL OBSERVATIONS
AD/T			B WIS.RAN	0.00		9.0	0.0		FIL	NA	0.00 FILL/Sandy GRAVEL trace silt; grey;	NA	NA	
				0.30					FIL	NA	0.10 GRAVEL is fine to coarse, angular to sub-angular; Sand is fine to coarse grained.	NA	NA	
DT									NA	NA	0.30 FILL/Gravelly SAND trace clay; dark grey; SAND is fine to coarse grained; Gravel is angular to sub angular, fine to coarse grained.	NA	NA	
				0.70					FIL	NA	0.68	NA	NA	
			SPT COL.PIN	1.00	SPT: 2,4,6 N=10	8.01.0					0.78 CONCRETE; grey; Aggregate up to 20mm *0.40: rebar (<5mm)* *0.60: rebar (<5mm)*			
				1.15							FILL/SAND trace silt, trace gravel; grey; SAND is fine to medium grained; gravel is angular to sub angular fine to coarse grained			
			B AHA.ROT						ALV and AEO	SP	SAND trace silt, trace gravel; grey; SAND is fine to medium grained; gravel is fine to medium; trace vegetation	D	MD	
			SPT INN.SPY	2.00	SPT: 4,6,8 N=14	7.02.0								
			B TOD.ORB	2.45							*2.30-2.70: trace becoming with pockets of black silt*			
				2.70										
			B RIP.BAY	3.00		6.03.0			ALV and AEO	SC	2.70 SAND with silt, trace gravel; black grey; SAND is fine to medium grained; gravel is fine to medium; Hydrocarbon odour	M-W	VL	
			SPT GET.LAM		SPT: HW/150 mm, 1,0,2 N=2									
			B LIB.DEN	3.45										
				3.50										
			SPT SPY.JUG	3.95										
				4.00		5.04.0			ALV and AEO	SM	3.70 Silty SAND; grey black; SAND is fine to medium grained; Hydrocarbon odour	W	L-MD	
			B VOW.BIS											
			SPT BOB.BAT	5.00	SPT: 6,14,26 N=40	4.05.0			ALV and AEO	SP	5.00 SAND trace silt; grey; SAND is fine to coarse grained; trace lenses of black silt	W	MD-D	
			B TUB.SOY	5.45										
			SPT CUB.MEG	6.00	SPT: 9,10,15 N=25	3.06.0								
				6.45							Terminated at 6.45 m. Criteria Satisfied.			
						2.07.0								

Remarks:

VERSION CONTROL
HOLE ID: BH05c
PRODUCTION CODE: 2502241754
PAGE ID: BH05c{GDMS[LOG]_001}

EXPLORATORY HOLE - SAMPLE PHOTOS

ID: **BH05c**

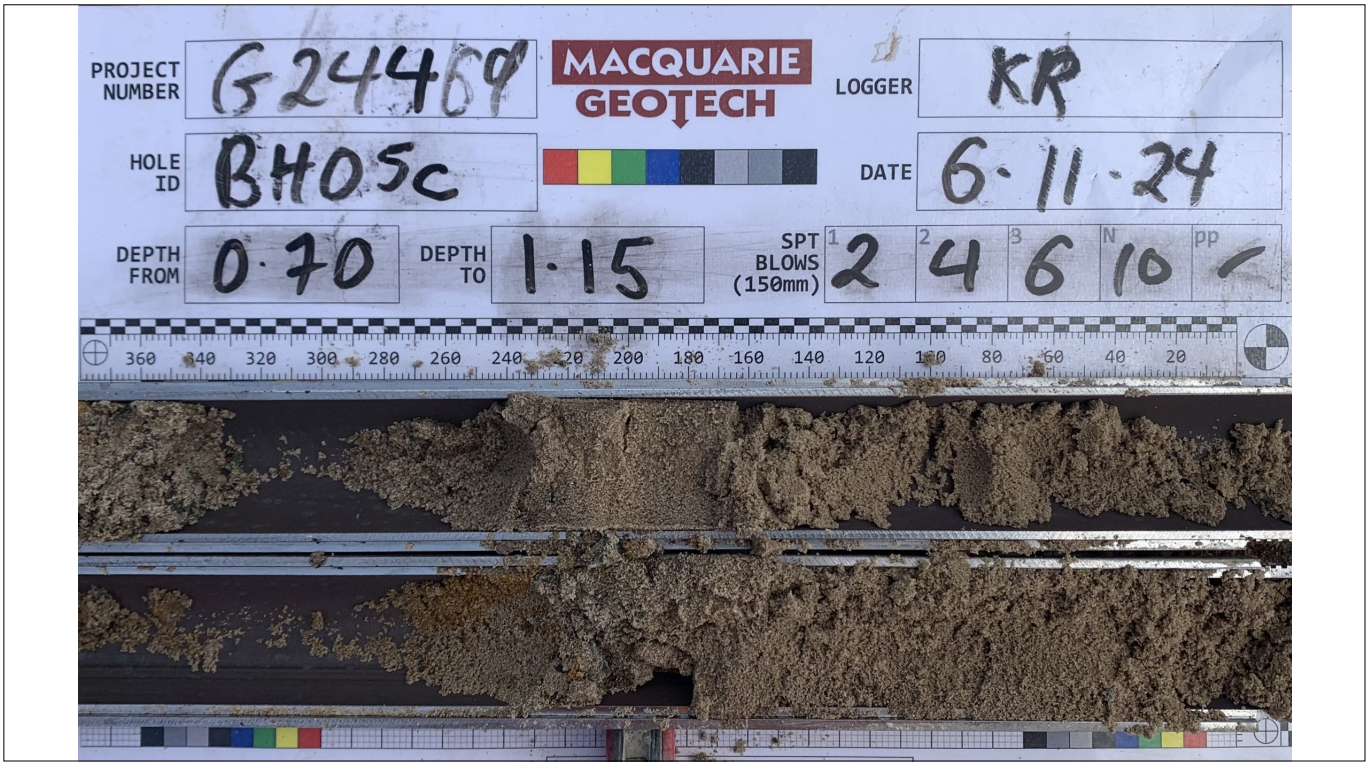
PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

HOLE TYPE:

PROJECT LOCATION:

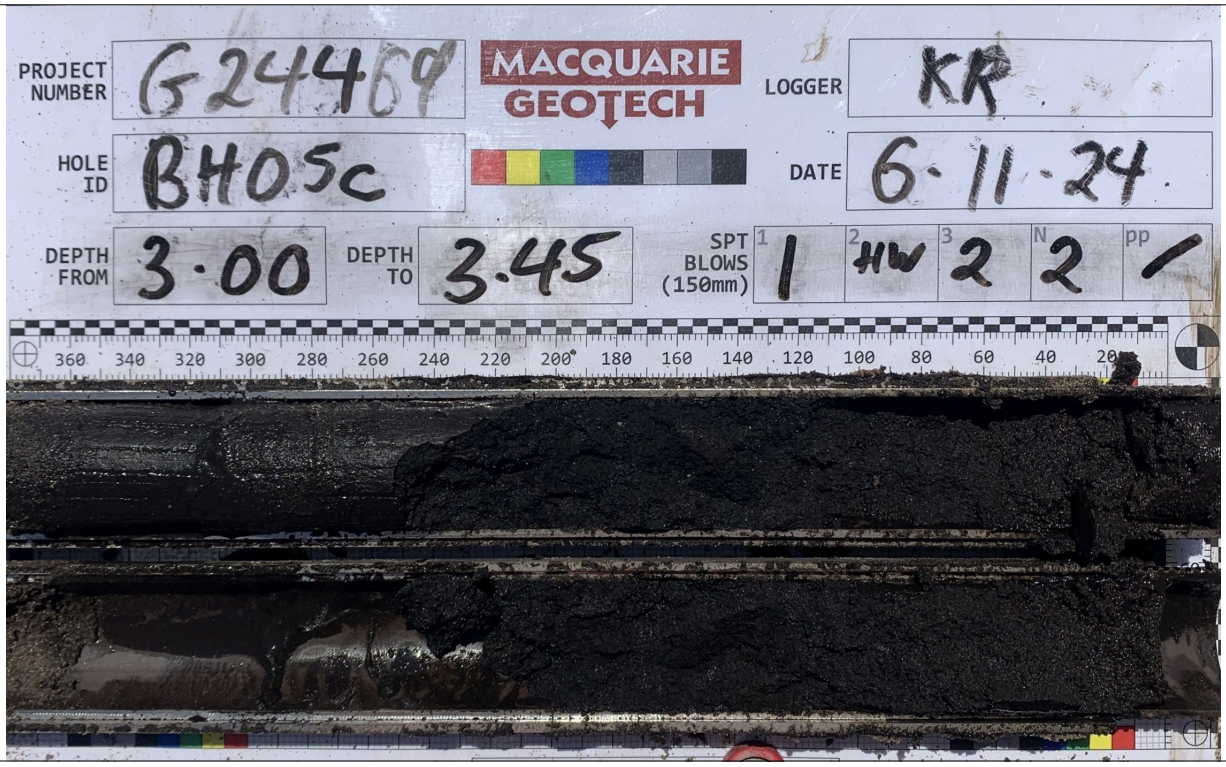
MacGeo PROJECT: **G24469**

CLIENT: **KBR**

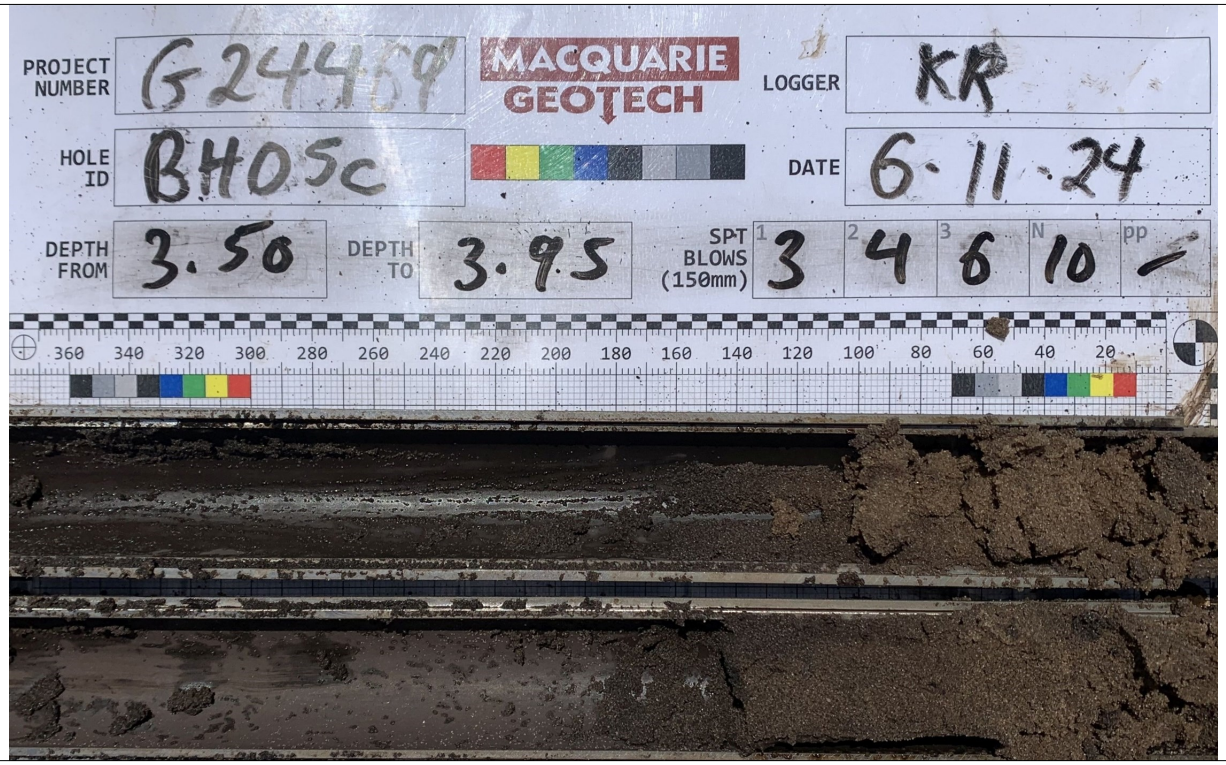


BH05c | 0.70-1.15 | Standard Penetration Test

BH05c | 2.00-2.45 | Standard Penetration Test



BH05c | 3.00-3.45 | Standard Penetration Test



BH05c | 3.50-3.95 | Standard Penetration Test

EXPLORATORY HOLE - SAMPLE PHOTOS

ID: **BH05c**

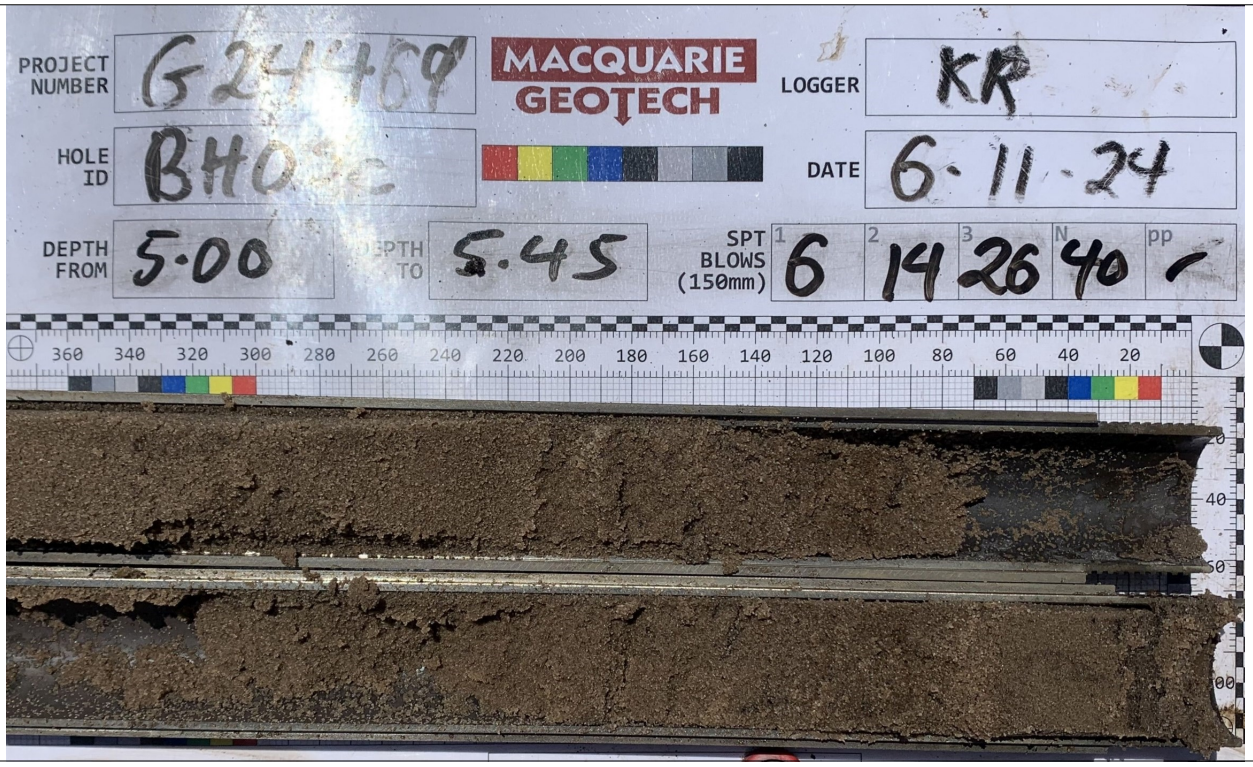
PROJECT NAME: **Matraville Chlorine Liquefaction Plant**

HOLE TYPE:

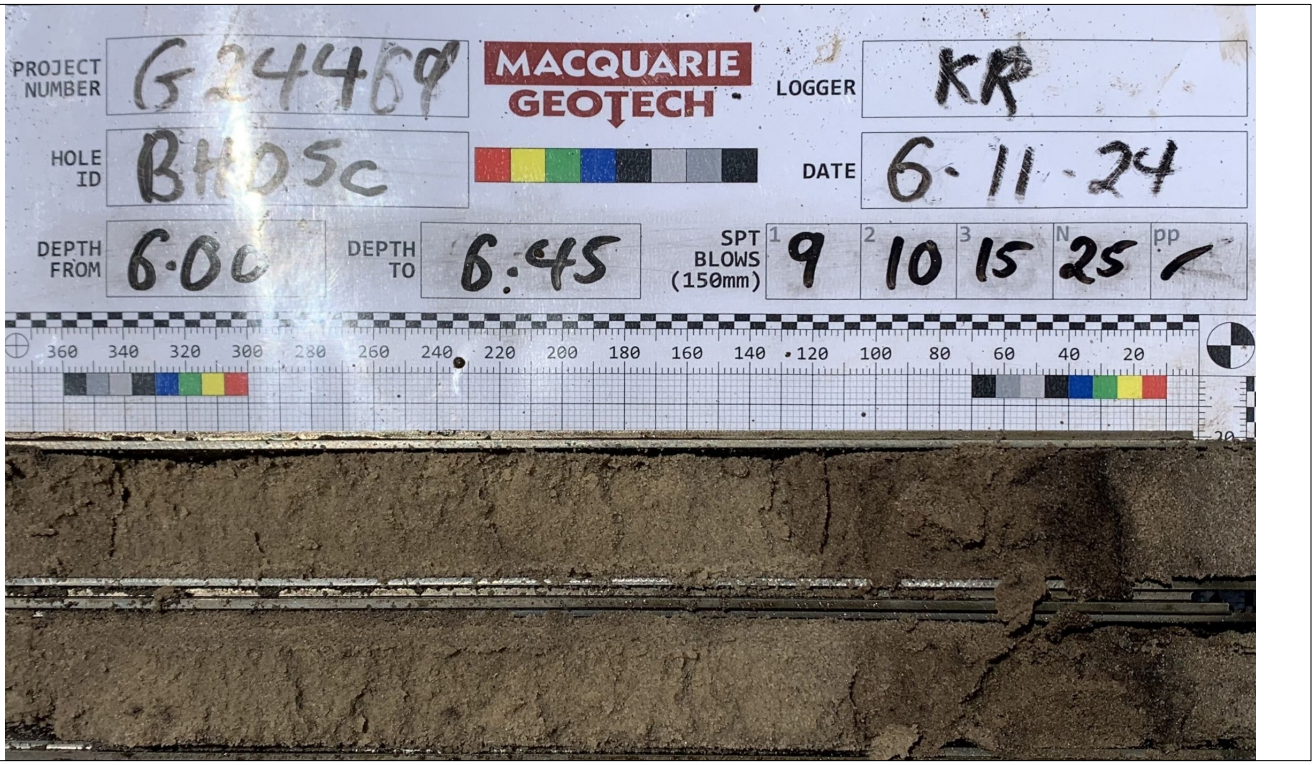
PROJECT LOCATION:

MacGeo PROJECT: **G24469**

CLIENT: **KBR**



BH05c | 5.00-5.45 | Standard Penetration Test



BH05c | 6.00-6.45 | Standard Penetration Test

Appendix D – Laboratoty Test Results

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 365939

Client Details

Client	Macquarie Geotech
Attention	Gavin Boyd, k routledge
Address	3 Watt Dr, Bathurst, NSW, 2795

Sample Details

Your Reference	**G24469**
Number of Samples	4 Soil
Date samples received	08/11/2024
Date completed instructions received	08/11/2024

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	15/11/2024
Date of Issue	15/11/2024

NATA Accreditation Number 2901. This document shall not be reproduced except in full.

