REPORT TO

FDC CONSTRUCTION (NSW) PTY LTD ON BEHALF OF CHARTER HALL HOLDINGS PTY LTD

ON

PRELIMINARY SALINITY INVESTIGATION

FOR

PROPOSED HUNTINGWOOD PROCESSING EXPANSION

AT

65 HUNTINGWOOD DRIVE, HUNTINGWOOD, NSW

Date: 9 August 2021

Ref: E34067PrptRev2-SAL

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ABBREVIATIONS

Australian Height Datum	**AHD**
Acid Sulfate Soil	**ASS**
Below Ground Level	**BGL**
Borehole	**BH**
Cation Exchange Capacity	**CEC**
Calcium	**Ca**
Cement, Concrete and Aggregates Australia	**CCAA**
Chain of Custody	**COC**
Damp Proof Course	**DPC**
Department of Land and Water Conservation	**DLWC**
Dissolved Oxygen	**DO**
Environmental Impact Statement	**EIS**
International Organisation of Standardisation	**ISO**
JK Environments	**JKE**
Local Government Authority	**LGA**
Map Grid of Australia	**MGA**
Magnesium	**Mg**
National Association of Testing Authorities	**NATA**
Potassium	**K**
Polyvinyl Chloride	**PVC**
Practical Quantitation Limit	**PQL**
Redox Potential	**Eh**
Site Assessment Criteria	**SAC**
Standard Penetration Test	**SPT**
Standard Sampling Procedure	**SSP**
Standing Water Level	**SWL**
Standard Sampling Procedure	**SSP**
Sodium	**Na**
Western Sydney Regional Organisation of Councils	**WSROC**

Units

deci Siemens per Metre	**dS/m**
Electrical Conductivity	**EC**
Exchangeable Sodium Percentage (Sodicity)	**ESP%**
Litres	**L**
Metres	**m**
Metres Below Ground Level	**mBGL**
Millivolts	**mV**
Millilitres	**ml**
Milliequivalents	**meq**
Milligrams per Litre	**mg/L**
Milligrams per Kilogram	**mg/kg**
ohm Centimetres	**ohm.cm**
Parts Per Million	**ppm**
micro Siemens per Centimetre	**µS/cm**

1 INTRODUCTION

FDC Construction (NSW) Pty Ltd ('the client') on behalf of Charter Hall Holdings Pty Ltd commissioned JK Environments (JKE) to undertake a preliminary salinity investigation for the proposed development at 65 Huntingwood Drive, Huntingwood, NSW ('the site'). The site location is shown on Figure 1 and the investigation was confined to the proposed development area in the north-western section of the site as shown on Figure 2. The proposed development areas shown on Figure 2 were delineated by JKE to capture the extent of the proposed works, including tree/vegetation removal.

We understand that this report will be used to support the lodgement of a State Significant Development Application (SSDA).

The salinity investigation was undertaken in conjunction with a Preliminary Site Investigation (PSI)/Limited Detailed Site Investigation (DSI) and references some of the documentation attached to the PSI/limited DSI report (Ref: E34067PrptRev2)[1].

A geotechnical investigation was undertaken in conjunction with this investigation by JK Geotechnics (JKG). The results of the investigation are presented in a separate report (Ref: 34067BCrptRev2)[2]. This report should be read in conjunction with the JKG report.

Background information on salinity is included in the appendices.

1.1 Proposed Development Details

The proposed development comprises the expansion of the existing food processing operations at the site. The development is outlined in the following table:

Table 1-1: Overview of Proposed Development

Element	Proposed
Site Preparation	• Removal of existing car parking, driveway and ancillary structures; • Vegetation clearing; • Excavation for car park and bulk earthworks and supporting structures; • Drainage connections; and • Land stabilisation.
Development summary	• Construction of a new processing facility (24,775sqm) with first-floor amenities in the northwest corner of the site; • Construction of a new ingredient silo building (1,000sqm) along the Huntingwood Drive frontage; • Construction of a storage building (270sqm) to the east of the existing building; • Construction of a new processing building (1,200sqm) and ingredient silo building (120sqm) to the south of the main facility; • Replacement of the existing on-site detention (OSD) basin with an OSD tank below the basement car park; and

[1] Referred to as the PSI/limited DSI

[2] Referred to as JKG report

Element	Proposed
	• Landscaped setbacks along both street frontages to screen the new processing facility and loading area.
Access and Parking	• New loading area above two levels of car parking (468 spaces) at the north-west corner of Huntingwood Drive and Brabham Drive. The basement will include excavation up to approximately 3m deep to a finished floor level approximately to RL59m; • Trucks will utilise the existing access point adjacent to the eastern boundary of the site; and • The existing (westernmost) vehicle access to Huntingwood Drive will be retained and upgraded to provide access to the new basement car park.

