Proposed Industrial Warehouse Facility Preliminary Geotechnical Assessment

Lot 152 Raven Street, Kooragang, NSW

NEW20P-0171-AB
16 February 2021

Qualtest
LABORATORY (NSW) PTY LTD

GEOTECHNICAL I LABORATORY I EARTHWORKS I QUARRY I CONSTRUCTION MATERIAL TESTING

16 February 2021

EJE Architecture Pty Ltd
412 King Street,
NEWCASTLE NSW 2300

Attention: Mr Grant Shultz

Dear Grant

RE: PROPOSED INDUSTRIAL WAREHOUSE FACILITY
LOT 152 RAVEN STREET, KOORAGANG
PRELIMINARY GEOTECHNICAL ASSESSMENT

Please find enclosed our Preliminary Geotechnical Assessment report for the proposed industrial warehouse facility to be located at Lot 152 Raven Street, Kooragang NSW.

The report includes a description of geotechnical conditions at the site, preliminary foundation design parameters, soil aggressivity to buried structures, preliminary pavement design parameters, excavation conditions and earthworks.

If you have any questions regarding this report, please do not hesitate to contact Ben Bunting, Shannon Kelly, or the undersigned.

For and on behalf of Qualtest Laboratory (NSW) Pty Ltd

Jason Lee
Principal Geotechnical Engineer

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1.0 Introduction

Qualtest Laboratory NSW Pty Ltd (Qualtest) is pleased to present this preliminary geotechnical report to EJE Architecture Pty Ltd (EJE) on behalf of Port of Newcastle (PoN), to support a DA submission for the proposed Industrial Warehouse Facility to be located at Lot 152 Raven Street, Kooragang, NSW.

Based on the brief and concept plans provided in an email from EJE dated 18 August 2020, the proposed redevelopment is understood to comprise an industrial warehouse building covering approximately 3,000m² of the approximately 5,800m² available building area at the site.

The scope of work for the geotechnical assessment included providing discussion and recommendations on the following:

- Description of the surface and subsurface conditions;
- Excavation conditions;
- Depth to rock and groundwater (where encountered);
- Preliminary recommendations on suitable footing types, founding levels and foundation design parameters (within depth of investigation);
- Soil aggressivity to concrete and steel (exposure classifications for foundations);
- Preliminary pavement design parameters;
- Site preparation and recommended earthworks construction procedures;
- Suitability of the site soils for use as fill and on fill construction procedures; and,
- Recommendations on anticipated requirements for additional geotechnical investigations as part of detailed design once concept design is finalised.

This report presents the results of the field work investigations, and provides recommendations for the scope outlined above.

2.0 Field Work

The field work investigations were carried out on 12 January 2021 and comprised of:

- DBYD search and scanning of proposed test locations using an accredited professional cable locator to check for the presence of underground services;
- Site walkover to make observations of surface features at the property and in the immediate surrounding area;
- Drilling of four boreholes (BH01 to BH04) using a track mounted drill rig with V-bit auger attachment to depths of between 2.20mm and 4.10m within proposed development areas;
- Standard Penetrometer Tests (SPTs) were undertaken at the nominal 1.5m intervals at each borehole location to assist in the interpretation of the in-situ density / consistency of the soil and assess conditions;
- Boreholes were backfilled with the excavation spoil and compacted using the drill rig auger attachment and tracks.

Investigations were carried out by an experienced Environmental Scientist from Qualtest who located the boreholes, carried out the testing and sampling, produced field logs of the boreholes, and made observations of the site surface conditions.

Engineering logs of the boreholes are presented in Appendix A. Approximate borehole locations are shown on the attached Figure AB1. Boreholes were located in the field by handheld GPS and relative to existing site features.

3.0 Site Description

3.1 Surface Conditions

The site is located at Lot 152 DP1202468 (No. 70) Raven Street, Kooragang, which is an irregular battle-axe shaped allotment. The western side of the lot generally comprises a Right of Carriageway providing access to Raven Street. The subject site comprises the available building area on the eastern side of the lot, which is a roughly trapezium shaped area of approximately 5800m².

The site is located north of Raven Street in Kooragang, about 840m north of the South Channel of the Hunter River. The site consisted of vacant land with asphalt paved road in the western portion of the lot aligned north-south, an asphalt paved crossing in the northern portion of the site aligned roughly east-west. The majority of the remainder of the site appeared to be covered with road base or similar gravel material. Grass is present along the eastern side of the site, and in other scattered areas of the site.

Photographs of the site taken on the day of the site investigations are shown below.

Photograph 1: Facing east from near BH03.

Photograph 2: Facing southeast from near BH03.

Photograph 3: Facing south from near BH04 (near north-eastern corner of site).

Photograph 4: Facing southwest from near BH04.

On the day of the investigation, the site was judged to be well drained primarily by way of infiltration into the site soils in unsealed areas of the site. Excess surface water is expected to follow the site topography, and flow to the south towards Raven Street

3.2 Subsurface Conditions

Reference to the 1:100,000 Newcastle-Hunter Coastal Quaternary Geology map indicates that the site is underlain by "*modern fill on Quaternary deposits*".

The 1:100,000 Newcastle Coalfield Geology Map shows that the fill at the site is underlain by Quaternary aged Alluvial deposits, comprising Gravel, Sand, Silt, and Clay soil types.

Table 1 presents a summary of the typical soil types encountered at borehole locations during the field investigation, divided into representative geotechnical units.

Table 2 contains a summary of the distribution of the above geotechnical units at the borehole locations.