Accredited for compliance with ISO/IEC 17025 - Testing. **Tests not covered by NATA are denoted with ***

Results Approved By
Diego Bigolin, Inorganics Supervisor

Authorised By
Nancy Zhang, Laboratory Manager

Misc Inorg - Soil					
Our Reference		365939-1	365939-2	365939-3	365939-4
Your Reference	UNITS	BH03 COX.TOT	BH04a JOG>RAM	BH05c COL.PIN	BH05c TOD.ORB
Depth		1.50-0.95	0.10-0.50	0.70-1.15	2.70-3.00
Date Sampled		24/10/2024	24/10/2024	06/11/2024	06/11/2024
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	13/11/2024	13/11/2024	13/11/2024	12/11/2024
Date analysed	-	13/11/2024	13/11/2024	13/11/2024	12/11/2024
pH 1:5 soil:water	pH Units	9.0	8.7	8.4	[NA]
Electrical Conductivity 1:5 soil:water	µS/cm	76	86	190	[NA]
Chloride, Cl 1:5 soil:water	mg/kg	20	<10	210	[NA]
Sulphate, SO4 1:5 soil:water	mg/kg	10	30	20	[NA]
Total Organic Matter in soil/solids	mg/kg	[NA]	[NA]	[NA]	36,000

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.
INORG-137	Total Carbon Nitrogen Sulfur by high temperature catalytic combustion with IR detection.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	365939-2
Date prepared	-			12/11/2024	1	13/11/2024	13/11/2024		12/11/2024	12/11/2024
Date analysed	-			12/11/2024	1	13/11/2024	13/11/2024		12/11/2024	12/11/2024
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	9.0	9.2	2	100	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	1	76	66	14	97	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	20	20	0	108	104
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	10	20	67	110	114
Total Organic Matter in soil/solids	mg/kg	1000	INORG-137	<1000	[NT]	[NT]	[NT]	[NT]	90	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

The recommended maximums for analytes in urine are taken from “2018 TLVs and BEIs”, as published by ACGIH (where available). Limit provided for Nickel is a precautionary guideline as per Position Paper prepared by AIOH Exposure Standards Committee, 2016.

Guideline limits for Rinse Water Quality reported as per analytical requirements and specifications of AS 4187, Amdt 2 2019, Table 7.2

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals (not SPOCAS); 60-140% for organics/SPOCAS (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Where matrix spike recoveries fall below the lower limit of the acceptance criteria (e.g. for non-labile or standard Organics <60%), positive result(s) in the parent sample will subsequently have a higher than typical estimated uncertainty (MU estimates supplied on request) and in these circumstances the sample result is likely biased significantly low.

Measurement Uncertainty estimates are available for most tests upon request.

Analysis of aqueous samples typically involves the extraction/digestion and/or analysis of the liquid phase only (i.e. NOT any settled sediment phase but inclusive of suspended particles if present), unless stipulated on the Envirolab COC and/or by correspondence. Notable exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, total recoverable metals and PFAS where solids are included by default.

Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

MISC_INORG_DRY: pH/EC
Samples 1 amd 2 were out of the recommended holding time for this analysis.

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
customerservice@envirolab.com.au
www.envirolab.com.au

CERTIFICATE OF ANALYSIS 366170

Client Details

Client	Macquarie Geotech
Attention	Gavin Boyd
Address	3 Watt Dr, Bathurst, NSW, 2795

Sample Details

Your Reference	**G24469**
Number of Samples	1 Soil
Date samples received	12/11/2024
Date completed instructions received	12/11/2024

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	19/11/2024
Date of Issue	15/11/2024

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Results Approved By
Nick Sarlamis, Assistant Operation Manager

Authorised By
Nancy Zhang, Laboratory Manager

Soil Aggressivity		
Our Reference		366170-1
Your Reference	UNITS	BH01 DIG.JAY
Depth		0.15-0.50
Date Sampled		25/10/2024
Type of sample		Soil
Date prepared	-	14/11/2024
Date analysed	-	14/11/2024
pH 1:5 soil:water	pH Units	8.2
Electrical Conductivity 1:5 soil:water	µS/cm	45
Chloride, Cl 1:5 soil:water	mg/kg	<10
Sulphate, SO4 1:5 soil:water	mg/kg	21

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA latest edition, 4110-B. Waters samples are filtered on receipt prior to analysis. Alternatively determined by colourimetry/turbidity using Discrete Analyser.

QUALITY CONTROL: Soil Aggressivity						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			13/11/2024	[NT]	[NT]	[NT]	[NT]	13/11/2024	[NT]
Date analysed	-			13/11/2024	[NT]	[NT]	[NT]	[NT]	13/11/2024	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	[NT]	[NT]	[NT]	[NT]	100	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	[NT]	[NT]	98	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	108	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	[NT]	[NT]	[NT]	[NT]	111	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
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Samples for Microbiological analysis (not Amoeba forms) received outside of the 2-8°C temperature range do not meet the ideal cooling conditions as stated in AS2031-2012.

Report Comments

pH analysed outside holding time.

Shear Strength by Direct Shear Report

Client	KBR	**Source**	TAM.REM BH01 0.50-1.00 + WAY.JOY BH01 1.00-1.50m + PAD.SHE BH01 1.50-2.20m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT, 2609	**Sample Description**	Silty SAND
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101423-DS
Job No	S24581-1	**Lab No**	S101423

Test Procedure	AS1289 6.2.2 Soil strength and consolidation tests - Determination of the shear strength of a soil - Direct shear test using a shear box		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	24-25/10/2024
Preparation	Prepared in accordance with the test method	**Date Tested**	20/11/2024

Test Details						
Remoulding Details	100% Standard Compaction @ 100% Optimum Moisture Content					
Size of Shear Box (mm)	100mm Square					
Test Parameter	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**	**Stage 5**	**Stage 6**
Specimen Dimensions (mm)	99.98 x 100.03	99.98 x 100.03	99.98 x 100.03	-	-	-
Rate of Strain (mm/min)	0.05	0.05	0.05	-	-	-
Placement Moisture Content (%)	14.3	14.3	14.3	-	-	-
Placement Wet Density (t/m^3)	1.90	1.90	1.90	-	-	-
Placement Dry Density (t/m^3)	1.66	1.66	1.66	-	-	-
Peak Values						
Normal Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Shear Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Normal Stress at Peak Shear Stress (kPa)	50.0	100.0	200.0	-	-	-
Peak Shear Stress (kPa)	27.6	74.8	129.6	-	-	-
Normal Stress at Ultimate Shear Stress (kPa)	50.0	100.0	200.0	-	-	-
Shear Stress at Ultimate Shear Stress (kPa)	27.8	75.9	129.9	-	-	-
Residual Values						
Normal Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Shear Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Normal Stress at Peak Shear Stress (kPa)	-	-	-	-	-	-
Peak Shear Stress (kPa)	-	-	-	-	-	-
Normal Stress at Ultimate Shear Stress (kPa)	-	-	-	-	-	-
Shear Stress at Ultimate Shear Stress (kPa)	-	-	-	-	-	-

Failure Envelopes			
		Peak Values	**Residual Values**
At Displacement	Friction Angle (°)	**-**	**-**
	Cohesion (kPa)	**-**	**-**
	Correlation	**-**	**-**
Peak Shear Stress	Friction Angle (°)	**33.5**	**-**
	Cohesion (kPa)	**0.2**	**-**
	Correlation	**0.9892**	**-**
Ultimate Shear Stress	Friction Angle (°)	**33.4**	**-**
	Cohesion (kPa)	**0.8**	**-**
	Correlation	**0.9878**	**-**

Notes

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Authorised Signatory: Chris Lloyd

Date: 22/11/2024

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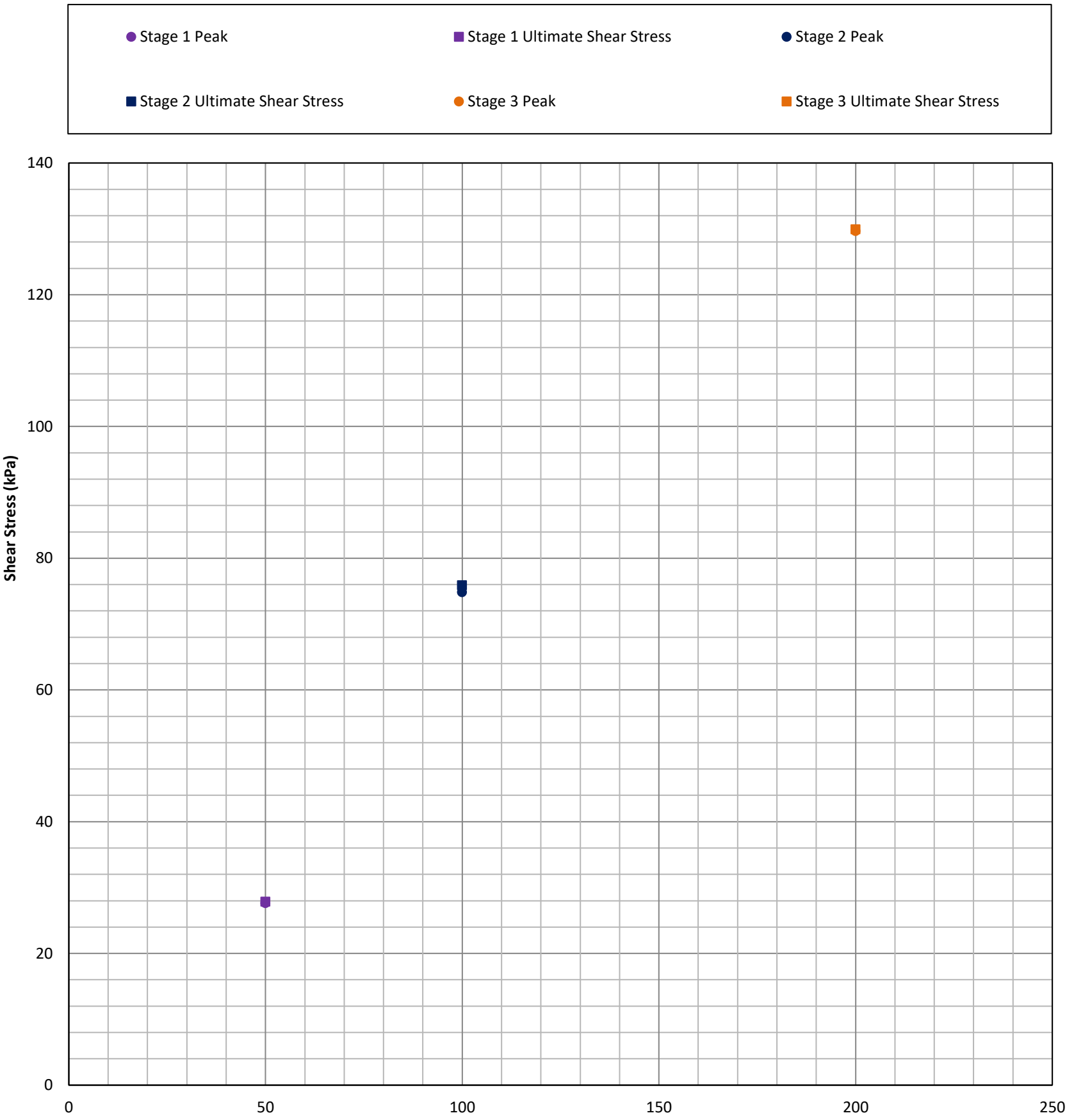
14 Carter St
Lidcombe NSW 2141

Shear Strength by Direct Shear Report

Client	KBR	**Report No**	S101423-DS

Peak Shear Stress / Normal Stress



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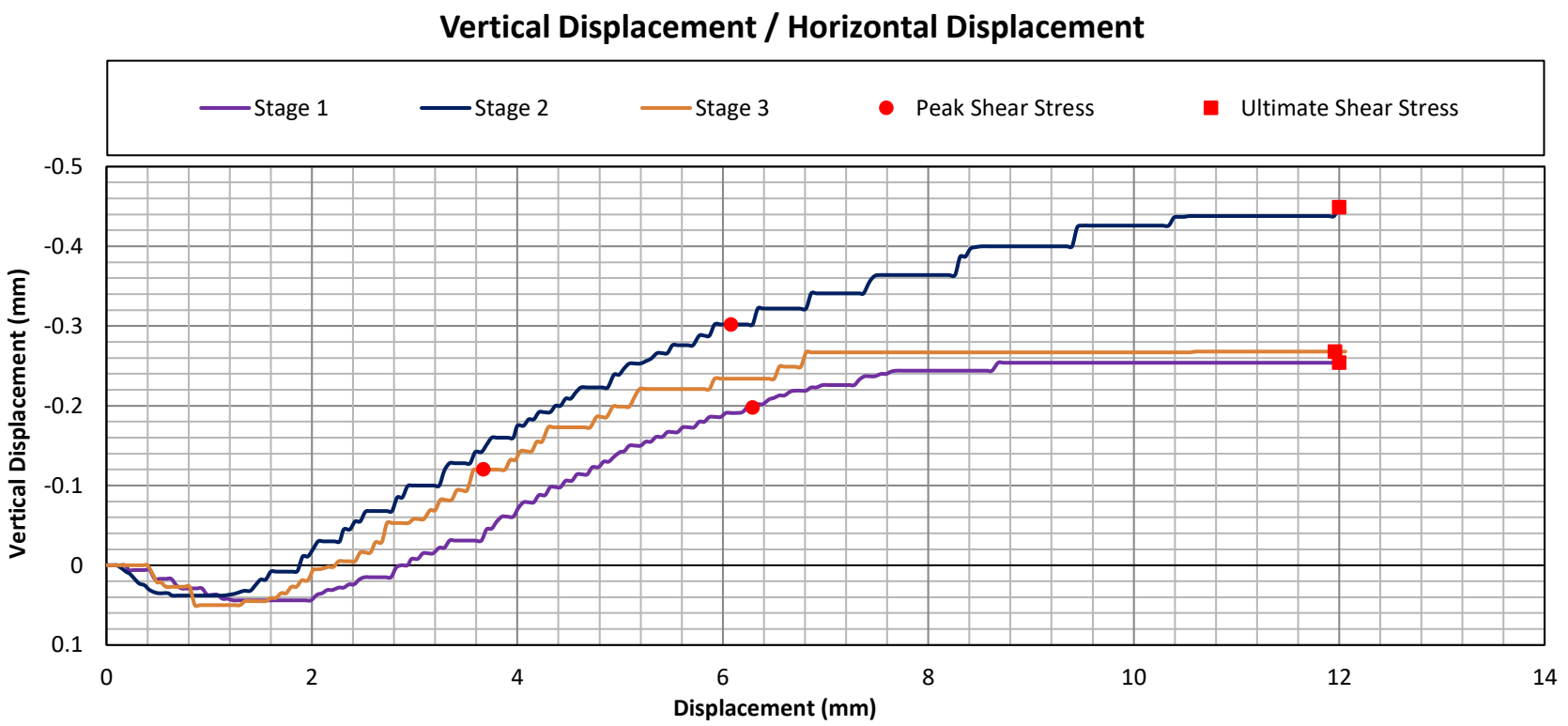
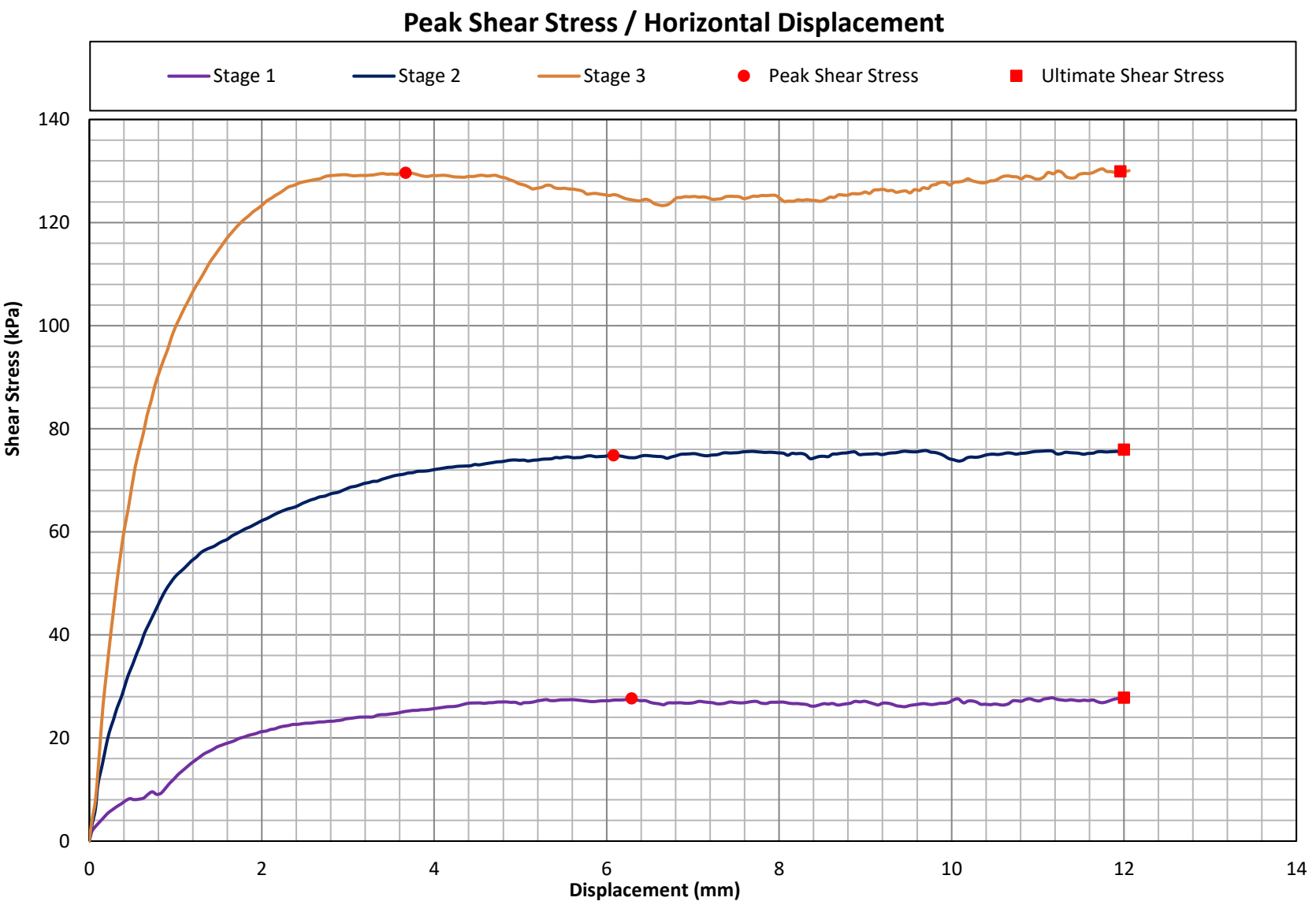
Shear Strength by Direct Shear Report