1.2 Aim and Objectives

The primary aim of the investigation was to characterise the broad scale salinity conditions at the site in the context of the proposed development works. The assessment objectives were to:

- Assess the current site conditions via a site walkover inspection;
- Assess the soil and groundwater salinity conditions via implementation of a preliminary sampling and analysis program; and
- Provide recommendations on the requirement for salinity management.

1.3 Scope of Work

The assessment was undertaken generally in accordance with a JKE proposal (Ref: EP54095P) of 7 May 2021 and written acceptance from the client of 10 May 2021. The scope of work included the following:

- Review site information including topography, soils maps, regional geology and hydro-geology in the vicinity of the site;
- A walkover site inspection to identify obvious visual indicators of salinity or potential problem areas;
- Design and implementation of a field sampling and laboratory analysis program;
- Interpretation of the analytical results based on established assessment criteria; and
- Preparation of a report presenting the results of the assessment and providing recommendations on the requirement for salinity management.

The assessment was designed and the report was prepared with reference to regulations/guidelines outlined in the table below. Individual guidelines/documents are also referenced within the text of the report.

Table 1-2: Guidelines

Guidelines/Regulations/Documents
Site Investigations for Urban Salinity (2002)[3]
Salinity Code of Practice (2004)[4]
Managing Urban Stormwater – Soil and Construction (4th ed.) (2004)[5]
Salinity Potential in Western Sydney Map (2002)[6]
Piling – Design and Installation AS2159-2009 (2009)[7]
Industry Guide T56: Residential Slabs and Footings in Saline Environments (2018)[8]

[3] Department of Land and Water Conservation (DLWC), (2002). *Site Investigations for Urban Salinity,* (referred to as DLWC 2002)

[4] Western Sydney Regional Organisation of Councils (WSROC) and Department of Infrastructure, Planning and Natural Resources (DIPNR), (2003 amended 2004). *Western Sydney Salinity Code of Practice* (referred to as Salinity Code of Practice)

[5] NSW Government/Landcom, (2004). *Managing Urban Stormwater – Soil and Construction*, (4th ed.) (referred to as Blue Book)

[6] DIPNR, (2002). *1:100,000 Map – Salinity Potential in Western Sydney*, (referred to as Salinity Potential Map)

[7] Standards Australia, (2009). *Piling – Design and Installation, AS2159-2009* (referred to as AS2159-2009)

[8] Cement, Concrete and Aggregates Australia (CCAA), (2018). Industry Guide *T56: Residential Slabs and Footings in Saline Environments* (referred to as CCAA 2018)

2 SITE INFORMATION

2.1 Site Identification

Table 2-1: Site Identification

Site Address:	65 Huntingwood Drive, Huntingwood
Lot & Deposited Plan:	Lot 1 in DP 866251
Local Government Authority (LGA):	Blacktown Council
RL (AHD in m) (approx.):	60
Geographical Location (decimal degrees) (approx.):	Latitude: -33.797434 Longitude: 150.871965

2.2 Site Location and Regional Setting

The site is located within the Huntingwood Industrial Estate, 32km west of the Sydney CBD and 4km south of Blacktown Town Centre. The site is situated along the southern boundary of Huntingwood, bordering the Western Motorway (M4) to the south, Huntingwood Drive to the north and Brabham Drive to the west. The site is located approximately 1.6km to the north-west of the Prospect Reservoir.

2.3 Topography

The regional topography is characterised by a west facing hillside. The site generally slopes towards the west at approximately 3°-4°, in sympathy with the regional topography. The site appeared to have been cut within the north-western area to accommodate the existing oval.

A soil batter of approximately 1.5m high was observed along parts of the northern and western site boundaries. The north-western edge of the site was up to approximately 4m above the surrounding road reserves. Additionally, the eastern area of the site was generally elevated from the majority of the site levels with a localised slope towards the west at approximately 11°-12° that extended from the floor level of the main processing building. Other localised areas of filling (i.e. mounding) were also observed within landscaped areas of the site.

Surface runoff from the site was expected to flow towards the west in keeping with the site topography. Local stormwater drains were observed within paved areas of the site and along road curb gutters. Surface runoff received by onsite stormwater infrastructure was assumed to discharge into the regional stormwater system.