TABLE 1 – SUMMARY OF GEOTECHNICAL UNITS AND SOIL TYPES

Unit	Soil Type	Description
1	FILL	Sandy GRAVEL / Gravelly SAND – fine to medium grained, sub-angular to angular, pale grey to brown, fine to medium grained sand, trace fines of low plasticity. SAND – fine to medium grained, brown to pale brown / yellow-brown, with some shells, trace fine grained gravel in places. Clayey Sandy GRAVEL – fine to medium grained, sub-angular to angular, brown to grey-brown, fine to coarse grained sand, fines of low to medium plasticity. SILT – low plasticity, white to pale grey, with some crystalline material (suspected gypsum). CLAY – medium to high plasticity, brown to dark brown. At BH03, surface layer of Asphalt.
2	ESTUARINE DEPOSITS	Silty CLAY – medium to high plasticity, grey to dark grey. Silty Sandy CLAY – medium to high plasticity, grey to dark grey, fine to medium grained sand. CLAY – medium to high plasticity, grey and dark grey.
3	ALLUVIUM	At BH01, layer of Alluvium/Estuarine Deposits: Clayey SAND – fine to medium grained, grey to dark grey, fines of low to medium plasticity. SAND – fine to medium/coarse grained (mostly fine to medium grained), grey to dark grey-brown / brown to pale brown, with some shells in places.

TABLE 2 – SUMMARY OF GEOTECHNICAL UNITS ENCOUNTERED AT EACH BOREHOLE LOCATION

Location	Unit 1 Fill	Unit 2 Estuarine Deposits	Unit 3 Alluvium
BH01	0.00 - 1.40	1.40 - 2.70	2.70 - 4.10#
BH02	0.00 - 1.50	-	1.50 - 2.20#
BH03	0.00 - 1.60	-	1.60 - 4.10#
BH04	0.00 - 2.00	2.00 - 2.90	2.90 - 4.10#
NOTES:	# denotes borehole collapse below depth of water table.		

Groundwater levels were encountered in BH01 to BH04 at depths of 2.30m, 2.10m, 3.00m, and 3.50m, respectively.

It should be noted that groundwater conditions can vary due to rainfall and other influences including tidal fluctuation, regional groundwater flow, temperature, permeability, recharge areas, surface condition, and subsoil drainage.

4.0 Acid Sulfate Soils

Reference to the Acid Sulfate Soil Risk Mapping for Lower Hunter Catchment (1:25,000 scale, 2008 Edition 3) indicates that the site is located within an area of "disturbed terrain".

Qualtest completed an Acid Sulfate Soil Assessment in conjunction with the Preliminary Contamination Assessment (PCA). Based on the field observations, and the laboratory results, the estuarine/alluvial sands and clays below fill material (from about 1.5m below ground surface (bgs)), were assessed to comprise Acid Sulfate Soils and a management plan was developed for the site, refer to Qualtest report ref: NEW20P-0171-AC, dated 8 February 2021.

5.0 Soil Aggressivity to Buried Structures

Samples considered representative of conditions on site for the proposed development were sent under chain of custody conditions to Eurofins NATA-accredited laboratories for the aggressivity testing. Results of the testing are presented in Appendix B, with a summary of the results presented in Table 3.

TABLE 3 – SUMMARY OF LABORATORY TEST RESULTS FOR AGGRESSIVITY

Location	Depth (m)	Material Description	pH (1:5 Aqueous extract)	Chloride (mg/kg)	Sulphate (mg/kg)	Resistivity (ohm.cm)
BH02	1.50 – 1.60	SAND	6.5	< 10	9600	560
BH03	3.50 – 3.60	SAND	7.8	19	820	4400

The above results indicate neutral alkaline soil, of variable sulphate and low chloride content.

The sample results are compared to exposure classifications given in Australian Standard AS2159-2009, *Piling Design and Installation* in Table 4.

TABLE 4 – SOIL AGGRESSIVITY TO BURIED STRUCTURAL ELEMENTS

Sample	Exposure Classification for Concrete Piles	Exposure Classification for Steel Piles
BH02 (1.50 – 1.60m)	Moderate	Severe
BH03 (3.50 – 3.60m)	Mild	Mild

A uniform corrosion allowance of 0.04mm to 0.1mm per year would apply for steel piles with a 'Severe' exposure classification in accordance with AS2159-2009.

For concrete placement within a 'Moderate' exposure classification, the following shall apply in accordance with AS2159-2009:

Minimum concrete strength (f'_c) for reinforced cast in place piles = 40 MPa;

Minimum cover to reinforcement = 25mm for precast piles, 65mm for cast in place piles.

6.0 Discussion and Recommendations

6.1 General

It is assessed that the site has been altered by filling to depths in the order of 1.4m to 2.0m. Placement of the fill has not been witnessed by Qualtest, and it is understood fill was not placed as controlled fill in accordance with the requirements of AS2870-2011 or AS3798-2007.

The fill is underlain in places by firm to stiff clay which is likely to be susceptible to consolidation settlement if loaded. Based upon the limited information from four boreholes, the clay ranges from not observed in BH02 and BH03, to a depth of 2.7m at BH01 and 2.9m at BH04.

Therefore, for low risk engineering construction, it is recommended that settlement sensitive structures be founded beneath the fill and firm clay.

It is generally envisaged that footing options will include piles founded within the underlying Unit 3 Sand Alluvium possibly at depths in the order of 3m to 5m.