Client	KBR	**Report No**	S101423-DS





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MOISTURE CONTENT TEST REPORT

Client	KBR	**Job #**	S24581-1
Address	Level 4, 11 Lancaster Place, Majura Park, ACT, 2609	**Report #**	S101423-MC
Project	G24469 - Matraville Chlorine Liquefaction Plant		

Test Procedure

- ☑ AS 1289 2.1.1 Determination of the moisture content of a soil - Oven drying method (Standard method).
- ☐ AS4133 1.1.1 Determination of the moisture content of rock - Oven drying method (standard method)
- ☐ RMS T120 Moisture content of road construction materials (Standard method)
- ☐ RMS T262 Determination of moisture content of aggregates (Standard method)

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 24-25/10/2024

Preparation Prepared in accordance with the test method **Date Tested** 14/11/2024

Sample #	Source	Sample Description	Moisture Content %
S101423	TAM.REM BH01 0.50-1.00 + WAY.JOY BH01 1.00-1.50m + PAD.SHE BH01 1.50-2.20m	SAND	**4.3**
S101424	OWE.PAP BH01 4.60-5.50m	SAND	**9.6**
S101427	WAX.MET BH02 3.75-4.00m + EGG.OLD BH02 4.00-4.50m	SAND with Silt, trace of Gravel	**17.7**
S101431	PSI.DIS BH04a 4.00-4.50m	SAND with Clay, trace of Gravel	**29.6**
S101435	TOD.ORB BH05c 2.00-2.70m	SAND trace of Silt and Gravel	**14.0**

Notes

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Authorised Signatory:

Jacob Lloyd

2/12/2024

Date:

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DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

Client	KBR	**Source**	TAM.REM BH01 0.50-1.00 + WAY.JOY BH01 1.00-1.50m + PAD.SHE BH01 1.50-2.20m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT, 2609	**Sample Description**	SAND
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101423-MDD
Job No	S24581-1	**Sample No**	S101423

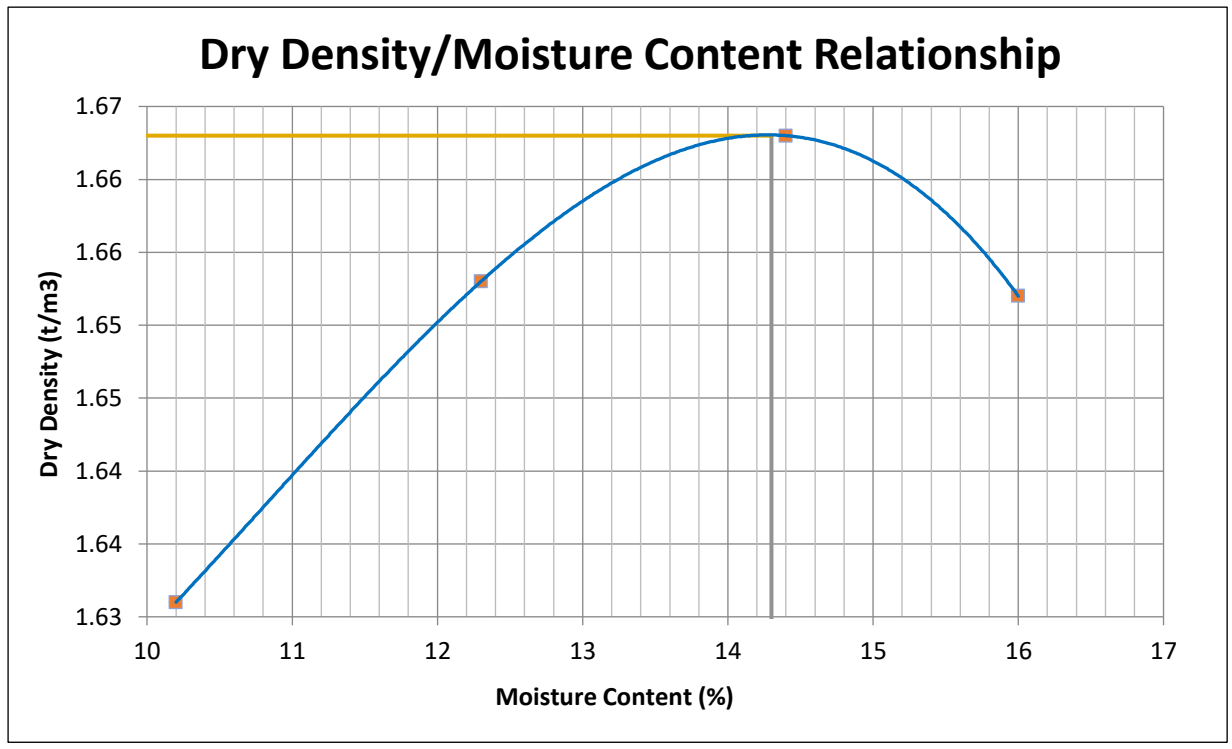
Test Procedure

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 24-25/10/2024

Preparation Prepared in accordance with the test method **Date Tested** 15/11/2024



Maximum Dry Density (t/m^3)	1.66
Optimum Moisture Content (%)	14.3
Oversize Retained on 19mm sieve (%)	0
Oversize Retained on 37.5mm sieve (%)	0
Curing Time	2 hrs
Liquid Limit Determination	Technician Assessment

Notes

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Chris Lloyd

22/11/2024

Date:

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14 Carter St
Lidcombe NSW 2141

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SOIL PARTICLE DENSITY REPORT

Client	KBR	**Source**	TAM.REM BH01 0.50-1.00 + WAY.JOY BH01 1.00-1.50m + PAD.SHE BH01 1.50-2.20m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT 2609	**Sample Description**	SAND
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report #**	S101423-SPD
Job #	S24581-1	**Lab #**	S101423

Test Procedure	☑ AS1289 3.5.1 (2006) Soil classification tests - Determination of the soil particle density of a soil - Standard method		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	24-25/10/2024
Preparation	Prepared in accordance with the test method	**Date Tested**	21/11/2024

Average Apparent Particle Density: Fraction Retained 2.36mm (g/cm^3)	*
Average Apparent Particle Density: Fraction Passing 2.36mm (g/cm^3)	**2.63**
Soil Particle Density: Total Soil Sample (g/cm^3)	*

** Value unable to be determined due to limited amount of sample.*

Notes

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Chris Lloyd

22/11/2024

Date:

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Shear Strength by Direct Shear Report

Client	KBR	**Source**	OWE.PAP BH01 4.60-5.50m + HAM. ASP BH01 5.50-6.00m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT. 2609	**Sample Description**	Silty SAND
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101425-DS
Job No	S24581-1	**Lab No**	S101425

Test Procedure	AS1289 6.2.2 Soil strength and consolidation tests - Determination of the shear strength of a soil - Direct shear test using a shear box		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	24-25/10/2024
Preparation	Prepared in accordance with the test method	**Date Tested**	21/11/2024

Test Details						
Remoulding Details	100% Standard Compaction @ 100% Optimum Moisture Content					
Size of Shear Box (mm)	100mm Square					
Test Parameter	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**	**Stage 5**	**Stage 6**
Specimen Dimensions (mm)	99.98 x 100.03	99.98 x 100.03	99.98 x 100.03	-	-	-
Rate of Strain (mm/min)	0.05	0.05	0.05	-	-	-
Placement Moisture Content (%)	15.5	15.5	15.5	-	-	-
Placement Wet Density (t/m^3)	1.94	1.94	1.94	-	-	-
Placement Dry Density (t/m^3)	1.68	1.68	1.68	-	-	-
Peak Values						
Normal Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Shear Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Normal Stress at Peak Shear Stress (kPa)	50.0	100.0	200.0	-	-	-
Peak Shear Stress (kPa)	28.9	74.9	116.2	-	-	-
Normal Stress at Ultimate Shear Stress (kPa)	50.0	100.0	200.0	-	-	-
Shear Stress at Ultimate Shear Stress (kPa)	28.1	72.1	127.3	-	-	-
Residual Values						
Normal Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Shear Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Normal Stress at Peak Shear Stress (kPa)	-	-	-	-	-	-
Peak Shear Stress (kPa)	-	-	-	-	-	-
Normal Stress at Ultimate Shear Stress (kPa)	-	-	-	-	-	-
Shear Stress at Ultimate Shear Stress (kPa)	-	-	-	-	-	-

Failure Envelopes			
		Peak Values	**Residual Values**
At Displacement	Friction Angle (°)	**-**	**-**
	Cohesion (kPa)	**-**	**-**
	Correlation	**-**	**-**
Peak Shear Stress	Friction Angle (°)	**29.2**	**-**
	Cohesion (kPa)	**8.3**	**-**
	Correlation	**0.9757**	**-**
Ultimate Shear Stress	Friction Angle (°)	**32.9**	**-**
	Cohesion (kPa)	**0.5**	**-**
	Correlation	**0.9921**	**-**

Notes

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Authorised Signatory: Chris Lloyd

Date: 22/11/2024

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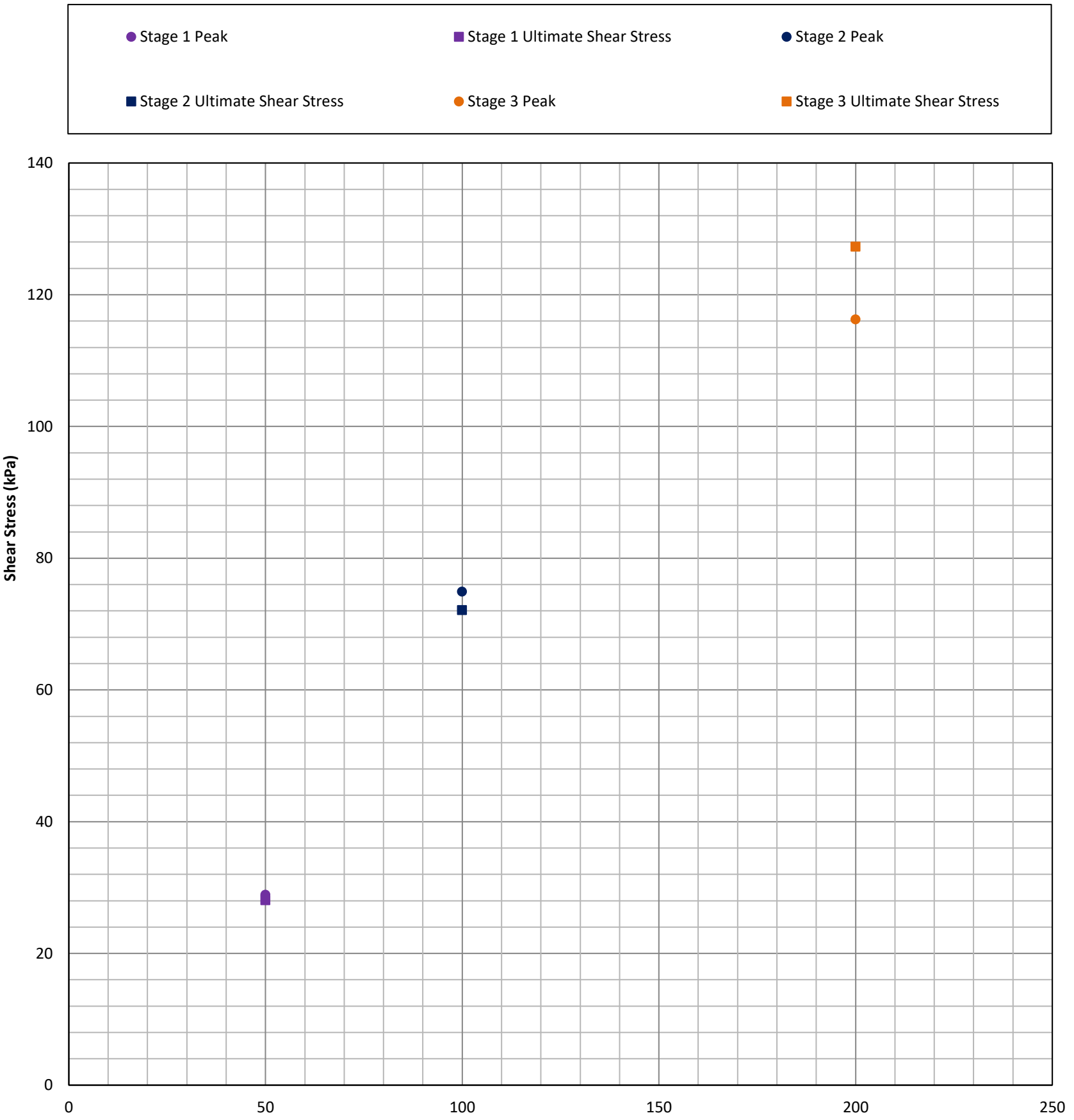
Shear Strength by Direct Shear Report

Client	KBR	**Report No**	S101425-DS

Peak Shear Stress / Normal Stress



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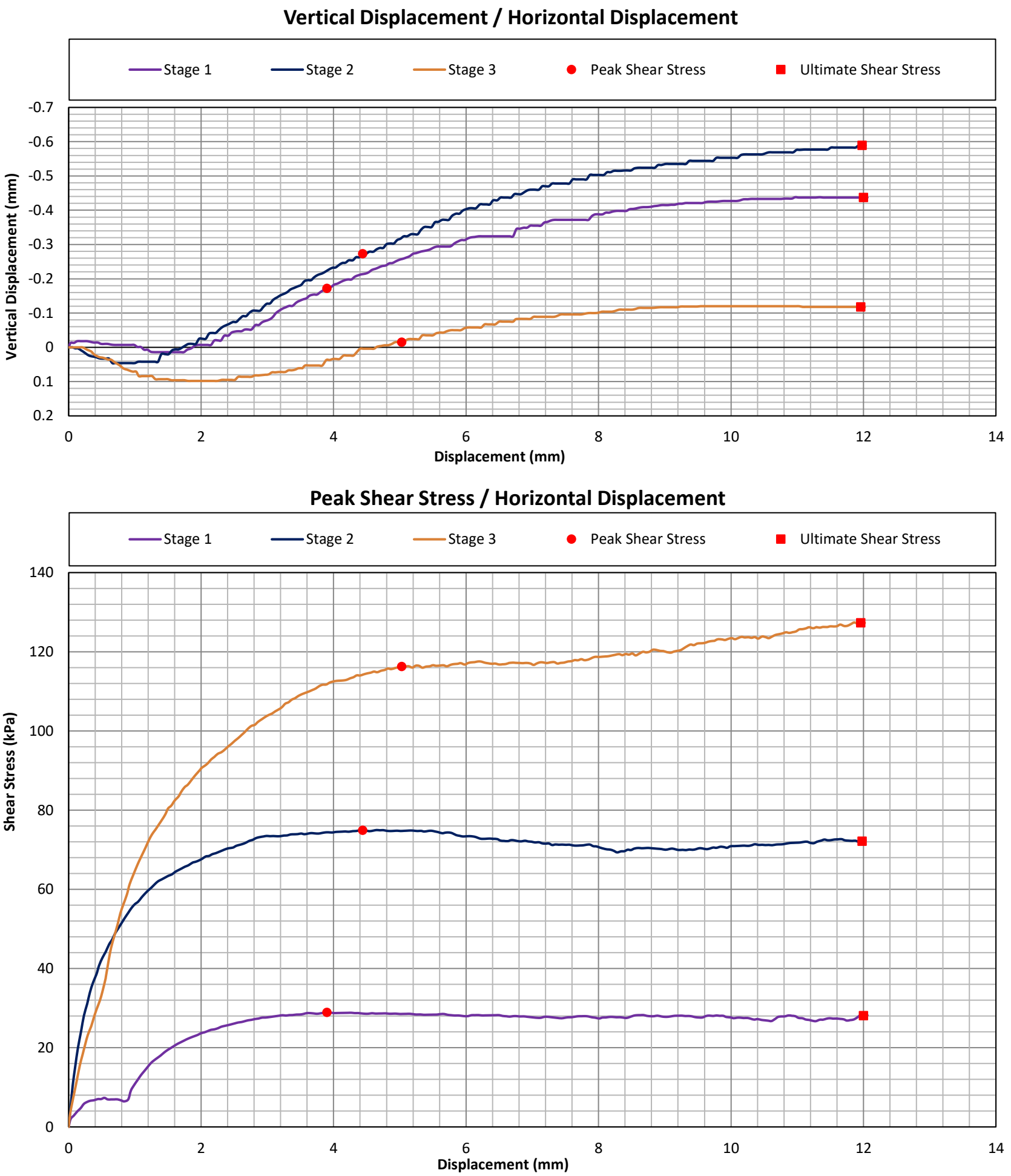

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DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

Client	KBR	**Source**	OWE.PAP BH01 4.60-5.50m + HAM. ASP BH01 5.50-6.00m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT, 2609	**Sample Description**	SAND
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101425-MDD
Job No	S24581-1	**Sample No**	S101425

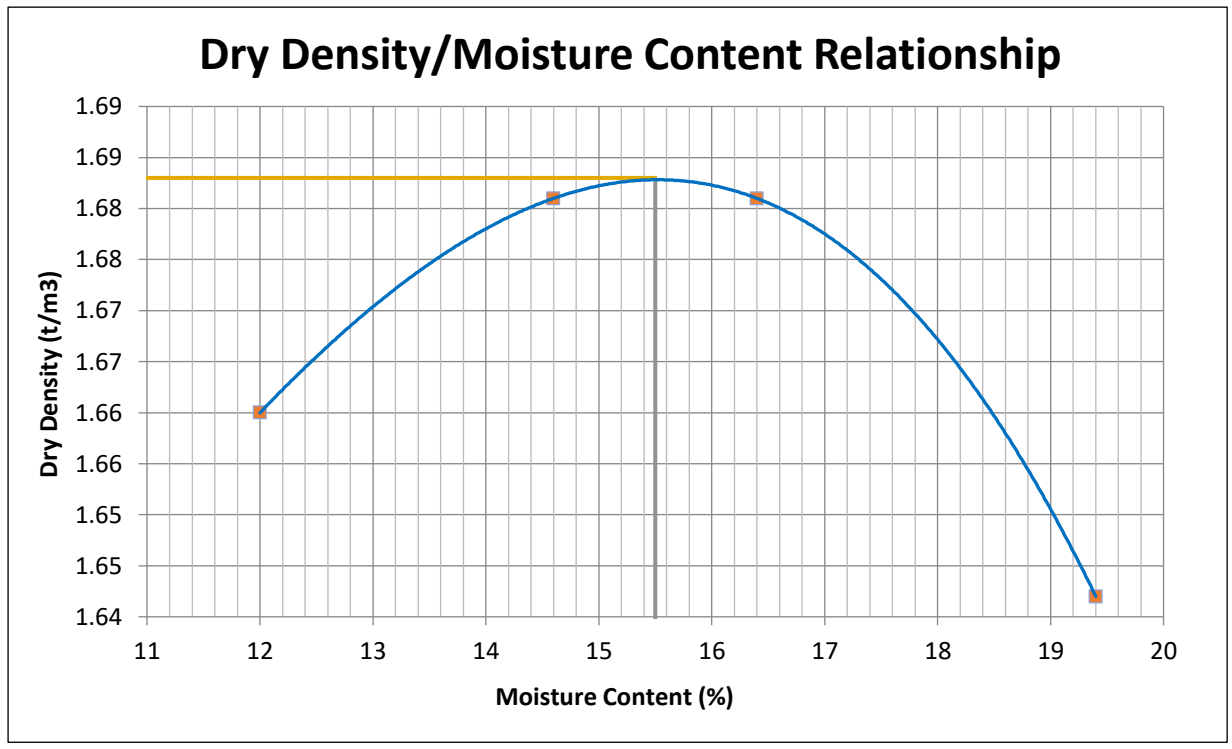
Test Procedure

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 24-25/10/2024

Preparation Prepared in accordance with the test method **Date Tested** 15/11/2024