2.4 Site Inspection

A walkover inspection of the site (external to the buildings) was undertaken by JKE on 14 and 20 May 2021. The inspection was limited to accessible areas of the site and was focussed on assessing the site conditions relevant to salinity-related factors only, in the proposed development area.

At the time of the inspection, the site was occupied by the existing Arnott's Biscuits food processing (bakery) facility. The site included processing facilities, administration offices, staff amenities, maintenance areas and logistical support facilities (i.e. loading docks and driveways). Outdoor areas included landscaped areas, staff/visitor car parks and outdoor recreational area including tennis and basketball courts and grassed sports oval.

The site was occupied by three large freestanding industrial buildings, the main 'L-shaped' processing building to the north and two warehouses to the south. The large 'L' shaped multi-storey building was located across the eastern and southern areas of the site. This building was used as the processing/packaging facility of Arnott's Biscuits. Other buildings included a smaller rectangular shaped building located within the central area of the site used as an amenities block, and an engineering/ building located within the south-eastern section of the site. The engineering building was of steel construction founded on a concrete pavement. All other buildings were of concrete and steel construction with corrugated iron roof. No existing basements were observed within the site.

Asphaltic paved areas were located centrally at the site which included a larger staff carpark and an adjacent smaller visitor carpark located to the west of the main processing building. Other asphaltic paved areas included internal access roads and associated concrete paved footpaths accessible from Huntingwood Drive to the north and a roundabout feature located to the south-east of the staff carpark. All paved areas appeared in good condition, with no major areas of settlement or cracking observed.

Exotic grasses, shrubs and native trees of approximately 10m high were located within land scaped areas of the site located throughout the open areas of the site, with the exception of paved areas (i.e. the carparks and internal access roads). No signs of dieback or phyto-toxic stress were noted based on a cursory examination of the onsite vegetation. There were no adverse salinity indicators observed such as vegetation dieback or salt scalding etc.

2.5 Surrounding Land Use

During the site inspection, JKE observed the following land uses in the immediate surrounds:

- North – Huntingwood Drive and commercial warehouse properties beyond Huntingwood Drive to the north;
- South – Arnott's distribution centre (activities included truck operations and food product distribution);
- East – Neighbouring commercial property including endeavour energy (offices) and associated carparks; and
- West – Brabham Drive and large warehouse property (Hunter & northern Logistics).

3 GEOLOGY AND HYDROGEOLOGY

3.1 Regional Geology and Soils

A review of the regional geological information contained in the Lotsearch report attached to the PSI/limited DSI indicated that the site is underlain by Bringelly Shale of the Wianamatta Group, which typically consists of shale, carbonaceous claystone, claystone, laminite, fine to medium grained lithic sandstone, rare coal and tuff.

The Lotsearch report indicated that the site is located within the Blacktown soil landscape. Blacktown soils are characterised by moderate erodibility with some higher local occurrences, low dispersivity and localised areas of moderate salinity.

3.2 Salinity Hazard Map

The site is located within the area of Western Sydney included in the Salinity Potential Map. Based upon interpretation from the geological formations and soil groups presented on the map, the site is located in a region of moderate to high salinity potential.

The moderate classification is attributed to scattered areas of scalding and indicator vegetation, in areas where concentrations have not been mapped. Saline areas may occur in this zone, which have not been identified or may occur if risk factors change adversely.

3.3 Acid Sulfate Soil Risk and Planning

The site is not located in an acid sulfate soil (ASS) risk area according to the risk maps prepared by the Department of Land and Water Conservation.

3.4 Hydrogeology

Hydrogeological information presented in the Lotsearch report indicated that the regional aquifer on-site and in the areas immediately surrounding the site includes porous, extensive aquifers of low to moderate productivity. No registered bores were located within 1,000m of the site.

The Wianamatta Formation is characterised by very low permeability, low storage and high groundwater salinity as a consequence of the depositional environment during the middle Triassic period. This typically renders the shale groundwater unsuitable for any use due to low yield and poor quality. A perched groundwater table condition may occur in the residual soils overlying the Shale at some locations especially during prolonged wet conditions. This occurs due to the relatively higher permeability of soil at the soil-rock interface. Due to the shorter residence time, the perched water is typically less saline than flows within the bedrock.

3.5 Receiving Water Bodies and Surface Water Run-off

Surface water bodies were not identified in the immediate vicinity of the site. The closest surface water body is Eastern Creek located approximately 950m to the west of the site.