Parameters for pile footings are provided in this report based upon the limited information obtained at borehole locations during the preliminary assessment. Further investigations including CPT testing may allow the adoption of larger geotechnical capacities depending upon the results of such investigations.

Alternatively, shallow footings may be considered for some or all elements of the development if:

- Further investigations indicate the existing fill is of acceptable density/consistency, or the density/consistency is increased by replacement and compaction where required;
- Overall pressures are limited to reduce the potential for settlement of compressible clay, or the site could be preloaded with fill to remove primary settlement and reduce creep settlement. E.g. limit bearing pressures of shallow footings with widths of less than 0.5m to 100kPa, and bearing pressures of slabs etc. greater than about 0.5m wide to 25kPa; and,
- The risks of founding on the fill above the compressible clay are understood and accepted.

This option is more likely to be acceptable for elements which are less settlement sensitive such as driveways and external parking areas which are isolated from the pile supported elements, subject to specific assessment by, and following any treatment recommended by, the geotechnical authority.

Further advice on this option may be provided at the time of further investigations.

Based on the assessed presence of a firm clay layer at depths in the order of 1.4m to 2.9m at some locations, it is recommended that assessment of potential compressibility of this layer is undertaken if fill mounds or other broad surcharge loading is proposed.

6.2 Foundations

For low risk engineering construction, it is recommended that settlement sensitive structures be founded beneath the fill and firm clay as discussed in Section 6.1.

Structural footings and any other settlement sensitive elements of the proposed development should be founded beneath all uncontrolled fill, and firm/loose material.

Footing options for the proposed development may include piles such as progressively cased bored piles, screw piles, grout injected continuous flight auger (CFA) piles, or driven piles, founded in the medium dense or better natural sand soils soils.

Conventional bored piers are likely to be problematic due to the presence of sands and groundwater. Allowance should be made to progressively case the holes during drilling.

There is a risk of causing vibration-induced damage to adjacent buildings or structures with driven displacement piles. Vibration monitoring and dilapidation survey on nearby structures prior to any pile driving are recommended if driven piles are to be used.

Driven piles and steel screw piles may need to be pre-bored through the upper fill in some places depending on pile type, and allowance for this should be made.

Table 5 presents a summary of ultimate pile design parameters for deep footings (founding depth greater than 3 times maximum footing width) that have been adopted for the relevant site materials. Elastic soil parameters are also provided for use in elastic analysis of foundations.

TABLE 5 – SUMMARY OF ULTIMATE PILE DESIGN PARAMETERS

Soil Description	E (MPa)	ν	Displacement Piles		Non Displacement Piles	
			f_b (kPa)	f_s (kPa)	f_b (kPa)	f_s (kPa)
Fill	-	-	-	-	-	-
Topsoil	-	-	-	-	-	-
CLAY – Stiff or better (if encountered)	10	0.4	450	40	450	40
SAND – Medium Dense or better	20	0.35	900	50	900	35
f_b = Ultimate End Bearing Capacity E = Young's Modulus			f_s = Ultimate Shaft Adhesion ν = Poisson's Ratio			

Notes:

- The parameters provided are for footings founded within the depths investigated by boreholes (to depths of 4.10m or less). If deeper footings are proposed, additional investigations should be carried out to assess conditions to a depth of at least three pile diameters below the pile toe level.
- Ultimate values occur at large settlements (>5% of minimum footing dimensions).
- The ultimate pile parameters presented in Table 1 should be used in limit state pile design in accordance with Australian Standard AS 2159-2009, *Piling – Design and Installation*.
- A geotechnical strength reduction factor should be adopted for use with the above ultimate soil and rock parameters. A geotechnical strength reduction factor of 0.45 is recommended based on available information at this stage.
- With the exception of steel “Screw-Piles”, it is expected that the settlement of deep footings proportioned as recommended above should be less than about 1% of the effective pile diameter.
- Where the founding stratum is underlain by a weaker layer, the pile toe should be located at least three pile diameters above the top of the weaker layer.
- Piles should be no closer than 2.5 pile diameters apart. If closer than this, interaction effects between piles should be taken into account and pile group settlement assessed.
- More accurate ultimate bearing capacities and settlement estimates can be obtained by undertaking static load tests on trial piles.
- These recommendations do not preclude the use of established correlations for specific pile types and may be upgraded by carrying out pile load testing.

The parameters are based upon the limited information obtained at borehole locations during the preliminary assessment. Further investigations including CPT testing may allow the adoption of larger geotechnical capacities depending upon the results of such investigations.

The values presented in Table 5 are for the purposes of calculating minimum geotechnical capacities. These values may be exceeded in site soils, particularly if dense sands are encountered during activities such as pile driving. It is recommended that pile driving equipment and piles have some additional capacity to allow piles to be driven to the design depths if higher resistance is encountered.

Softwood timber mini-piles of 125mm toe diameter driven to a design set in dense sands generally achieve working loads of about 75kN. A test pile may be carried out to assess the depth at which the design capacity may be achieved.

As screw pile dimensions, configurations and installation procedures vary between piling contractors, pile design optimisation is usually best conducted by the piling contractor proposed to undertake the installation work. The piling contractors typically have established performance data from load testing and experience, specifically for their pile types and configurations.

These recommendations do not preclude the use of established correlations for specific pile types and may be upgraded by carrying out pile load testing.

Inspection should be carried out by a geotechnical authority during construction to confirm the conditions assumed in this report and in the design.