Maximum Dry Density (t/m^3)	1.68
Optimum Moisture Content (%)	15.5
Oversize Retained on 19mm sieve (%)	0
Oversize Retained on 37.5mm sieve (%)	0
Curing Time	5 hrs
Liquid Limit Determination	Technician Assessment

Notes

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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Chris Lloyd

22/11/2024

Date:

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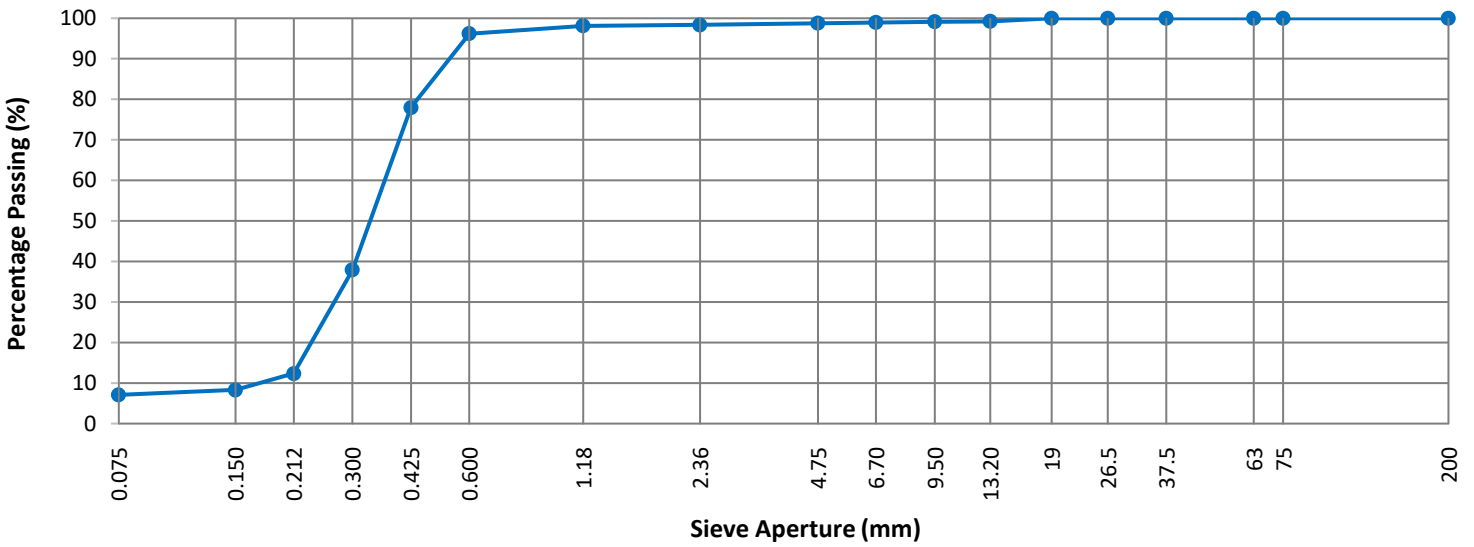
Particle Size Distribution Report

Client	KBR	**Source**	WAX.MET BH02 3.75-4.00m + EGG.OLD BH02 4.00-4.50m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT 2609	**Sample Description**	SAND with Silt, trace of Gravel
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101427-PSD
Job No	S24581-1	**Lab No**	S101427

Test Procedure	AS 1289.3.6.1 Determination of the particle size distribution of a soil - Standard method of analysis by sieving		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	24-25/10/2024
Preparation	Prepared in accordance with the test method	**Date Tested**	2/12/2024



Sieve Aperture (mm)	Percentage Passing (%)
200	**100**
75	**100**
63	**100**
37.5	**100**
26.5	**100**
19.0	**100**
13.2	**99**
9.50	**99**
6.70	**99**
4.75	**99**
2.36	**98**

Sieve Aperture (mm)	Percentage Passing (%)
1.18	**98**
0.600	**96**
0.425	**78**
0.300	**38**
0.212	**12**
0.150	**8**
0.075	**7**

Notes

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Authorised Signatory: Jacob Lloyd

Date: 2/12/2024

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SOIL PARTICLE DENSITY REPORT

Client	KBR	**Source**	WAX.MET BH02 3.75-4.00m + EGG.OLD BH02 4.00-4.50m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT 2609	**Sample Description**	SAND with Silt, trace of Gravel
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report #**	S101427-SPD
Job #	S24581-1	**Lab #**	S101427

Test Procedure	☑ AS1289 3.5.1 (2006) Soil classification tests - Determination of the soil particle density of a soil - Standard method		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	24-25/10/2024
Preparation	Prepared in accordance with the test method	**Date Tested**	22/11/2024

Average Apparent Particle Density: Fraction Retained 2.36mm (g/cm^3)	*
Average Apparent Particle Density: Fraction Passing 2.36mm (g/cm^3)	**2.58**
Soil Particle Density: Total Soil Sample (g/cm^3)	*

** Value unable to be determined due to limited amount of sample.*

Notes

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2/12/2024

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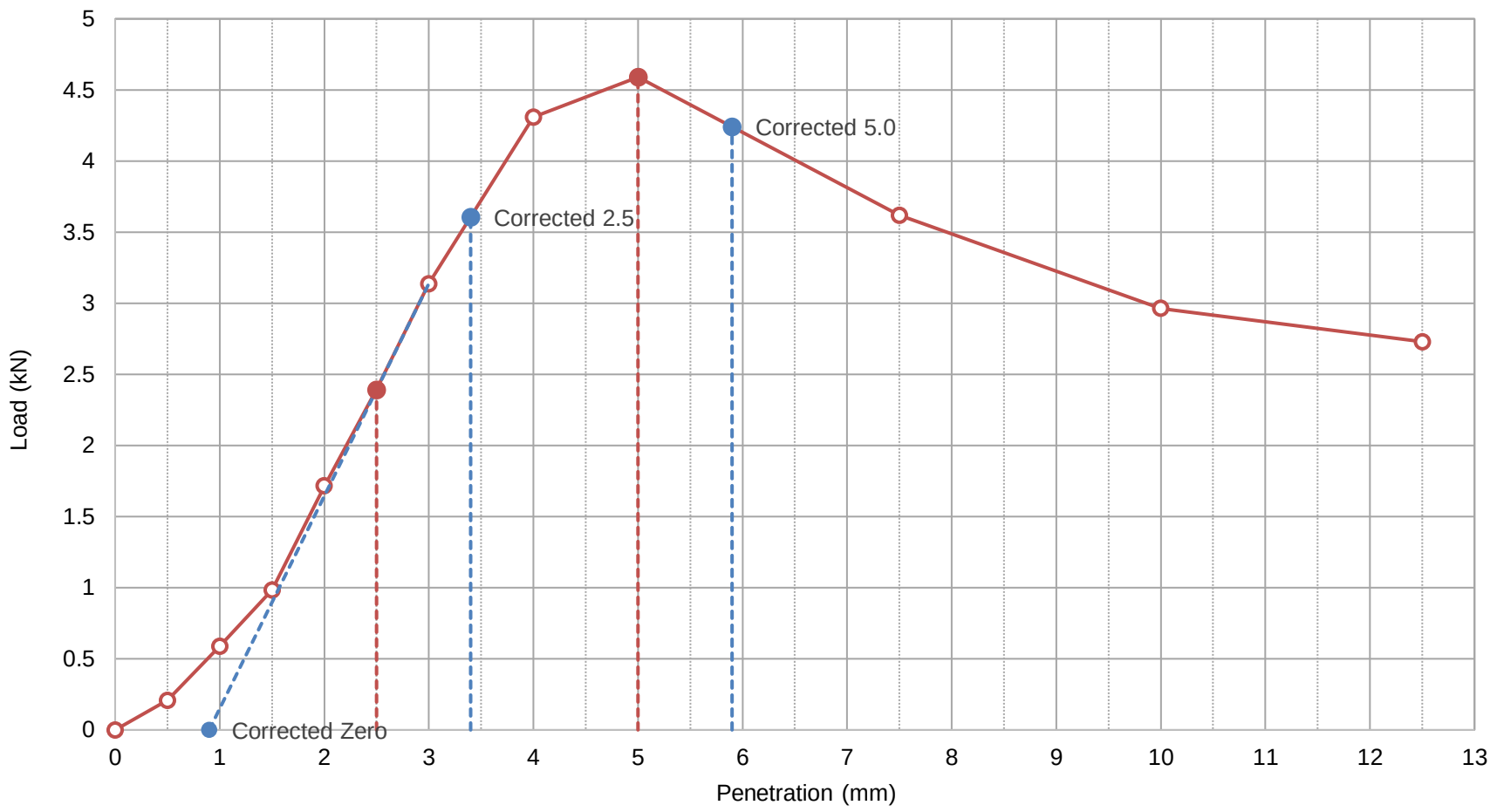
CALIFORNIA BEARING RATIO REPORT

Client	KBR	**Source**	SAC.SAY BH02a 0.10-1.20m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT 2609	**Sample Description**	SAND
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No.**	S101428-CBR
Job No.	S24581-1	**Sample No.**	S101428

Test Procedure	☑ AS 1289.6.1.1	☐ RMS T117	California Bearing Ratio
	☑ AS 1289.5.1.1	☐ RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
	☐ AS 1289.5.2.1	☐ RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
	☑ AS 1289.2.1.1	☐ RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 24-25/10/2024

Preparation Prepared in accordance with the test method **Date Tested** 19/11/2024



Preparation & Specification	
Retained on 19.0mm Sieve (%)	5
Method of Establishing Plasticity Level	Technician Assessment
Sample Curing Time (hrs)	2 hrs
Compaction Hammer Used	Standard
Surcharge Mass Applied (kg)	4.5
Period of Soaking (Days)	4
Maximum Dry Density - MDD (t/m³)	1.68
Optimum Moisture Content - OMC (%)	14.0

Density & Moisture	Achieved	Target
Lab Moisture Ratio - LMR (%)	100.5	100.0
Lab Density Ratio - LDR (%)	100.0	100.0
Dry Density - At Compaction (t/m³)	1.68	1.68
Dry Density - After Soaking (t/m³)	1.68	
Specimen Swell (%)	0.0	
Moisture Content - At Compaction (%)	14.1	
Moisture Content - Top 30mm (%)	14.4	
Moisture Content - Remainder (%)	14.2	

Material CBR Value (%): 25 at a penetration of 2.5 mm

Notes

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Authorised Signatory:

21/11/2024

Chris Lloyd Date:

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DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

Client	KBR	**Source**	SAC.SAY BH02a 0.10-1.20m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT, 2609	**Sample Description**	SAND
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101428-MDD
Job No	S24581-1	**Sample No**	S101428

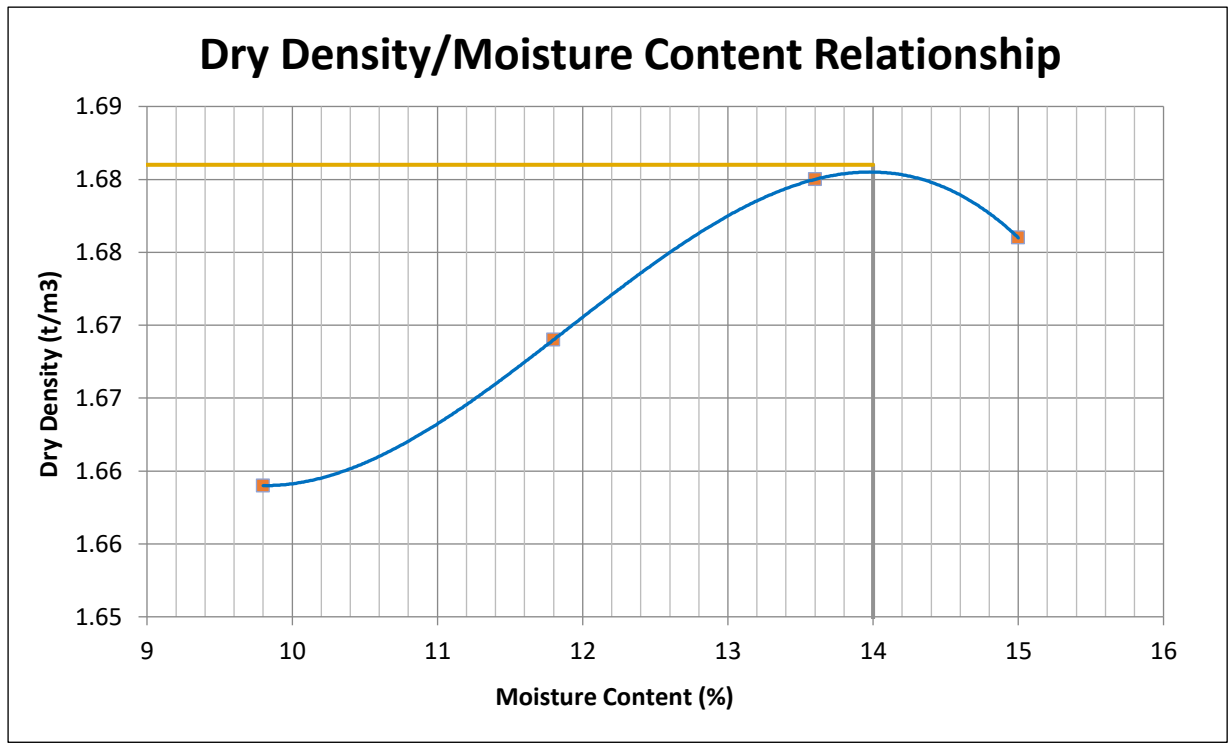
Test Procedure

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 24-25/10/2024

Preparation Prepared in accordance with the test method **Date Tested** 14/11/2024



Maximum Dry Density (t/m^3)	1.68
Optimum Moisture Content (%)	14.0
Oversize Retained on 19mm sieve (%)	5
Oversize Retained on 37.5mm sieve (%)	1
Curing Time	2 hrs
Liquid Limit Determination	Technician Assessment

Notes

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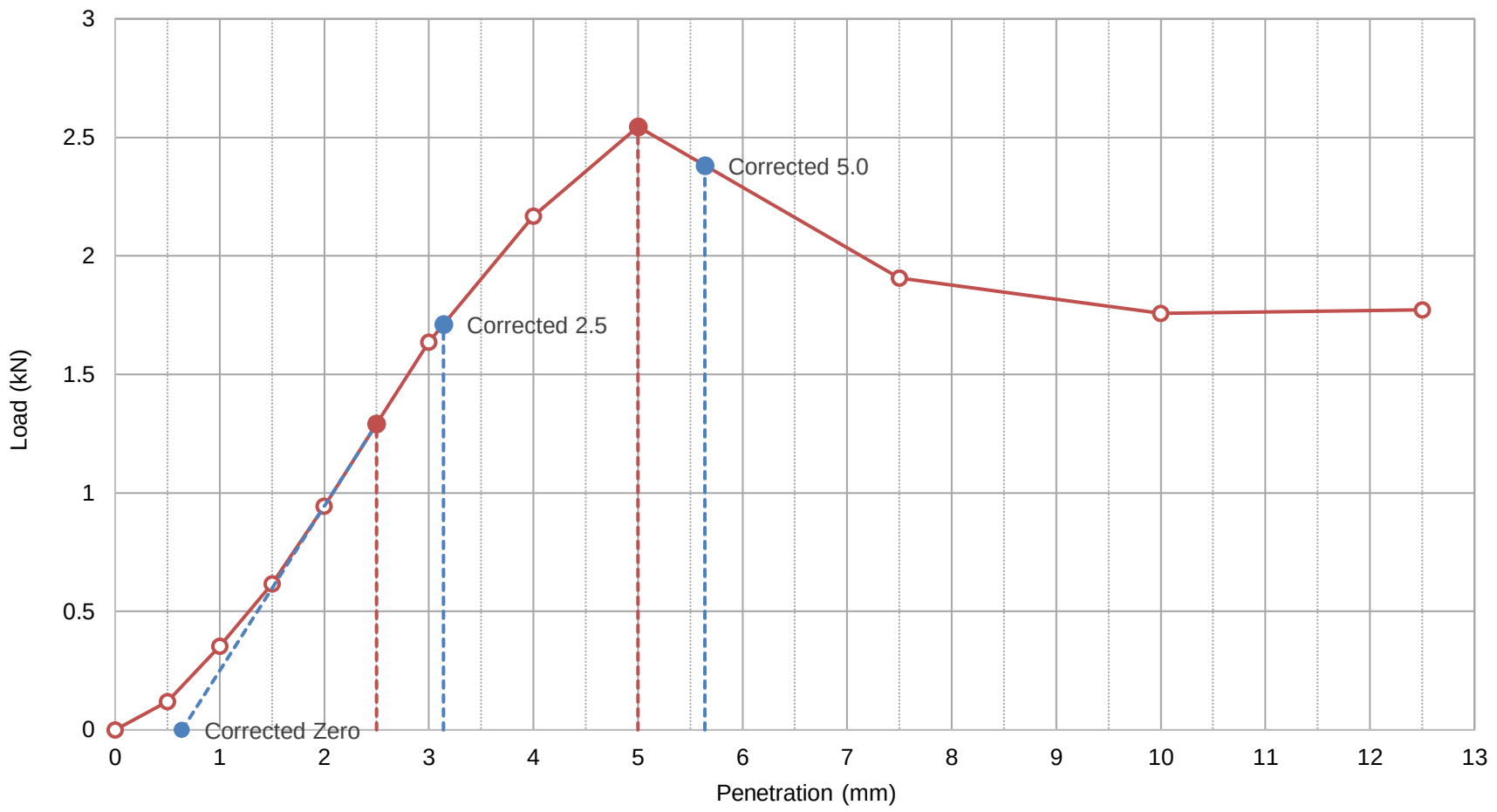
CALIFORNIA BEARING RATIO REPORT

Client	KBR	**Source**	ANY.FOG BH02a 1.20-1.70m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT 2609	**Sample Description**	Gravelly SAND
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No.**	S101429-CBR
Job No.	S24581-1	**Sample No.**	S101429

Test Procedure	☑ AS 1289.6.1.1	☐ RMS T117	California Bearing Ratio
	☑ AS 1289.5.1.1	☐ RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
	☐ AS 1289.5.2.1	☐ RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
	☑ AS 1289.2.1.1	☐ RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 24-25/10/2024

Preparation Prepared in accordance with the test method **Date Tested** 19/11/2024