4 SAMPLING AND ANALYSIS PLAN

4.1 Soil Sampling Rationale

The investigation included soil sampling from six locations spread across the site as shown on Figure 2. This density is equivalent to approximately 1.5 sampling points per hectare (the area of the site is approximately four hectares) and approximately meets the requirements for an 'initial site investigation' recommended in the DLWC 2002 document for 'moderately intensive construction' when considering the footprint of the proposed development area. The density was considered adequate to identify large areas of salinity impacted soils at the site.

Soil sampling for this investigation was confined to the depth of approximately 6m below existing ground level. This was considered adequate as the proposed development includes excavations to a maximum depth of 3m for the proposed basement.

4.2 Soil Sampling Methods

Fieldwork for this investigation was undertaken on 14 May 2021. The sample locations were drilled using a truck mounted hydraulically operated drill rig equipped with spiral flight augers. Soil samples were obtained from a Standard Penetration Test (SPT) sampler or directly from the auger when conditions did not allow use of the SPT sampler.

Soil samples were collected from the fill and natural profiles encountered during the investigation based on distinct change in lithology or field observations. All samples were recorded on the borehole logs attached in the appendices.

Samples were placed in plastic bags and sealed using twist ties. Sampling personnel used disposable nitrile gloves during sampling activities. The samples were labelled with the job number, sampling location, sampling depth and date.

On completion of the fieldwork, the samples were delivered in the insulated sample container to a NATA registered laboratory for analysis under standard COC procedures. Field sampling protocols adopted for this assessment are summarised in the appendices.

4.3 Groundwater Sampling Rationale

The assessment included the installation of one groundwater monitoring well at the site as shown on Figure 2. The well was positioned to be as representative of overall site conditions.

4.4 Monitoring Well Installation

The monitoring well construction details are documented on the BH103 borehole logs presented in the appendices. The well was installed to a depth of approximately 6m with PVC casing from the surface to 3.2m and slotted PVC from 3.2m to 6m. A sand filter pack was installed from 3m to 6m with a bentonite seal above. The well was finished with a gatic cover.

4.5 Monitoring Well Development and Groundwater Sampling

JKE attempted to develop the monitoring well on 14 May 2021, however, the well was dry. JKE re-visited the site and checked the well again on 20 May 2021, however, the well remained dry. No further groundwater assessment was undertaken.

4.6 Laboratory Analysis

Samples were analysed by Envirolab Services Pty Ltd (NATA accreditation number 2901). Reference should be made to the laboratory reports (Ref: 269247) attached in the appendices for further details of the analytical methods.

4.7 Analytical Schedule

The analytical schedule is outlined in the following table:

Table 4-1: Analytical Schedule

Analyte	Fill Samples	Natural Soil Samples	Natural Bedrock Samples
pH	10	7	2
Electrical Conductivity (EC)	10	7	2
Resistivity	10	7	2
Texture (used to determine EC extract – ECe)	10	7	2
Sulphate	10	7	2
Chloride	10	7	2

5 SITE ASSESSMENT CRITERIA (SAC)

5.1 Soil Salinity and Plant Growth

The electrical conductivity (EC) of a 1:5 soil:water extract is commonly used as an indicator of soil salinity conditions as the reading is directly related to the electrolyte (salt) concentration of the extract. In order to compare the laboratory data with published salinity classes, the results are converted to equivalent saturated paste (ECe) using texture adjustment values presented in DLWC 2002.

The following table provides a summary of plant response with reference to salinity:

Table 5-1: Plant Response to Soil Salinity

ECe (dS/m)	Salinity Class	Plant Response[1]
<2	Non-saline	Salinity effects mostly negligible
2-4	Slightly saline	Yields of very sensitive crops may be affected
4-8	Moderately saline	Yield of many crops affected
8-16	Very saline	Only tolerant crops yield satisfactorily
>16	Highly saline	Only a few very tolerant crops yield satisfactorily

Note:

1 - Plant Response to Salinity Class has been adopted from DLWC 2002

5.2 Soil pH and Plant Growth

Soil pH is a measure of the acidity or alkalinity of the soils and values have been assessed as an indicator of soil fertility with respect to plant growth. The optimal pH for plant growth is between 5.5 and 7. Beyond this range, effective revegetation of exposed soil following disturbance is increasingly difficult and the potential for erosion is considered to increase.

Highly alkaline soils are commonly associated with saline and sodic soil conditions and can limit the ability of plants to take up water and nutrients. Highly acidic soils exhibit aluminium toxicity toward plants and can limit the ability of plants to take up other essential nutrients including molybdenum.