6.3 Excavation Conditions

The depths of Fill, Estuarine deposits and Alluvium encountered in the boreholes are summarised in Table 2.

It is expected that excavations could be achievable using conventional backhoe or excavator bucket, at least to the depth of excavation indicated on borehole logs.

Temporary excavations should be battered at 1V:1.5H or flatter and protected from erosion. Steeper excavations may be supported by means of temporary shoring.

Groundwater levels were encountered in BH01 to BH04 at depths of 2.30m, 2.10m, 3.00m, and 3.50m, respectively. Groundwater inflows are likely to occur if excavations proceed below the water table. These inflows are likely to cause collapse of unsupported excavations in sandy soils.

If encountered, groundwater inflows are likely to be rapid due to the relatively high permeability of the sand soils. It is recommended that further assessment is carried out to assist plans for shoring and dewatering if excavation below the water table is proposed.

The safe working procedures of Work Cover NSW *Excavation work code of practice*, dated January 2020 should be followed.

Care must be taken not to cause relaxation of ground supporting nearby structures or services during excavations on site.

6.4 Site Preparation

Site preparation suitable for structures, pavement support and site re-grading should consist of:

- Following any bulk excavation to proposed subgrade level, areas for proposed structures, pavement construction or site re-grading should be stripped to remove all existing uncontrolled fill, vegetation, topsoil, root affected or any other potentially deleterious materials;
- Following stripping, the exposed subgrade should be proof rolled (minimum 10 tonne static roller), to identify any wet or excessively deflecting material. Any such areas should be over excavated and backfilled with clean sand or approved select material;
- Heavy compaction (vibrating smooth drum roller, with addition of water where necessary) of the foundation subgrade may be required to improve the subgrade prior to construction in consultation with the geotechnical authority;
- The moisture content of the subgrade materials and therefore the need for moisture conditioning or over-excavation and replacement, will be largely dependent on pre-existing and prevailing weather conditions at the time of construction;
- Subgrade preparation should be carried out using a tracked excavator equipped with a smooth sided ('gummy') bucket to minimise the risk of over-disturbance of soils;
- Protect the area after subgrade preparation to maintain moisture content as far as practicable. The placement of subbase gravel would normally provide adequate protection;
- Site preparation should include provision of drainage and erosion control as required, as well as sedimentation control measures.

If over-wet subgrades exist at the time of construction or deleterious materials are encountered at subgrade level, these materials should be over-excavated and be replaced with a minimum depth of 300mm of well graded granular select material with CBR of 15% or greater.

The requirement for, and extent of subgrade replacement / select filling, should be confirmed by the geotechnical authority at the time of construction.

6.5 Fill Construction Procedures

Earthworks for pavement construction or support of foundations should consist of the following measures:

- Approved fill beneath structures and pavements should be compacted in layers not exceeding 300mm loose thickness;
- The top 300mm of natural subgrade below pavements or the final 300mm of road subgrade fill should be compacted to a minimum density index of 80% (AS1289 5.6.1) for granular soils, or a minimum density ratio of 100% Standard (AS1289 5.1.1) for cohesive soils;
- At design subgrade level for pavements or structures, the surface should be compacted for a depth of at least 1.0m to a minimum density index of 70% (AS1289 5.6.1) for granular soils, or a minimum density ratio of 95% Standard (AS1289 5.1.1) for cohesive soils. Compaction should be confirmed by penetrometer testing and/or density testing prior to placement of pavement materials or pouring of concrete for footings;
- If cohesive site fill (clay soils) are placed beneath structures, they should be compacted to a minimum density ratio of 98% Standard Compaction within ±2% of OMC;
- Where back filling of excavations is proposed (e.g. service trenches), approved clean fill should be compacted to a minimum density index of 70% (AS1289 5.6.1) for granular soils, or a minimum density ratio of 95% Standard (AS1289 5.1.1) for cohesive soils, in maximum lifts of 300mm depth;
- All fill should be supported by properly designed and constructed retaining walls or else battered at 1V:2H or flatter and protected against erosion;
- Earthworks should be carried out in accordance with the recommendations outlined in AS3798-2007 *'Guidelines for Earthworks for Commercial and Residential Developments'*.

6.6 Suitability of Site Materials for Re-Use as Fill

The following comments are made with respect to suitability of site materials for re-use as fill based upon geotechnical engineering considerations:

- Unit 1 Fill materials may be variable, and suitability for re-use should be confirmed at the time of construction. The suitability for re-use of some of these materials is likely to be affected by the presence of roots / organic matter, waste or other deleterious materials. Where soil which is unaffected by such materials are selectively won under the supervision of the geotechnical authority at the time of construction, they may be suitable for re-use as general fill for engineering purposes. It is anticipated that the Silt (possible gypsum) material would not be suitable where encountered at subgrade level of proposed pavements or footings;
- Unit 2 Estuarine Soil materials may be wet of OMC to an extent that it cannot be compacted to a stiff or better consistency. It will generally require moisture conditioning prior to re-use such as drying back, blending with drier soil and/or lime treatment. Following moisture conditioning these materials may be suitable for re-use as general fill for engineering purposes subject to any treatments required as part of the Acid Sulfate Soil Management Plan.

- Unit 3 Alluvium materials are generally expected to be suitable for re-use as general fill for engineering purposes subject to any treatments required as part of the Acid Sulfate Soil Management Plan.

Final selection of fill materials should consider properties such as reactivity which is anticipated to be low for site won granular fill material.