Preparation & Specification	
Retained on 19.0mm Sieve (%)	1
Method of Establishing Plasticity Level	Technician Assessment
Sample Curing Time (hrs)	2 hrs
Compaction Hammer Used	Standard
Surcharge Mass Applied (kg)	4.5
Period of Soaking (Days)	4
Maximum Dry Density - MDD (t/m³)	1.66
Optimum Moisture Content - OMC (%)	13.3

Density & Moisture	Achieved	Target
Lab Moisture Ratio - LMR (%)	100.0	100.0
Lab Density Ratio - LDR (%)	100.0	100.0
Dry Density - At Compaction (t/m³)	1.66	1.66
Dry Density - After Soaking (t/m³)	1.66	
Specimen Swell (%)	-0.1	
Moisture Content - At Compaction (%)	13.3	
Moisture Content - Top 30mm (%)	17.1	
Moisture Content - Remainder (%)	16.1	

Material CBR Value (%): 13 at a penetration of 2.5 mm

Notes

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Authorised Signatory:

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DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

Client	KBR	**Source**	ANY.FOG BH02a 1.20-1.70m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT, 2609	**Sample Description**	Gravelly SAND
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101429-MDD
Job No	S24581-1	**Sample No**	S101429

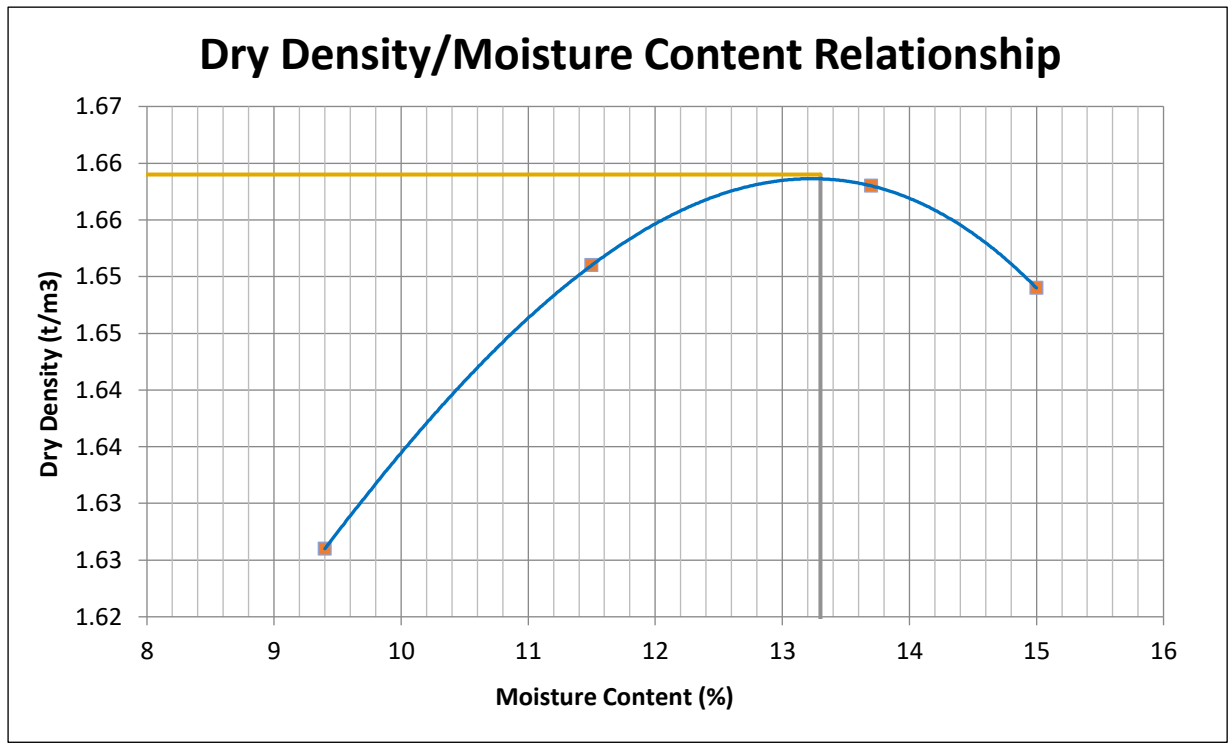
Test Procedure

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 24-25/10/2024

Preparation Prepared in accordance with the test method **Date Tested** 14/11/2024



Maximum Dry Density (t/m^3)	1.66
Optimum Moisture Content (%)	13.3
Oversize Retained on 19mm sieve (%)	1
Oversize Retained on 37.5mm sieve (%)	0
Curing Time	2 hrs
Liquid Limit Determination	Technician Assessment

Notes

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SOIL CLASSIFICATION REPORT

Client	KBR	**Source**	PSI.DIS BH04a 4.00-4.50m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT 2609	**Sample Description**	SAND with Clay, trace of Gravel
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No.**	S101431-PI
Job No.	S24581-1	**Lab No.**	S101431

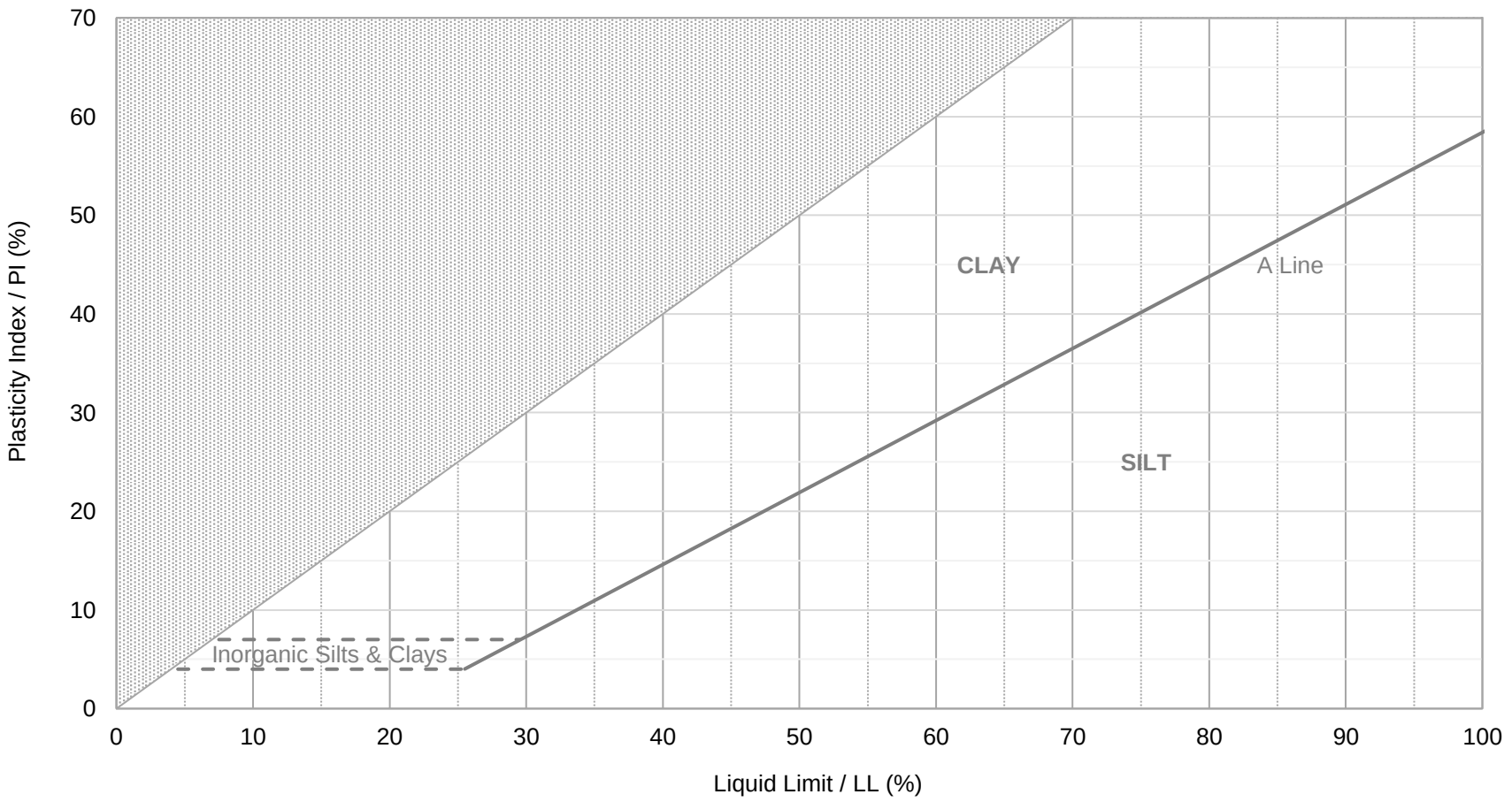
Test Procedure

☑	AS1289 3.1.1	Liquid Limit - Four point Casagrande method
☐	AS1289 3.1.2	Liquid Limit - One point Casagrande method
☑	AS1289 3.2.1	Plastic Limit - Standard method
☑	AS1289 3.3.1	Calculation of the Plasticity Index
☑	AS1289 3.4.1	Linear Shrinkage - Standard method

Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	24-25/10/2024
Preparation	Prepared in accordance with the test method	**Date Tested**	28/11/2024

Plasticity Chart for Classification of Fine-Grained Soils

AS 1726:2017 Clause 6.1.6 (Figure 5)



Preparation

Method of Preparation	**Dry Sieved**
History of the Sample	**Air Dried**

Results

Liquid Limit / LL (%)	**Unobtainable**
Plastic Limit (%)	**Unobtainable**
Plasticity Index / PI (%)	**Non-Plastic**
Linear Shrinkage (%)	**Unobtainable**
Condition upon Drying	**N/A**

Notes

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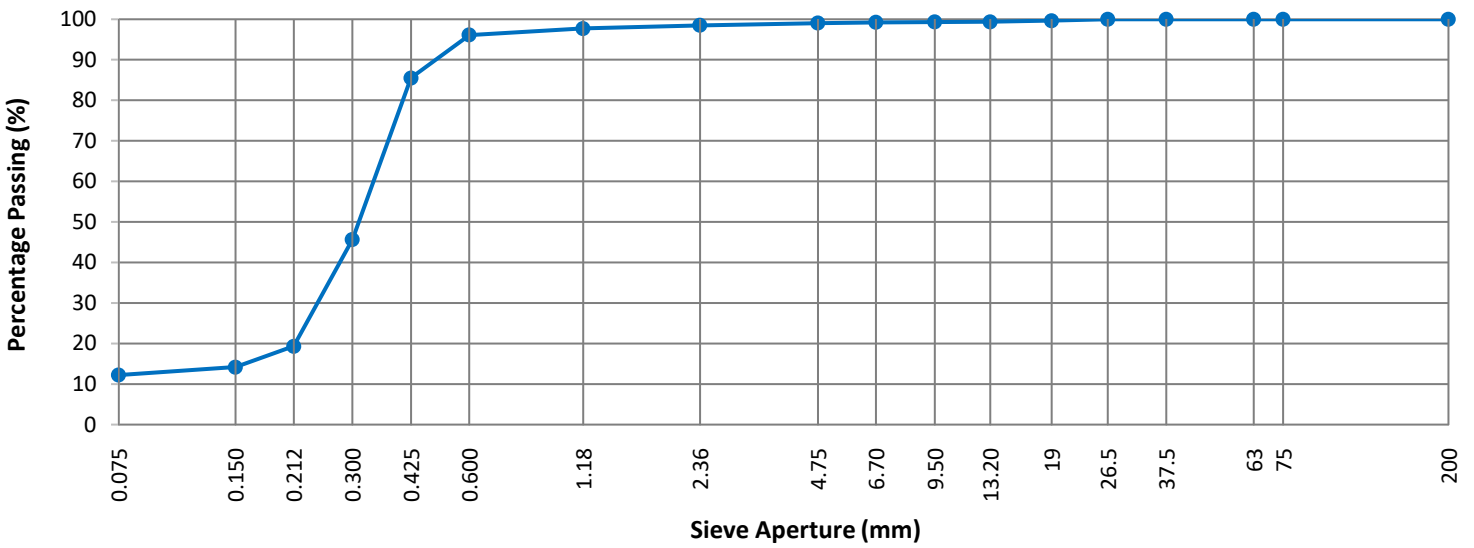
Particle Size Distribution Report

Client	KBR	**Source**	PSI.DIS BH04a 4.00-4.50m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT 2609	**Sample Description**	SAND with Clay, trace of Gravel
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101431-PSD
Job No	S24581-1	**Lab No**	S101431

Test Procedure	AS 1289.3.6.1 Determination of the particle size distribution of a soil - Standard method of analysis by sieving		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	24-25/10/2024
Preparation	Prepared in accordance with the test method	**Date Tested**	2/12/2024



Sieve Aperture (mm)	Percentage Passing (%)
200	**100**
75	**100**
63	**100**
37.5	**100**
26.5	**100**
19.0	**100**
13.2	**99**
9.50	**99**
6.70	**99**
4.75	**99**
2.36	**99**

Sieve Aperture (mm)	Percentage Passing (%)
1.18	**98**
0.600	**96**
0.425	**86**
0.300	**46**
0.212	**19**
0.150	**14**
0.075	**12**

Notes

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Authorised Signatory: Date:

2/12/2024

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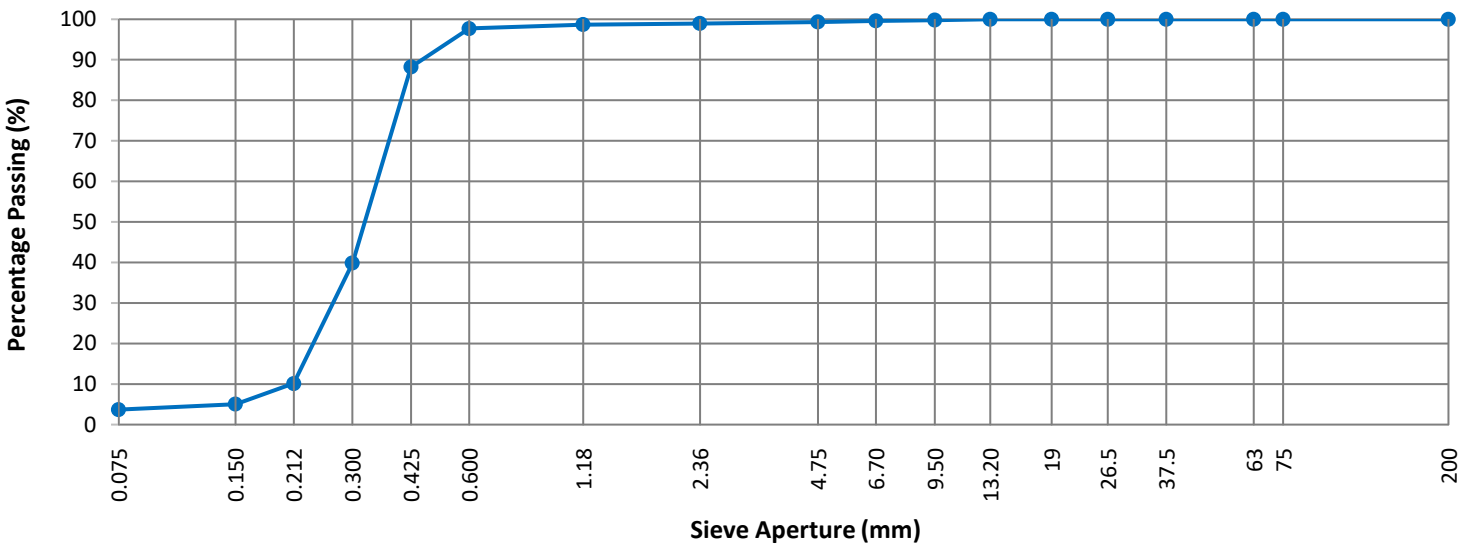
Particle Size Distribution Report

Client	KBR	**Source**	IGG.WET BH04a 1.50-2.50m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT 2609	**Sample Description**	SAND trace of Silt and Gravel
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101432-PSD
Job No	S24581-1	**Lab No**	S101432

Test Procedure	AS 1289.3.6.1 Determination of the particle size distribution of a soil - Standard method of analysis by sieving		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	24-25/10/2024
Preparation	Prepared in accordance with the test method	**Date Tested**	2/12/2024



Sieve Aperture (mm)	Percentage Passing (%)
200	**100**
75	**100**
63	**100**
37.5	**100**
26.5	**100**
19.0	**100**
13.2	**100**
9.50	**100**
6.70	**100**
4.75	**99**
2.36	**99**

Sieve Aperture (mm)	Percentage Passing (%)
1.18	**99**
0.600	**98**
0.425	**88**
0.300	**40**
0.212	**10**
0.150	**5**
0.075	**4**

Notes

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Authorised Signatory: Jacob Lloyd

Date: 2/12/2024

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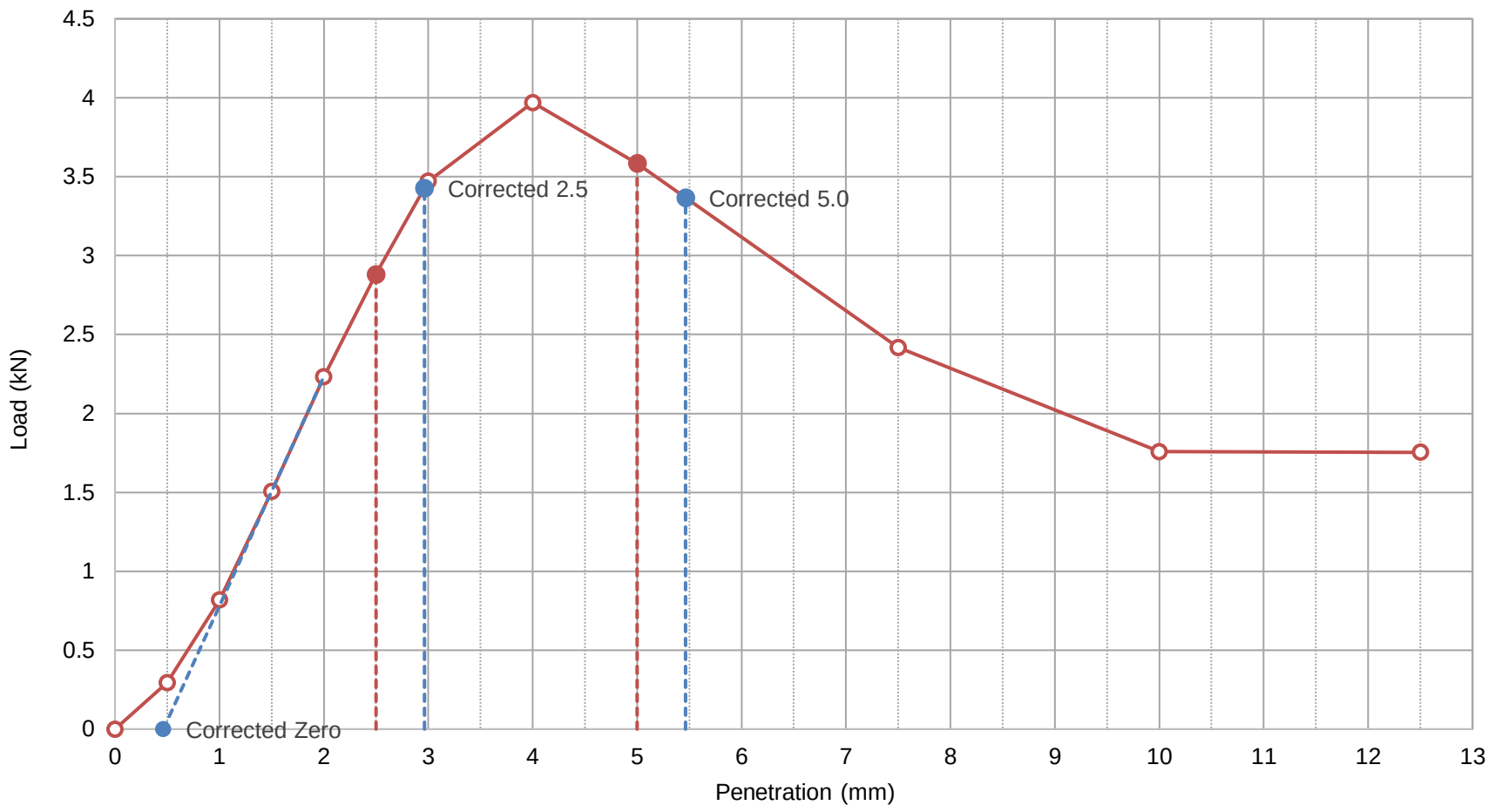
CALIFORNIA BEARING RATIO REPORT

Client	KBR	**Source**	AHA.ROT BH05c 1.00-2.00m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT 2609	**Sample Description**	SAND
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No.**	S101433-CBR
Job No.	S24581-1	**Sample No.**	S101433

Test Procedure	☑ AS 1289.6.1.1	☐ RMS T117	California Bearing Ratio
	☑ AS 1289.5.1.1	☐ RMS T111	Dry Density / Moisture Content Relationship - Standard Compaction
	☐ AS 1289.5.2.1	☐ RMS T112	Dry Density / Moisture Content Relationship - Modified Compaction
	☑ AS 1289.2.1.1	☐ RMS T120	Moisture Content - Oven Drying Method (Standard Method)

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 24-25/10/2024

Preparation Prepared in accordance with the test method **Date Tested** 19/11/2024



Preparation & Specification	
Retained on 19.0mm Sieve (%)	0
Method of Establishing Plasticity Level	Technician Assessment
Sample Curing Time (hrs)	2 hrs
Compaction Hammer Used	Standard
Surcharge Mass Applied (kg)	4.5
Period of Soaking (Days)	4
Maximum Dry Density - MDD (t/m³)	1.71
Optimum Moisture Content - OMC (%)	12.9

Density & Moisture	Achieved	Target
Lab Moisture Ratio - LMR (%)	99.5	100.0
Lab Density Ratio - LDR (%)	100.0	100.0
Dry Density - At Compaction (t/m³)	1.71	1.71
Dry Density - After Soaking (t/m³)	1.71	
Specimen Swell (%)	0.0	
Moisture Content - At Compaction (%)	12.8	
Moisture Content - Top 30mm (%)	14.8	
Moisture Content - Remainder (%)	14.7	

Material CBR Value (%): 25 at a penetration of 2.5 mm

Notes

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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

21/11/2024

Chris Lloyd Date:

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DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

Client	KBR	**Source**	AHA.ROT BH05c 1.00-2.00m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT, 2609	**Sample Description**	SAND
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101433-MDD
Job No	S24581-1	**Sample No**	S101433

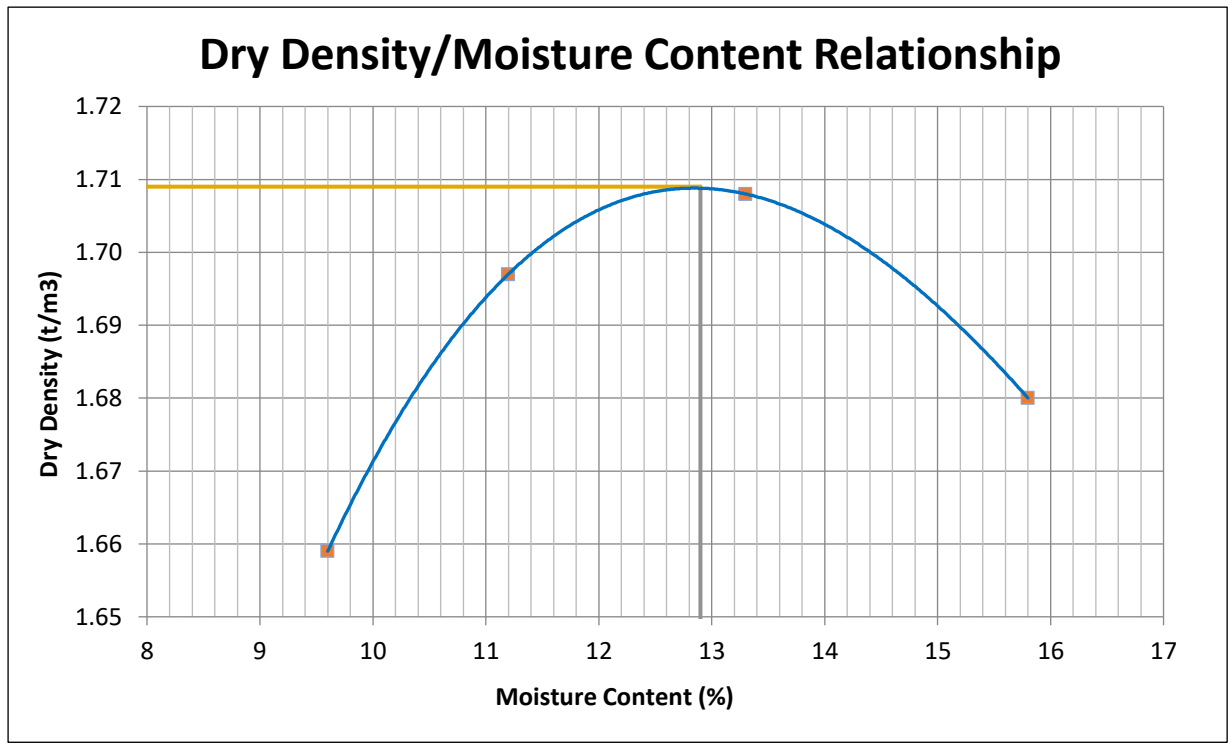
Test Procedure

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 24-25/10/2024

Preparation Prepared in accordance with the test method **Date Tested** 14/11/2024



Maximum Dry Density (t/m^3)	1.71
Optimum Moisture Content (%)	12.9
Oversize Retained on 19mm sieve (%)	0
Oversize Retained on 37.5mm sieve (%)	0
Curing Time	2 hrs
Liquid Limit Determination	Technician Assessment

Notes

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NATA Accredited Laboratory Number: 14874

Authorised Signatory:

Jacob Lloyd

15/11/2024

Date:

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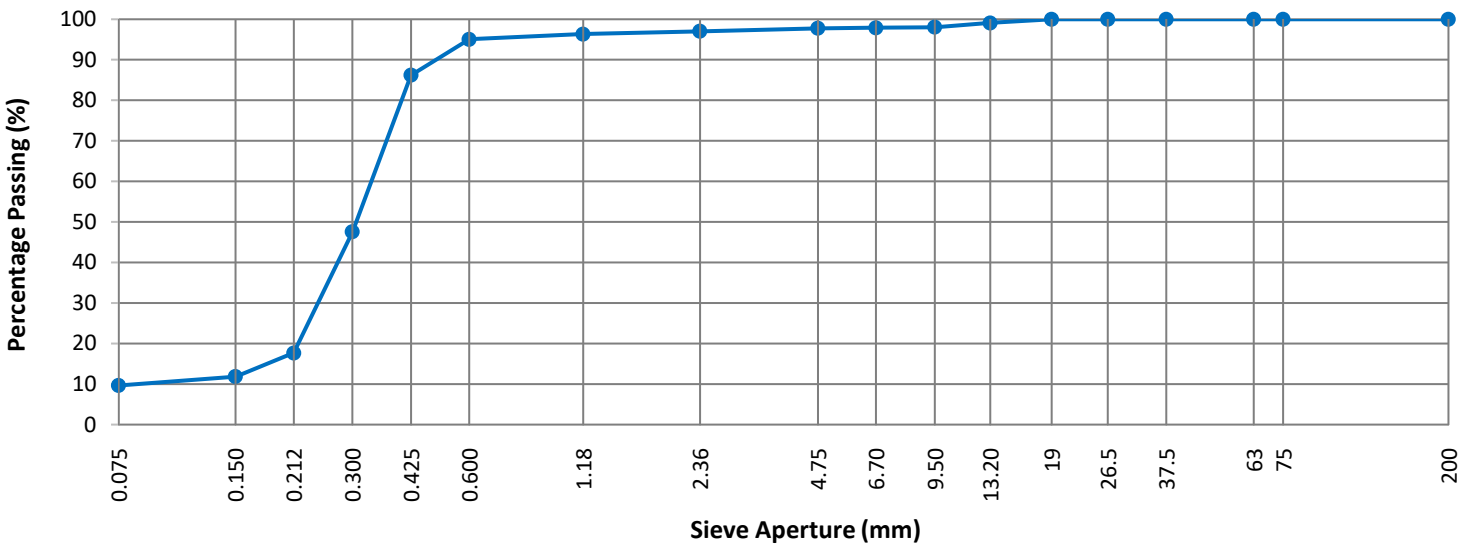
Particle Size Distribution Report

Client	KBR	**Source**	LIB.DEN BH05c 3.00-3.50m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT 2609	**Sample Description**	SAND with Silt, trace of Gravel
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101434-PSD
Job No	S24581-1	**Lab No**	S101434

Test Procedure	AS 1289.3.6.1 Determination of the particle size distribution of a soil - Standard method of analysis by sieving		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	24-25/10/2024
Preparation	Prepared in accordance with the test method	**Date Tested**	2/12/2024



Sieve Aperture (mm)	Percentage Passing (%)
200	**100**
75	**100**
63	**100**
37.5	**100**
26.5	**100**
19.0	**100**
13.2	**99**
9.50	**98**
6.70	**98**
4.75	**98**
2.36	**97**

Sieve Aperture (mm)	Percentage Passing (%)
1.18	**96**
0.600	**95**
0.425	**86**
0.300	**48**
0.212	**18**
0.150	**12**
0.075	**10**

Notes

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SOIL PARTICLE DENSITY REPORT

Client	KBR	**Source**	LIB.DEN BH05c 3.00-3.50m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT 2609	**Sample Description**	SAND with Silt, trace of Gravel
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report #**	S101434-SPD
Job #	S24581-1	**Lab #**	S101434

Test Procedure	☑ AS1289 3.5.1 (2006) Soil classification tests - Determination of the soil particle density of a soil - Standard method		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	24-25/10/2024
Preparation	Prepared in accordance with the test method	**Date Tested**	21/11/2024

Average Apparent Particle Density: Fraction Retained 2.36mm (g/cm^3)	*
Average Apparent Particle Density: Fraction Passing 2.36mm (g/cm^3)	**2.47**
Soil Particle Density: Total Soil Sample (g/cm^3)	*

** Value unable to be determined due to limited amount of sample.*

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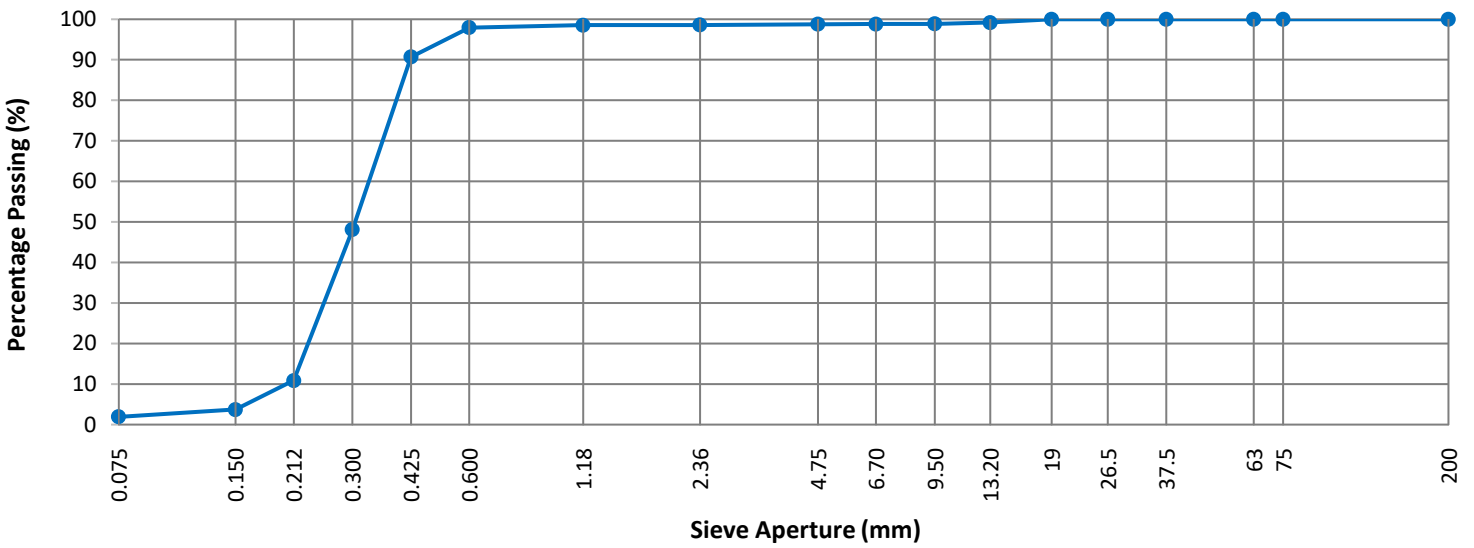
Particle Size Distribution Report

Client	KBR	**Source**	TOD.ORB BH05c 2.00-2.70m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT 2609	**Sample Description**	SAND trace of Silt and Gravel
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101435-PSD
Job No	S24581-1	**Lab No**	S101435

Test Procedure	AS 1289.3.6.1 Determination of the particle size distribution of a soil - Standard method of analysis by sieving		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	24-25/10/2024
Preparation	Prepared in accordance with the test method	**Date Tested**	2/12/2024



Sieve Aperture (mm)	Percentage Passing (%)
200	**100**
75	**100**
63	**100**
37.5	**100**
26.5	**100**
19.0	**100**
13.2	**99**
9.50	**99**
6.70	**99**
4.75	**99**
2.36	**99**

Sieve Aperture (mm)	Percentage Passing (%)
1.18	**99**
0.600	**98**
0.425	**91**
0.300	**48**
0.212	**11**
0.150	**4**
0.075	**2**

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SOIL PARTICLE DENSITY REPORT

Client	KBR	**Source**	TOD.ORB BH05c 2.00-2.70m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT 2609	**Sample Description**	SAND trace of Silt and Gravel
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report #**	S101435-SPD
Job #	S24581-1	**Lab #**	S101435

Test Procedure	☑ AS1289 3.5.1 (2006) Soil classification tests - Determination of the soil particle density of a soil - Standard method		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	24-25/10/2024
Preparation	Prepared in accordance with the test method	**Date Tested**	25/11/2024

Average Apparent Particle Density: Fraction Retained 2.36mm (g/cm^3)	*
Average Apparent Particle Density: Fraction Passing 2.36mm (g/cm^3)	**2.64**
Soil Particle Density: Total Soil Sample (g/cm^3)	*

** Value unable to be determined due to limited amount of sample.*

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Shear Strength by Direct Shear Report

Client	KBR	**Source**	SIS.CAN BH02 2.50-3.00m + BAY.DIM BH02 3.00-3.50m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT, 2609	**Sample Description**	SAND trace of Gravel
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101426-DS
Job No	S24581-1	**Lab No**	S101426

Test Procedure	AS1289 6.2.2 Soil strength and consolidation tests - Determination of the shear strength of a soil - Direct shear test using a shear box		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	24-25/10/2024
Preparation	Prepared in accordance with the test method	**Date Tested**	16/11/2024

Test Details						
Remoulding Details	100% Standard Compaction @ 100% Optimum Moisture Content					
Size of Shear Box (mm)	100mm Square					
Test Parameter	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**	**Stage 5**	**Stage 6**
Specimen Dimensions (mm)	99.98 x 100.03	99.98 x 100.03	99.98 x 100.03	-	-	-
Rate of Strain (mm/min)	0.05	0.05	0.05	-	-	-
Placement Moisture Content (%)	14.5	14.5	14.5	-	-	-
Placement Wet Density (t/m^3)	1.94	1.94	1.94	-	-	-
Placement Dry Density (t/m^3)	1.69	1.69	1.69	-	-	-
Peak Values						
Normal Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Shear Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Normal Stress at Peak Shear Stress (kPa)	50.0	100.0	200.0	-	-	-
Peak Shear Stress (kPa)	32.1	71.1	129.7	-	-	-
Normal Stress at Ultimate Shear Stress (kPa)	50.0	100.0	200.0	-	-	-
Shear Stress at Ultimate Shear Stress (kPa)	31.2	71.7	133.0	-	-	-
Residual Values						
Normal Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Shear Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Normal Stress at Peak Shear Stress (kPa)	-	-	-	-	-	-
Peak Shear Stress (kPa)	-	-	-	-	-	-
Normal Stress at Ultimate Shear Stress (kPa)	-	-	-	-	-	-
Shear Stress at Ultimate Shear Stress (kPa)	-	-	-	-	-	-

Failure Envelopes			
		Peak Values	**Residual Values**
At Displacement	Friction Angle (°)	-	-
	Cohesion (kPa)	-	-
	Correlation	-	-
Peak Shear Stress	Friction Angle (°)	**32.7**	-
	Cohesion (kPa)	**2.8**	-
	Correlation	**0.9972**	-
Ultimate Shear Stress	Friction Angle (°)	**33.8**	-
	Cohesion (kPa)	**0.6**	-
	Correlation	**0.9974**	-