The suitability of material for re-use should be assessed and confirmed by the geotechnical authority at the time of construction. The materials may require some moisture conditioning.

6.7 Preliminary Pavement Design Parameters

California Bearing Ratio (CBR) testing of site materials was beyond the scope of this preliminary assessment. Based upon the results of soil profiles encountered in the boreholes and our experience with similar type materials, as a preliminary guide it is anticipated that:

- The majority of subgrade material is likely to comprise granular fill, Sand fill or sand/gravel mixtures, assessed to have a design CBR in the order of 10%;
- Design CBR of cohesive layers where encountered may be in the order of 3% to 5% (TBC);
- Silt (possible gypsum) material would not be suitable where encountered at subgrade level;
- Existing pavement gravel material is likely to be suitable for re-use as Select Fill material subject to selectively excavating the material and excluding root affected and other unsuitable zones. It should be assessed for suitability if proposed for re-use as pavement subbase or base.

Pavement design parameters should be assessed as part of further investigations during the detail design stage. The suitability of material for re-use should be assessed and confirmed by the geotechnical authority at the time of construction. Subgrade should be prepared and compacted in accordance with the recommendations of the geotechnical report / design.

6.8 Anticipated Requirements for Additional Geotechnical Investigations as part of Detailed Design

Further geotechnical investigation and/or advice should be carried out as part of detailed design once concept design is finalised, including for foundations, earthworks procedures, pavement design, infiltration rates etc. where required.

It is recommended that electric piezocone tests (CPT's) are carried out within the footprint of any proposed settlement sensitive developments to assess piling founding conditions, depths and parameters. This would likely comprise several broadly spaced tests to provide coverage of the proposed building footprint, carried out to depths in the order of 10m (or deeper for highly loaded piles).

Additional boreholes may be conducted to correlate profiles with the CPTs, and to collect samples for subsequent laboratory testing, including but not necessarily limited to California Bearing Ratio (CBR) tests, Atterberg Limits and Particle Size Distribution (Gradings), for pavement design and suitability of existing site materials for re-use.

It is recommended that Dynamic Cone Penetrometer (DCP) Tests are undertaken at locations where shallow footings are proposed to assist in the interpretation of the in-situ density / consistency of the soil, and assessment of likely suitability for shallow footings and/or compaction requirements. This would likely comprise initial testing on a grid style pattern. Test locations would likely require pre-drilling through the upper gravel layer.

7.0 Limitations

The findings presented in the report and used as the basis for recommendations presented herein were obtained using normal, industry accepted geotechnical design practices and standards. To our knowledge, they represent a reasonable interpretation of the general conditions of the site.

The extent of testing associated with this assessment is limited to discrete test locations. It should be noted that subsurface conditions between and away from the test locations may be different to those observed during the field work and used as the basis of the recommendations contained in this report.

If subsurface conditions encountered during construction differ from those given in this report, further advice should be sought without delay.

Data and opinions contained within the report may not be used in other contexts or for any other purposes without prior review and agreement by Qualtest. If this report is reproduced, it must be in full.

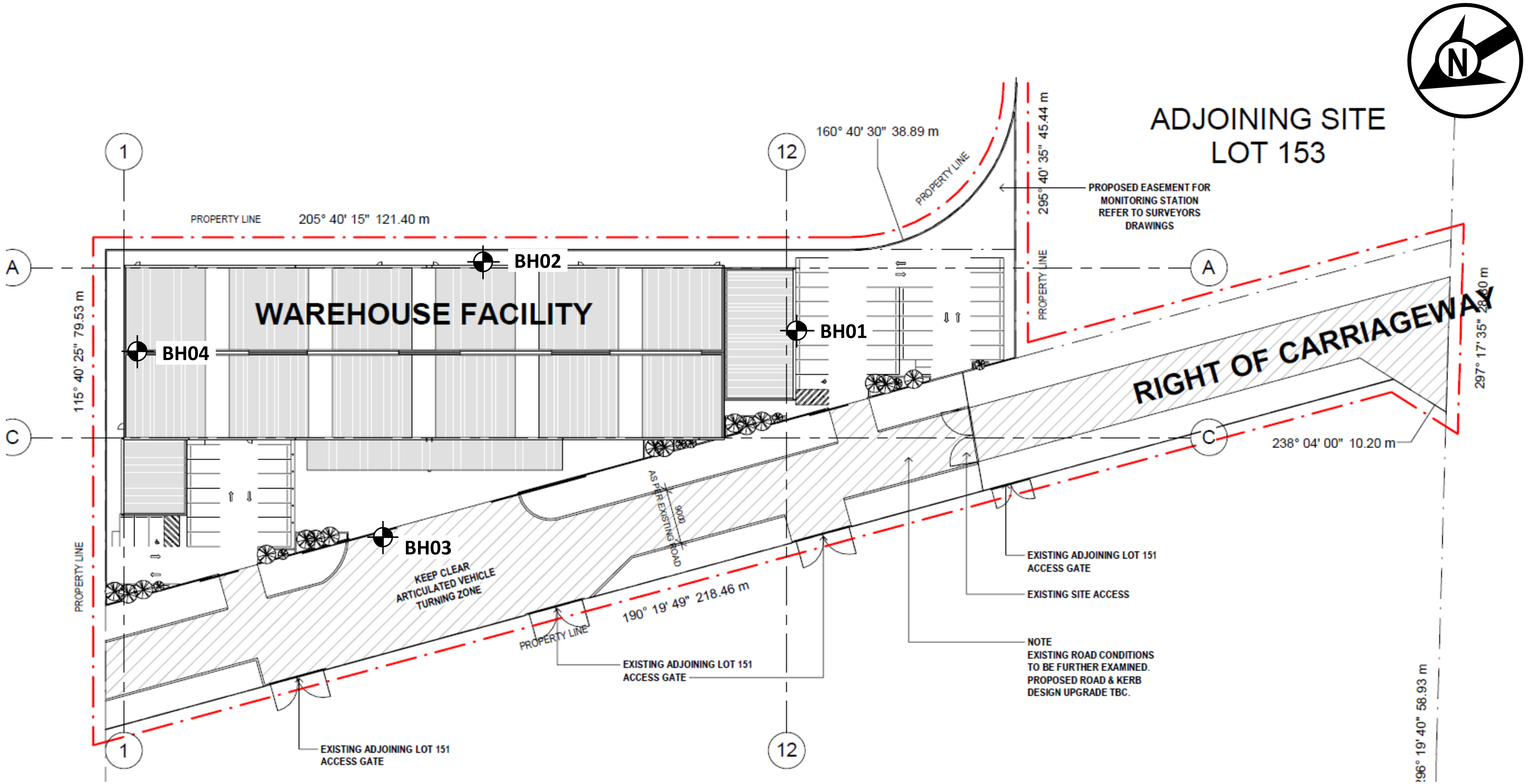
If you have any further questions regarding this report, please do not hesitate to contact Ben Bunting, Shannon Kelly, or the undersigned.