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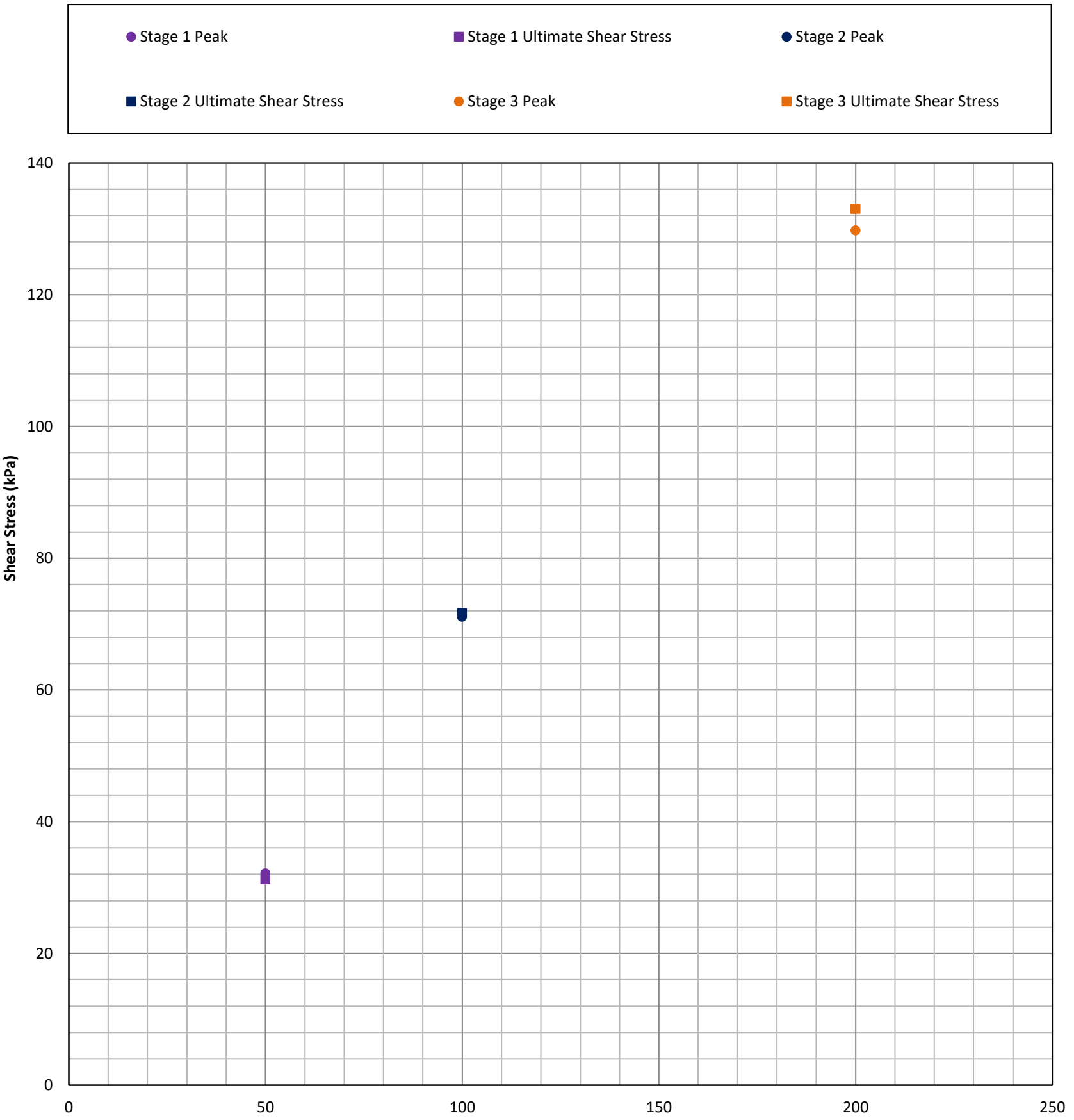
Shear Strength by Direct Shear Report

Client	KBR	**Report No**	S101426-DS

Peak Shear Stress / Normal Stress



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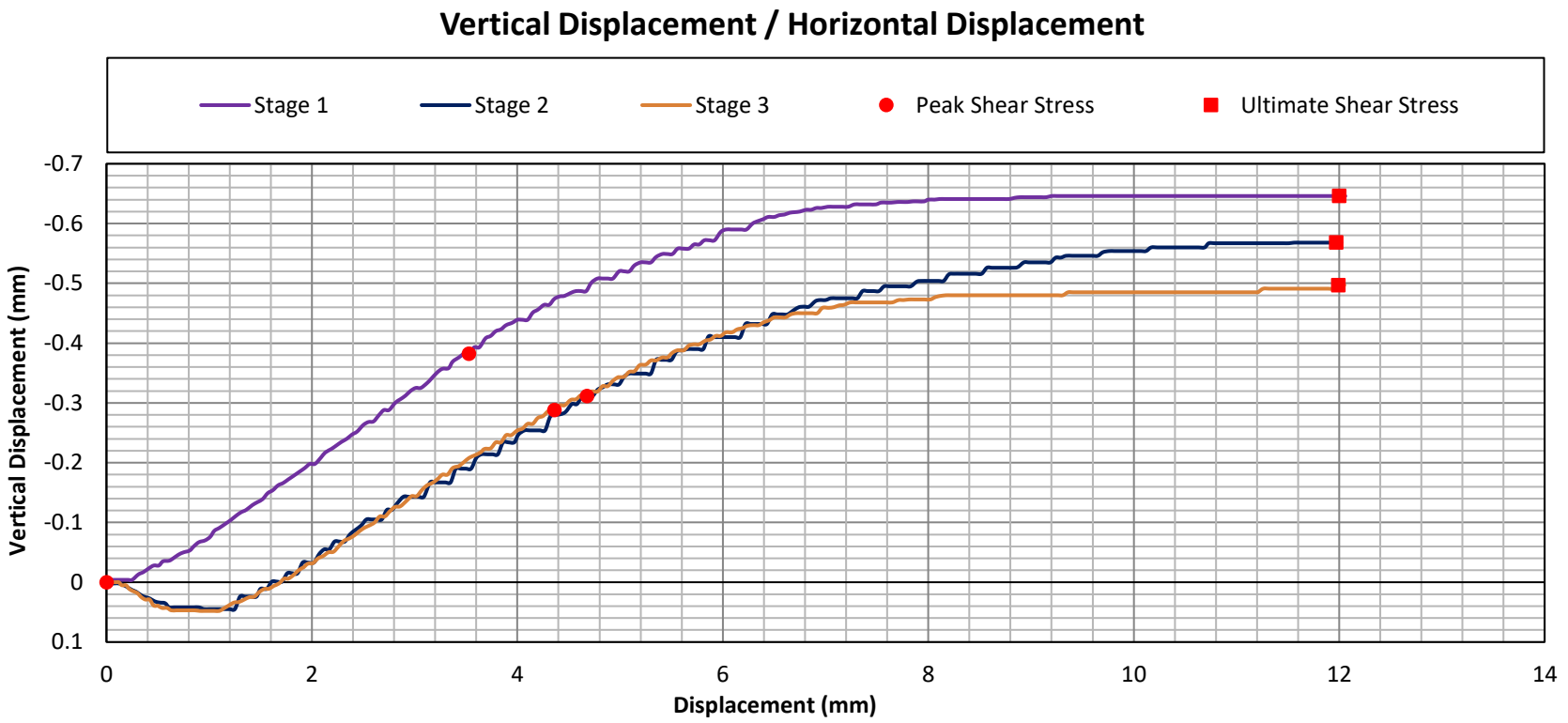
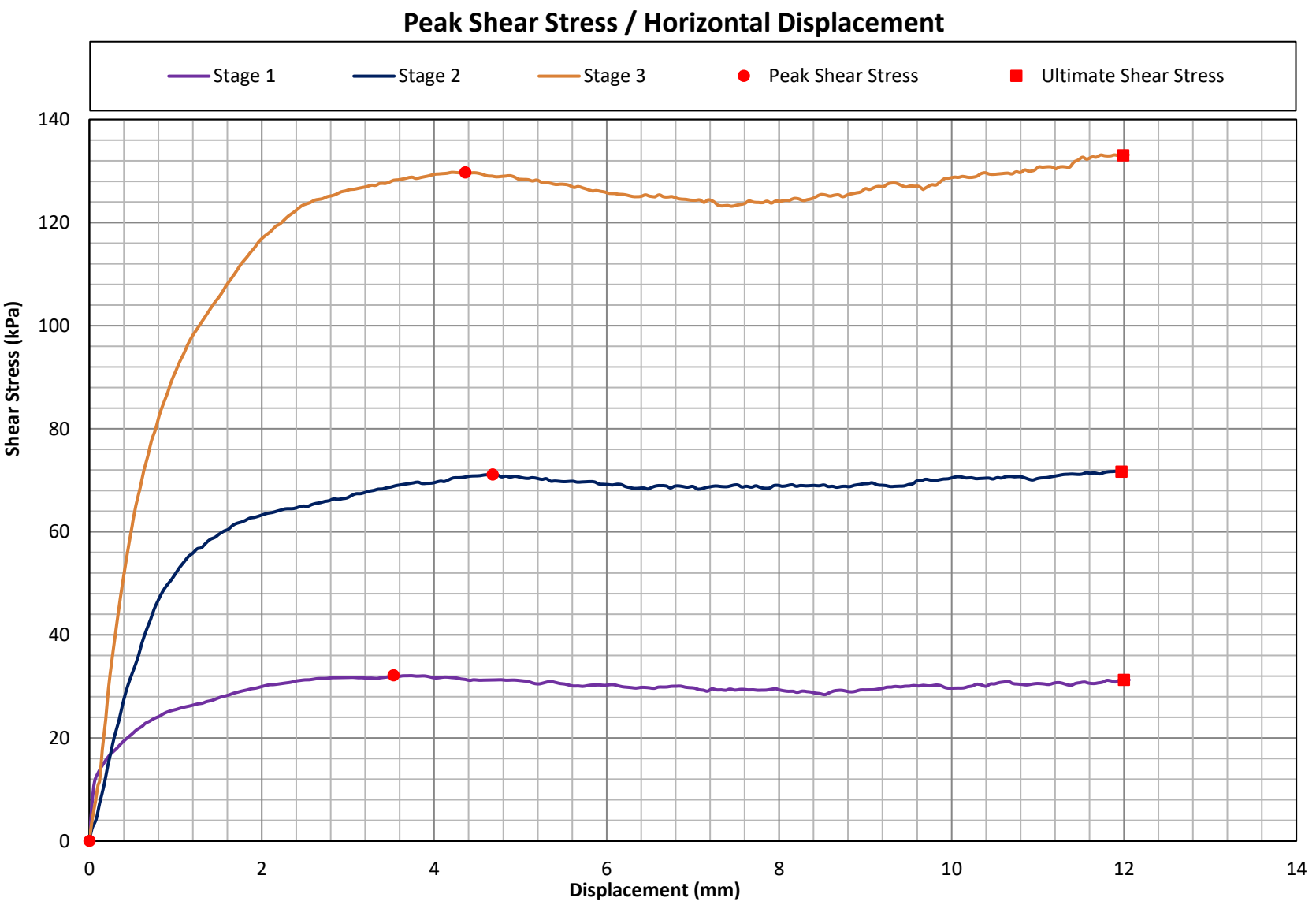
Shear Strength by Direct Shear Report

Client	KBR	**Report No**	S101426-DS





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DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

Client	KBR	**Source**	SIS.CAN BH02 2.50-3.00m + BAY.DIM BH02 3.00-3.50m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT, 2609	**Sample Description**	SAND trace of Gravel
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101426-MDD
Job No	S24581-1	**Sample No**	S101426

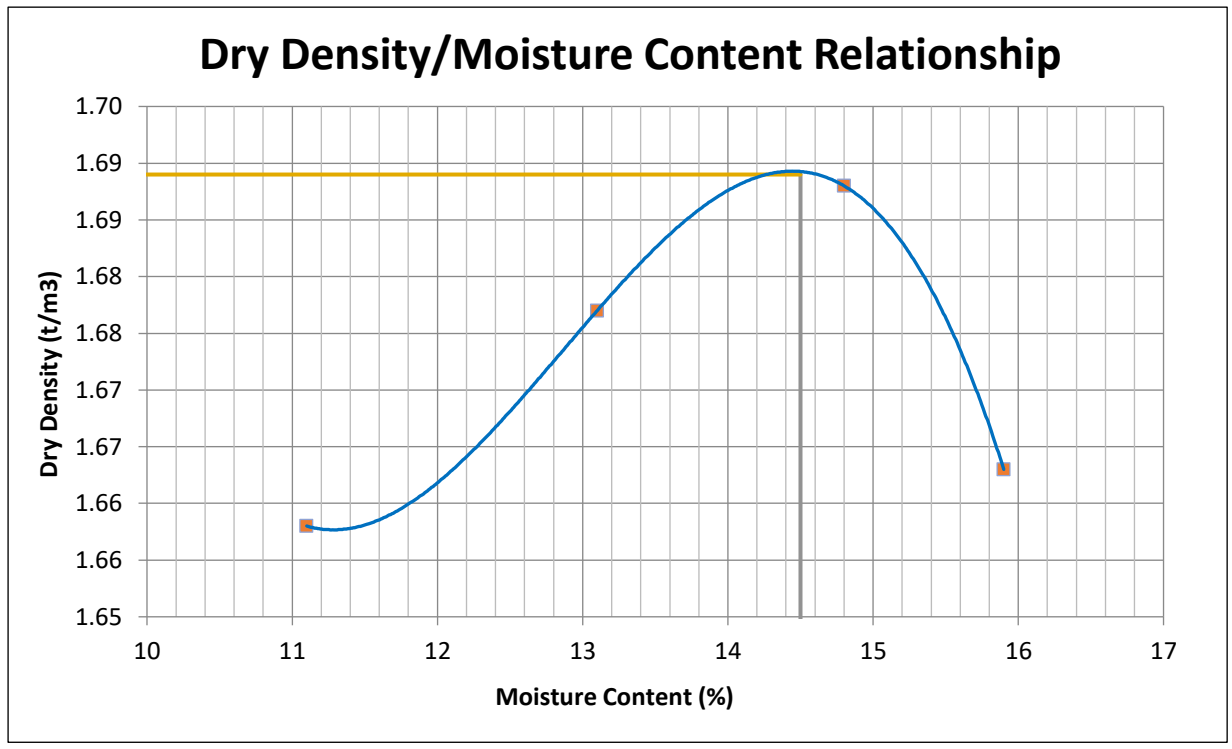
Test Procedure

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 24-25/10/2024

Preparation Prepared in accordance with the test method **Date Tested** 14/11/2024



Maximum Dry Density (t/m^3)	1.69
Optimum Moisture Content (%)	14.5
Oversize Retained on 19mm sieve (%)	2
Oversize Retained on 37.5mm sieve (%)	1
Curing Time	2 hrs
Liquid Limit Determination	Technician Assessment

Notes

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Shear Strength by Direct Shear Report

Client	KBR	**Source**	OLE.OFT BH03 1.50-2.50 + INN.LAG BH03 2.50-3.50m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT, 2609	**Sample Description**	Silty SAND
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101430-SB
Job No	S24581-1	**Lab No**	S101430

Test Procedure	AS1289 6.2.2 Soil strength and consolidation tests - Determination of the shear strength of a soil - Direct shear test using a shear box		
Sampling	Sampled by Client - results apply to the sample as received	**Date Sampled**	24-25/10/2024
Preparation	Prepared in accordance with the test method	**Date Tested**	18/11/2024

Test Details						
Remoulding Details	100% Standard Compaction @ 100% Optimum Moisture Content					
Size of Shear Box (mm)	100mm Square					
Test Parameter	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**	**Stage 5**	**Stage 6**
Specimen Dimensions (mm)	99.98 x 100.03	99.98 x 100.03	99.98 x 100.03	-	-	-
Rate of Strain (mm/min)	0.05	0.05	0.05	-	-	-
Placement Moisture Content (%)	14.1	14.1	14.1	-	-	-
Placement Wet Density (t/m^3)	1.89	1.89	1.89	-	-	-
Placement Dry Density (t/m^3)	1.66	1.66	1.66	-	-	-
Peak Values						
Normal Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Shear Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Normal Stress at Peak Shear Stress (kPa)	50.0	100.0	200.0	-	-	-
Peak Shear Stress (kPa)	31.1	69.4	125.8	-	-	-
Normal Stress at Ultimate Shear Stress (kPa)	50.0	100.0	200.0	-	-	-
Shear Stress at Ultimate Shear Stress (kPa)	29.9	66.9	125.0	-	-	-
Residual Values						
Normal Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Shear Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Normal Stress at Peak Shear Stress (kPa)	-	-	-	-	-	-
Peak Shear Stress (kPa)	-	-	-	-	-	-
Normal Stress at Ultimate Shear Stress (kPa)	-	-	-	-	-	-
Shear Stress at Ultimate Shear Stress (kPa)	-	-	-	-	-	-

Failure Envelopes			
		Peak Values	**Residual Values**
At Displacement	Friction Angle (°)	-	-
	Cohesion (kPa)	-	-
	Correlation	-	-
Peak Shear Stress	Friction Angle (°)	**31.9**	-
	Cohesion (kPa)	**2.9**	-
	Correlation	**0.9968**	-
Ultimate Shear Stress	Friction Angle (°)	**32.1**	-
	Cohesion (kPa)	**0.8**	-
	Correlation	**0.9980**	-

Notes

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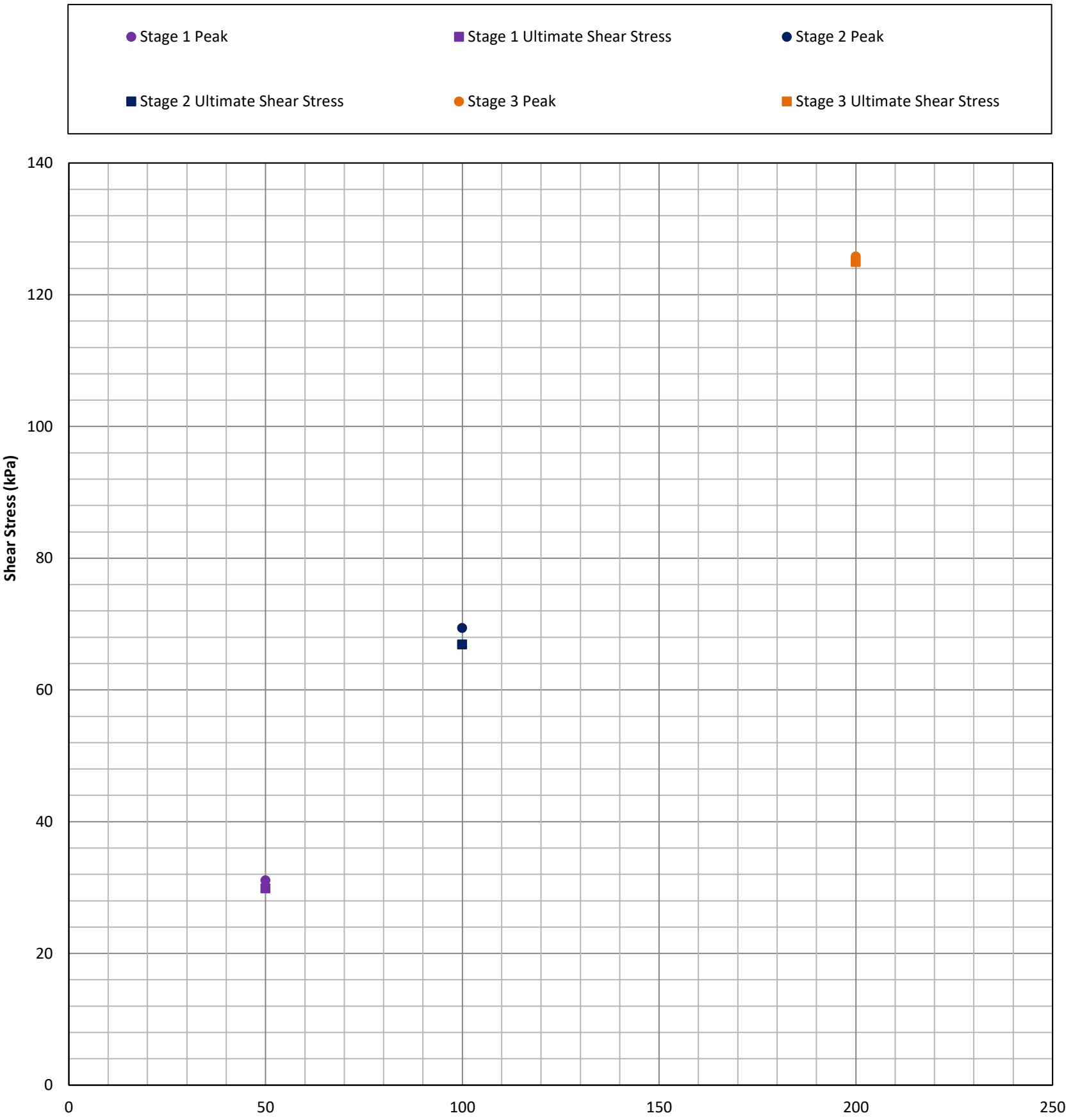
Shear Strength by Direct Shear Report