For and on behalf of Qualtest Laboratory (NSW) Pty Ltd.

Jason Lee
Principal Geotechnical Engineer

FIGURE AB1:

Site Plan and Approximate Test Locations



Based on drawing provided by client (Ref: Project No: 13281, Drawing No: A-010, Revision: A, dated: 23.10.2020, by EJE Architecture Pty Ltd).

LEGEND:

⌖ Approximate borehole location.

Qualtest LABORATORY (NSW) PTY LTD

Client:	EJE ARCHITECTURE PTY LTD	Drawing No:	FIGURE AB1
Project:	PROPOSED INDUSTRIAL DEVELOPMENT	Project No:	NEW20P-0171
Location:	LOT 152 DP1202468 RAVEN STREET, KOORAGANG NSW	Scale:	NOT TO SCALE
Title:	SITE PLAN AND APPROXIMATE TEST LOCATIONS	Date:	11/02/21

APPENDIX A:

Results of Field Investigations

ENGINEERING LOG - BOREHOLE

Qualtest LABORATORY (NSW) PTY LTD

CLIENT:	NORTHROP CONSULTING ENGINEERS	**BOREHOLE NO:**	**BH01**
PROJECT:	PROPOSED INDUSTRIAL WAREHOUSE FACILITY	**PAGE:**	1 OF 1
LOCATION:	LOT 152, RAVEN STREET, KOORAGANG	**JOB NO:**	NEW20P-0171
		LOGGED BY:	BS
		DATE:	12/1/21

DRILL TYPE: TRACK MOUNTED DRILL RIG **SURFACE RL:**
BOREHOLE DIAMETER: 100 mm **DATUM:** AHD

METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T		E 0.10m		0.00–0.20m	GP	FILL: Sandy GRAVEL - fine to medium grained, sub-angular to angular, pale grey to brown, fine to medium grained sand, trace fines of low plasticity.	D				FILL
		0.50m SPT 11, 17, 21 N* = 38; 0.95m; 1.00m E 1.10m		0.20–1.40m	SP	FILL: SAND - fine to medium grained, brown, with shells.	D - M				
	Water inflow at approx. 2.3m	1.50m SPT 3, 3, 4 N* = 7; 1.95m; 2.00m E 2.10m		1.40–2.50m	CH	Silty CLAY - medium to high plasticity, grey to dark grey.	M > W_P	F / St	HP HP HP	100 110 55	ESTUARINE DEPOSITS
		2.50m SPT 7, 9, 11 N* = 20		2.50–2.70m	CH	Silty Sandy CLAY - medium to high plasticity, grey to dark grey, fine to medium grained sand.	M > W_P	F / St	HP	65	
		2.95m; 3.00m E 3.10m		2.70–3.30m	SC	Clayey SAND - fine to medium grained, grey to dark grey, fines of low to medium plasticity.	W				ALLUVIUM / ESTUARINE DEPOSITS
		4.00m E 4.10m		3.30–4.10m	SP	SAND - fine to medium grained, grey, with shells.	W				ALLUVIUM

Hole Terminated at 4.10 m
Borehole Collapse

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - BOREHOLE

Qualtest LABORATORY (NSW) PTY LTD

CLIENT:	NORTHROP CONSULTING ENGINEERS	**BOREHOLE NO:**	**BH02**
PROJECT:	PROPOSED INDUSTRIAL WAREHOUSE FACILITY	**PAGE:**	1 OF 1
LOCATION:	LOT 152, RAVEN STREET, KOORAGANG	**JOB NO:**	NEW20P-0171
		LOGGED BY:	BS
		DATE:	12/1/21

DRILL TYPE: TRACK MOUNTED DRILL RIG **SURFACE RL:**

BOREHOLE DIAMETER: 100 mm **DATUM:** AHD

METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T		E 0.10m		0.00–0.65	GC	FILL: Clayey Sandy GRAVEL - fine to medium grained, sub angular to angular, brown to grey-brown, fine to coarse grained sand, fines of low to medium plasticity.	M				FILL
		0.50m SPT 2, 1, 1 N* = 2 0.95m		0.65–0.85	ML	FILL: SILT - low plasticity, white to pale grey, with some crystalline material, possibly gypsum.	M < w_p				
		1.00m SPT 3, 4, 6 N* = 10 1.45m		0.85–1.10	SP	FILL: SAND - fine to medium grained, brown.	D - M				
				1.10–1.30	CH	FILL: CLAY - medium to high plasticity, brown to dark brown.		VSt	HP HP HP	270 330 250	
		1.50m E 1.60m		1.30–1.50	SP	FILL: SAND - fine to medium grained, grey to dark grey, with some black, with trace glass.	M - W				
	Water inflow at ~2.05m	2.00m E 2.10m		1.50–2.20	SP	SAND - fine to medium grained, brown. Becoming brown to pale brown.	W				ALLUVIUM / POSSIBLE FILL
				2.20		Hole Terminated at 2.20 m Borehole Collapse					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - BOREHOLE

Qualtest LABORATORY (NSW) PTY LTD

CLIENT:	NORTHROP CONSULTING ENGINEERS	**BOREHOLE NO:**	**BH03**
PROJECT:	PROPOSED INDUSTRIAL WAREHOUSE FACILITY	**PAGE:**	1 OF 1
LOCATION:	LOT 152, RAVEN STREET, KOORAGANG	**JOB NO:**	NEW20P-0171
		LOGGED BY:	BS
		DATE:	12/1/21

DRILL TYPE:	TRACK MOUNTED DRILL RIG	**SURFACE RL:**	
BOREHOLE DIAMETER:	100 mm	**DATUM:**	AHD

Drilling and Sampling | Material description and profile information | Field Test

METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics,colour,minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T						Asphalt.	D				ASPHALT
		0.25m E 0.35m		0.25m	ML	FILL: SILT - low plasticity, white to pale grey, with some crystalline material, possibly gypsum.	M < W_P				FILL
		0.50m SPT 12, 20, 25 N* = 45 0.95m		0.60m	SP	FILL: SAND - fine to medium grained, pale brown to yellow-brown.	D				
				0.80m	SP	FILL: SAND - fine to medium grained, grey to grey-brown, trace fine grained angular gravel, with shells.	D - M				
				1.00m	SP	FILL: SAND - fine to medium grained, brown to dark brown with some grey-brown, trace fine grained, sub-rounded to sub-angular gravel, with shells.	D				
		1.50m SPT 8, 10, 10 N* = 20 1.95m		1.60m	SP	SAND - fine to medium grained, grey to dark grey-brown.	M				ALLUVIAL
		2.00m E 2.10m									
		2.50m SPT 3, 5, 6 N* = 11 2.95m				Becoming brown to pale brown.	M - W				
	Water Inflow (3.0m)	3.00m E 3.10m									
		3.50m E 3.60m				Becoming brown to grey-brown.	W				
		4.00m E 4.10m		3.80m	SP	SAND - fine to coarse grained, grey with some grey-brown.					
				4.10m		Hole Terminated at 4.10 m Borehole Collapse					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- — — Gradational or transitional strata
- —— Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		**UCS (kPa)**
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density

V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - BOREHOLE

Qualtest LABORATORY (NSW) PTY LTD

CLIENT:	NORTHROP CONSULTING ENGINEERS	BOREHOLE NO:	BH04
PROJECT:	PROPOSED INDUSTRIAL WAREHOUSE FACILITY	PAGE:	1 OF 1
LOCATION:	LOT 152, RAVEN STREET, KOORAGANG	JOB NO:	NEW20P-0171
		LOGGED BY:	BS
		DATE:	12/1/21

DRILL TYPE: TRACK MOUNTED DRILL RIG **SURFACE RL:**

BOREHOLE DIAMETER: 100 mm **DATUM:** AHD

METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	Structure and additional observations
AD/T		E 0.10m		0.0–0.20m	GP	FILL: Sandy GRAVEL - fine to medium grained, sub-angular to angular, grey-brown to brown, fine to medium grained sand, trace fines of low plasticity.	D - M				FILL
				0.20–0.40m	SP	FILL: Gravelly SAND - fine to medium grained, brown, fine grained, angular to sub-angular gravel.	M				
		0.50m SPT 8, 10, 12 N* = 22 0.95m; 1.00m SPT 2, 5, 5 N* = 10 1.45m; 1.50m E 1.60m		0.40–2.00m	SP	FILL: SAND - fine to medium grained, brown and pale brown, with shells.	M				
		2.00m E 2.10m; 2.50m SPT 2, 3, 9 N* = 12 2.95m		2.00–2.90m	CH	CLAY - medium to high plasticity, grey and dark grey.	M > W_p	F / St	HP HP HP HP HP	120 110 170 150 100	ESTUARINE DEPOSITS
	▶ (3.50m)	3.00m E 3.10m; 3.50m E 3.60m; 4.00m E 4.10m		2.90–4.10m	SP	SAND - fine to medium grained, grey, trace fines of low plasticity, trace fine grained, sub-rounded gravel. Becoming brown and pale brown.	M - W / W				ALLUVIAL
				4.10m		Hole Terminated at 4.10 m Borehole Collapse					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional strata
- Definitive or distict strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample

Field Tests

PID	Photoionisation detector reading (ppm)
DCP(x-y)	Dynamic penetrometer test (test depth interval shown)
HP	Hand Penetrometer test (UCS kPa)