Client	KBR	**Report No**	S101430-SB

Peak Shear Stress / Normal Stress



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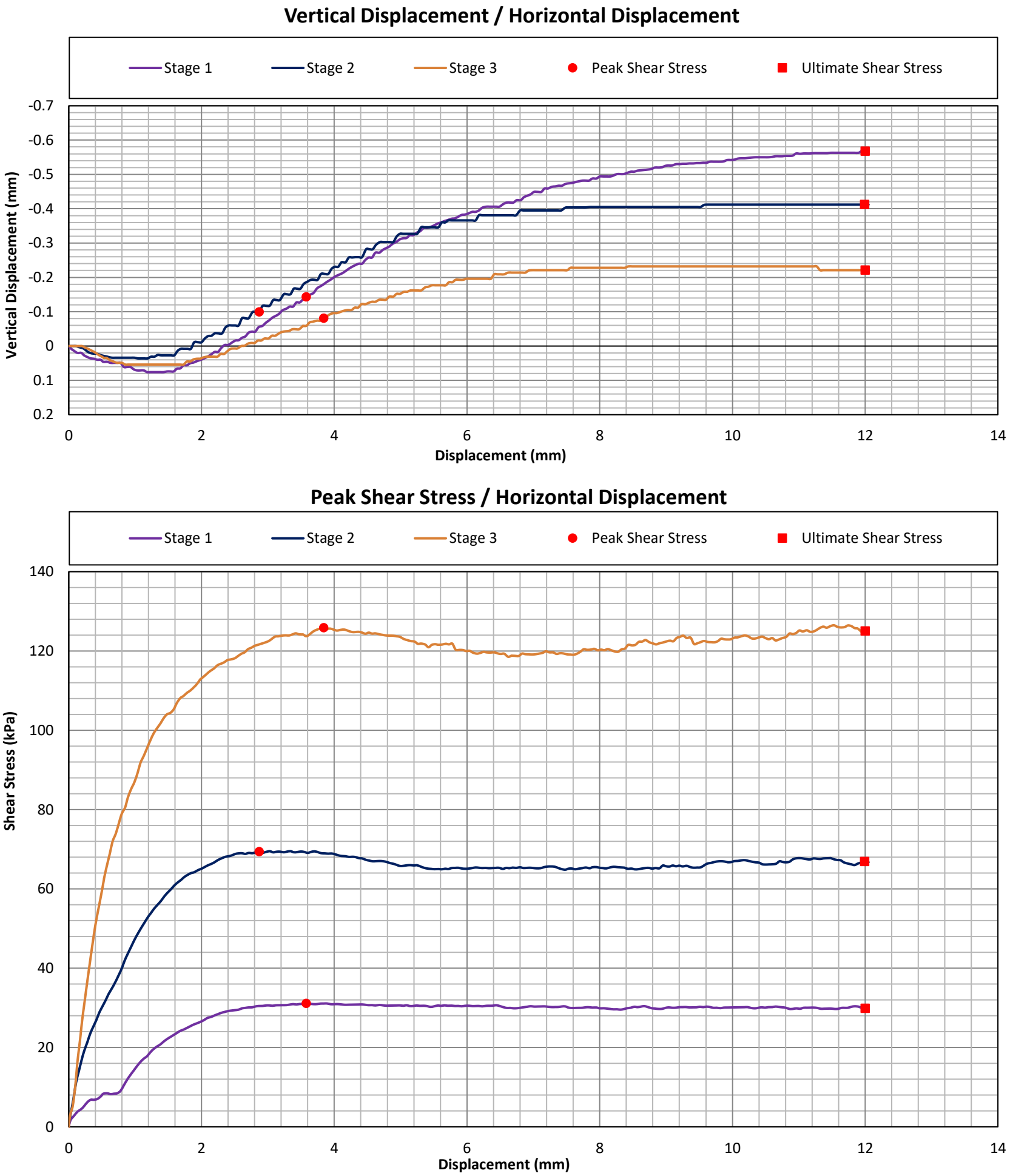
Shear Strength by Direct Shear Report

Client	KBR	**Report No**	S101430-SB



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DRY DENSITY / OPTIMUM MOISTURE CONTENT REPORT

Client	KBR	**Source**	OLE.OFT BH03 1.50-2.50 + INN.LAG BH03 2.50-3.50m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT, 2609	**Sample Description**	SAND
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101430-MDD
Job No	S24581-1	**Sample No**	S101430

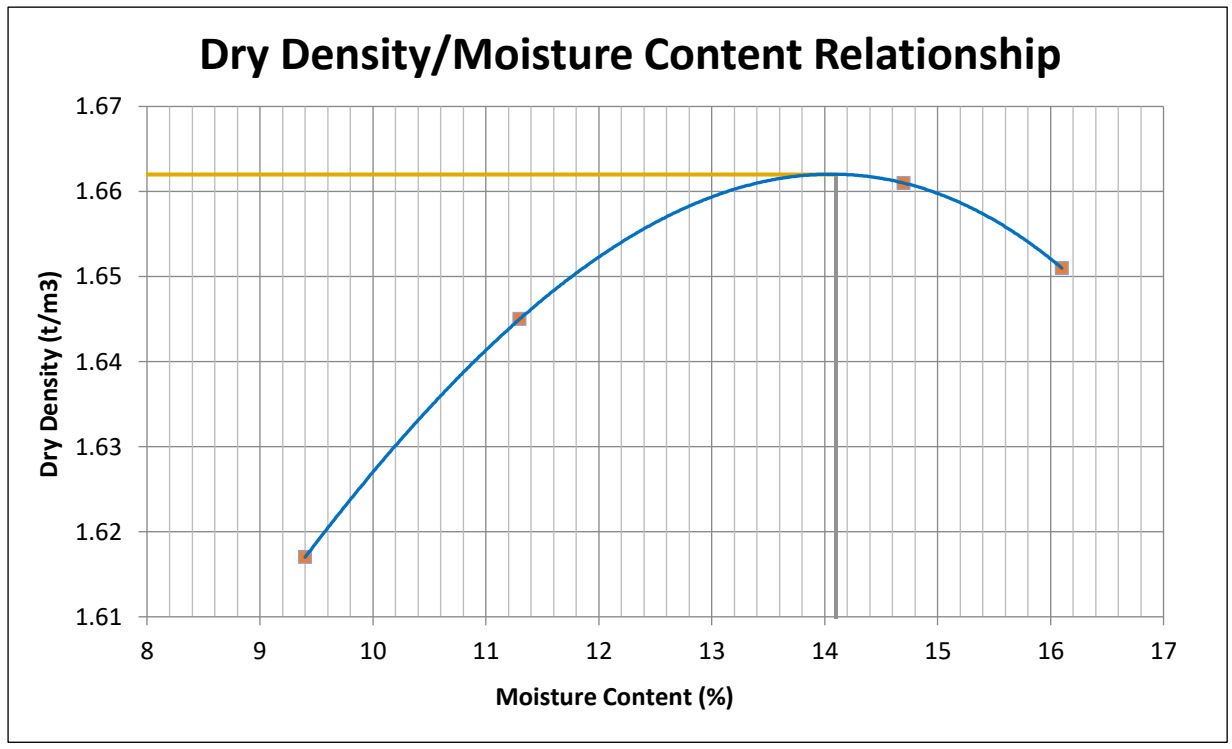
Test Procedure

☑ AS1289.5.1.1 Dry Density / Moisture Content Relationship - Standard Compaction

☑ AS1289.2.1.1 Moisture Content - Oven Drying Method (Standard Method)

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 24-25/10/2024

Preparation Prepared in accordance with the test method **Date Tested** 14/11/2024



Maximum Dry Density (t/m^3)	1.66
Optimum Moisture Content (%)	14.1
Oversize Retained on 19mm sieve (%)	0
Oversize Retained on 37.5mm sieve (%)	0
Curing Time	2 hrs
Liquid Limit Determination	Technician Assessment

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Shear Strength by Direct Shear Report

Client	KBR	**Source**	LIB.DEN BH05c 3.00-3.50m
Address	Level 4, 11 Lancaster Place, Majura Park, ACT, 2609	**Sample Description**	SAND with Silt, trace of Gravel
Project	G24469 - Matraville Chlorine Liquefaction Plant	**Report No**	S101434-SB
Job No	S24581-1	**Lab No**	S101434

Test Procedure AS1289 6.2.2 Soil strength and consolidation tests - Determination of the shear strength of a soil - Direct shear test using a shear box

Sampling Sampled by Client - results apply to the sample as received **Date Sampled** 24-25/10/2024

Preparation Prepared in accordance with the test method **Date Tested** 2/12/2024

Test Details						
Remoulding Details	100% Standard Compaction @ 100% Optimum Moisture Content					
Size of Shear Box (mm)	100mm Square					
Test Parameter	**Stage 1**	**Stage 2**	**Stage 3**	**Stage 4**	**Stage 5**	**Stage 6**
Specimen Dimensions (mm)	99.98 x 100.03	99.98 x 100.03	99.98 x 100.03	-	-	-
Rate of Strain (mm/min)	0.02	0.02	0.02	-	-	-
Placement Moisture Content (%)	22.3	22.3	22.3	-	-	-
Placement Wet Density (t/m^3)	2.08	2.08	2.08	-	-	-
Placement Dry Density (t/m^3)	1.70	1.70	1.70	-	-	-
Peak Values						
Normal Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Shear Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Normal Stress at Peak Shear Stress (kPa)	50.0	100.0	200.0	-	-	-
Peak Shear Stress (kPa)	40.7	80.3	155.2	-	-	-
Normal Stress at Ultimate Stress (kPa)	50.0	100.0	200.0	-	-	-
Shear Stress at Ultimate Stress (kPa)	36.9	72.4	151.2	-	-	-
Residual Values						
Normal Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Shear Stress at Nominated Displacement (kPa)	-	-	-	-	-	-
Normal Stress at Peak Shear Stress (kPa)	-	-	-	-	-	-
Peak Shear Stress (kPa)	-	-	-	-	-	-
Normal Stress at Ultimate Stress (kPa)	-	-	-	-	-	-
Shear Stress at Ultimate Stress (kPa)	-	-	-	-	-	-

Failure Envelopes			
		Peak Values	**Residual Values**
At Displacement	Friction Angle (°)	**-**	**-**
	Cohesion (kPa)	**-**	**-**
	Correlation	**-**	**-**
Peak Shear Stress	Friction Angle (°)	**37.3**	**-**
	Cohesion (kPa)	**3.2**	**-**
	Correlation	**0.9999**	**-**
At Ultimate Stress	Friction Angle (°)	**37.4**	**-**
	Cohesion (kPa)	**0.0**	**-**
	Correlation	**0.9997**	**-**

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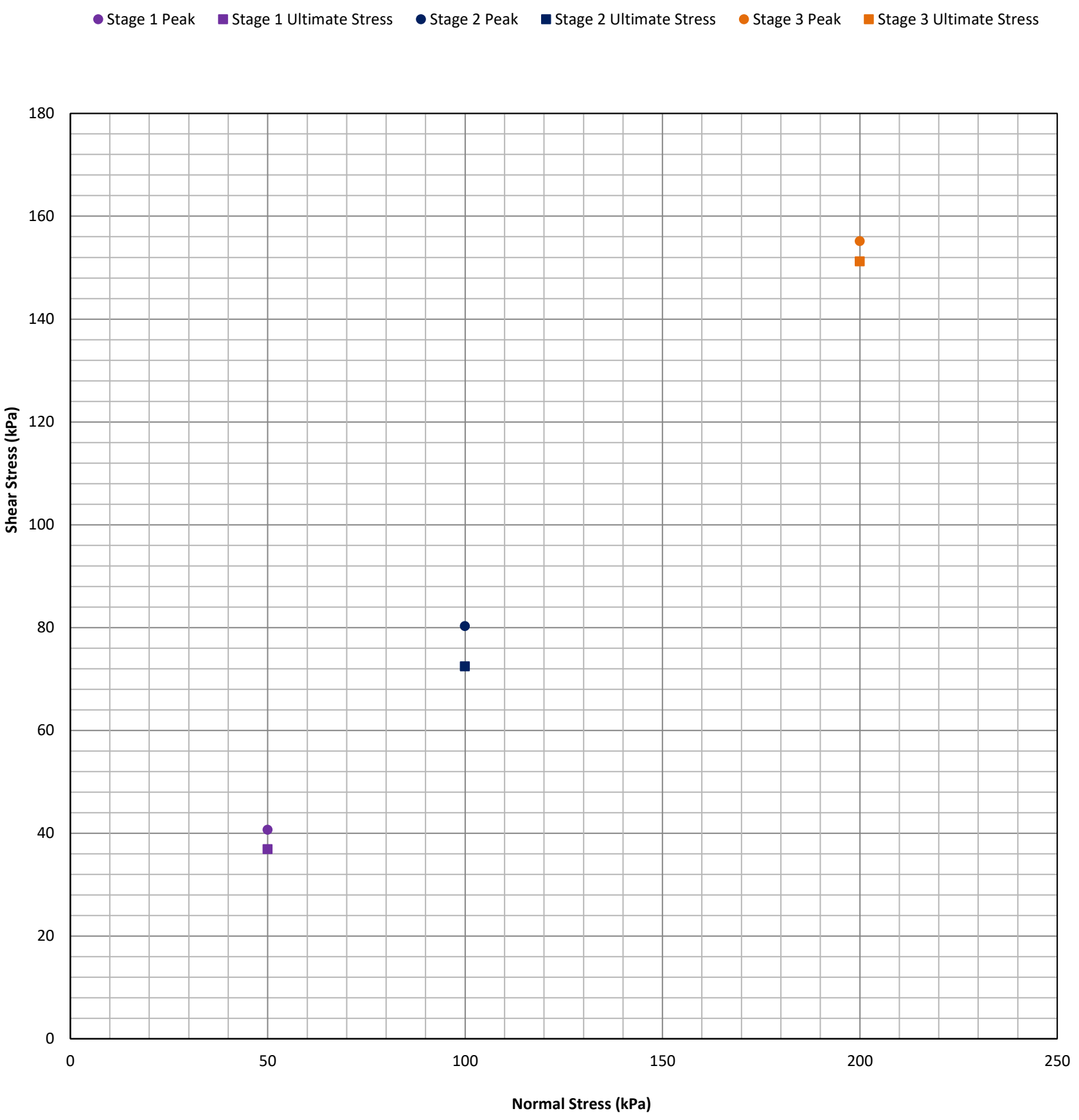
Shear Strength by Direct Shear Report

Client	KBR	**Report No**	S101434-SB

Peak Shear Stress / Normal Stress



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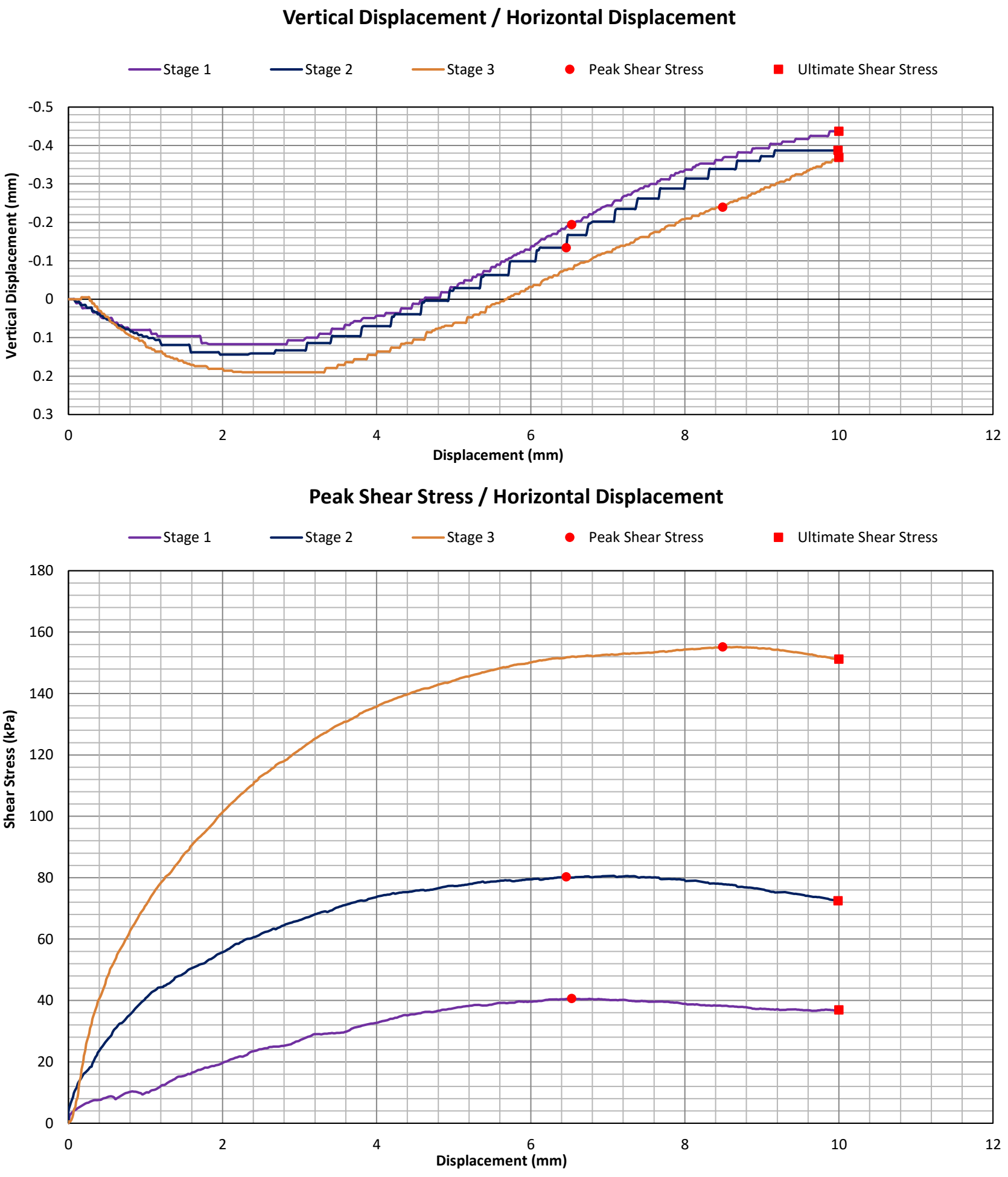
Shear Strength by Direct Shear Report

Client	KBR	**Report No**	S101434-SB



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