Consistency		UCS (kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition	
D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density		
V	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

APPENDIX B:

Results of Laboratory Testing

Certificate of Analysis

Environment Testing

Qualtest
8 Ironbark Close
Warabrook
NSW 2304

NATA Accredited
Accreditation Number 1261
Site Number 18217

Accredited for compliance with ISO/IEC 17025 – Testing
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Emma Coleman**

Report	**767263-S**
Project name	EJE KOORAGANG
Project ID	NEW20P-0171
Received Date	Jan 14, 2021

Client Sample ID			BH01 1.0-1.1	BH01 4.0-4.1	BH02 1.5-1.6	BH03 3.5-3.6
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			N21-Ja08375	N21-Ja08379	N21-Ja08381	N21-Ja08386
Date Sampled			Jan 12, 2021	Jan 12, 2021	Jan 12, 2021	Jan 12, 2021
Test/Reference	LOR	Unit				
Chromium Suite						
pH-KCL	0.1	pH Units	9.1	7.5	-	-
Acid trail - Titratable Actual Acidity	2	mol H+/t	< 2	< 2	-	-
sulfidic - TAA equiv. S% pyrite	0.003	% pyrite S	< 0.003	< 0.003	-	-
Chromium Reducible Sulfur[S04]	0.005	% S	< 0.005	0.12	-	-
Chromium Reducible Sulfur -acidity units	3	mol H+/t	< 3	72	-	-
Sulfur - KCl Extractable	0.02	% S	n/a	n/a	-	-
HCl Extractable Sulfur Correction Factor	1	factor	2.0	2.0	-	-
HCl Extractable Sulfur	0.02	% S	n/a	n/a	-	-
Net Acid soluble sulfur	0.02	% S	n/a	n/a	-	-
Net Acid soluble sulfur - acidity units	10	mol H+/t	n/a	n/a	-	-
Net Acid soluble sulfur - equivalent S% pyrite[S02]	0.02	% S	n/a	n/a	-	-
Acid Neutralising Capacity (ANCbt)	0.01	% CaCO3	2.1	0.40	-	-
Acid Neutralising Capacity - acidity (a-ANCbt)	2	mol H+/t	410	79	-	-
Acid Neutralising Capacity - equivalent S% pyrite (s-ANCbt)[S03]	0.02	% S	0.66	0.13	-	-
ANC Fineness Factor		factor	1.5	1.5	-	-
CRS Suite - Net Acidity (Sulfur Units)	0.02	% S	< 0.02	0.03	-	-
CRS Suite - Net Acidity (Acidity Units)	10	mol H+/t	< 10	19	-	-
CRS Suite - Liming Rate[S01]	1	kg CaCO3/t	< 1	1.5	-	-
Extraneous Material						
<2mm Fraction	0.005	g	150	140	-	-
>2mm Fraction	0.005	g	9.9	1.2	-	-
Analysed Material	0.1	%	94	99	-	-
Extraneous Material	0.1	%	6.1	0.8	-	-
% Moisture	1	%	14	18	24	16
Chloride	10	mg/kg	-	-	< 10	19
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	-	-	1800	230
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	-	-	6.5	7.8
Resistivity*	0.5	ohm.m	-	-	5.6	44
Sulphate (as SO4)	10	mg/kg	-	-	9600	820

eurofins Environment Testing

Client Sample ID			BH04 0.5-0.6	BH04 2.5-2.6
Sample Matrix			Soil	Soil
Eurofins Sample No.			N21-Ja08388	N21-Ja08390
Date Sampled			Jan 12, 2021	Jan 12, 2021
Test/Reference	LOR	Unit		
Chromium Suite				
pH-KCL	0.1	pH Units	9.1	6.7
Acid trail - Titratable Actual Acidity	2	mol H+/t	< 2	< 2
sulfidic - TAA equiv. S% pyrite	0.003	% pyrite S	< 0.003	< 0.003
Chromium Reducible Sulfur[S04]	0.005	% S	0.010	0.021
Chromium Reducible Sulfur -acidity units	3	mol H+/t	6.1	13
Sulfur - KCl Extractable	0.02	% S	n/a	n/a
HCl Extractable Sulfur Correction Factor	1	factor	2.0	2.0
HCl Extractable Sulfur	0.02	% S	n/a	n/a
Net Acid soluble sulfur	0.02	% S	n/a	n/a
Net Acid soluble sulfur - acidity units	10	mol H+/t	n/a	n/a
Net Acid soluble sulfur - equivalent S% pyrite[S02]	0.02	% S	n/a	n/a
Acid Neutralising Capacity (ANCbt)	0.01	% CaCO3	1.6	1.2
Acid Neutralising Capacity - acidity (a-ANCbt)	2	mol H+/t	310	250
Acid Neutralising Capacity - equivalent S% pyrite (s-ANCbt)[S03]	0.02	% S	0.50	0.39
ANC Fineness Factor		factor	1.5	1.5
CRS Suite - Net Acidity (Sulfur Units)	0.02	% S	< 0.02	< 0.02
CRS Suite - Net Acidity (Acidity Units)	10	mol H+/t	< 10	< 10
CRS Suite - Liming Rate[S01]	1	kg CaCO3/t	< 1	< 1
Extraneous Material				
<2mm Fraction	0.005	g	100	94
>2mm Fraction	0.005	g	9.9	< 0.005
Analysed Material	0.1	%	91	100
Extraneous Material	0.1	%	9.0	< 0.1
% Moisture	1	%	4.7	30