Interpretation of soil pH with respect to plant growth is undertaken using the ratings published in Bruce and Rayment (1982)[9] presented below:

Table 5-2: Plant Response to Soil pH

pH	Rating
<4.5	Extremely acidic
4.5-5.0	Very strongly acidic

[9] Bruce, R.C. and Rayment, G.E., (1982). *Analytical Methods and Interpretations used by the Agricultural Chemistry Branch for Soil and Land Use Surveys,* (referred to as Bruce and Rayment 1982)

pH	Rating
5.1-5.5	Strongly acidic
5.6 – 7.3	Optimal plant growth
7.4-7.8	Mildly alkaline
7.9-8.4	Moderately alkaline
8.5-9.0	Strongly alkaline
>9.1	Very strongly alkaline

5.3 Cation Exchange Capacity (CEC) in Soil

The ability of soils to attract, retain and exchange cations (positively charged ions) is estimated by the calculated CEC value. CEC represents the major controlling factor in stability of clay soil structure, nutrient availability for plant growth, soil pH and the reaction of the soil to chemical applications (fertilisers, conditioners etc.).

High CEC soils have a greater capacity to retain nutrients, however, deficient soils require greater applications of nutrients to correct imbalances. Low CEC soils have a reduced capacity to retain nutrients and may result in leaching of nutrients from the soil in the event of excess nutrient applications.

Metson (1961)[10] developed a set of ratings for effective CEC and the most abundant cations. These are summarised below (values are in meq/100g):

Table 5-3: CEC Rating

Rating	eCEC	Exch Na	Exch K	Exch Ca	Exch Mg
Very low	<6	0-0.1	0-0.2	0-2	0-0.3
Low	6-12	0.1-0.3	0.2-0.3	2-5	0.3-1
Moderate	12-25	0.3-0.7	0.3-0.7	5-10	1-3
High	25-40	0.7-2	0.7-2	10-20	3-8
Very high	>40	>2	>2	>20	>8

5.3.1 Ratio of Exchangeable Calcium to Magnesium

To maintain soil structure there should be a ratio of around 4:1 to 6:1 calcium to magnesium for a balanced soil (Eckert 1987)[11]. At ratios of less than 4:1 calcium is considered to be deficient, whilst at ratios of greater than 6:1 are considered to be magnesium deficient.

10 Metson, A.J, (1961). *Methods of Chemical Analysis for Soil Survey Samples* (referred to as Metson 1961)

11 Eckert, D.J, (1987) .*Soil Test Interpretation: Basic Cation Saturation Ratios and Sufficiency Levels* (referred to as Eckert 1987)

5.4 Exchangeable Sodium Percentage or Sodicity (ESP%)

Exchangeable sodium is an important soil stability and salinity parameter. Excessive exchangeable sodium leads to unstable soils, increased runoff, potential salinity, dispersivity and water logging problems.

Normally the sodium content is expressed as a percentage of the CEC as other cations counteract the negative effects of sodium (known as ESP% and termed sodicity). The effect of the exchangeable sodium (exchangeable sodium percentage, ESP) varies with other soil factors such as the type of clay, the relative quantity of magnesium and the quantity of organic matter. However, Charman & Murphy (2000)[12] indicate that a soil is generally considered sodic if the ESP exceeds 6% and extremely sodic if the ESP exceeds 15%.

5.5 Groundwater Salinity

EC values in groundwater are dependent on numerous factors and can vary with changes in temperature and pH conditions. Suttar (1990)[13] has classed water into different types based on EC values as outlined in the table below.

Table 5-4: EC Ranges in Water

Water Type	EC (µS/cm)
Deionised Water	0.5 – 3
Pure Rainwater	<15
Freshwater Rivers	0 – 800
Marginal River Water	800 – 1600
Brackish Water	1600 – 4800
Saline Water	>4800
Seawater	51,500
Industrial Waters	100 – 10,000

5.6 Recommendations for Concrete Slabs and Footings in Saline Soils

In the absence of endorsed recommendations for buildings in saline environments, reference is made to the CCAA 2018. The guide provides recommendations on the minimum concrete grade/strength required for slabs and footings in saline soils. Reference should be made to the CCAA 2018 publication for further information:

[12] Charman, P.E.V and Murphy, B.W (eds), (2000).*Soils: Their Management and Properties,* (referred to as Charman and Murphy 2000)
[13] Suttar, S., (1990). *Ribbons of Blue Handbook, Scitech*, Victoria (referred to as Suttar 1990)

Table 5-5: Minimum Concrete Grade for Slabs and Footings in Saline Soils

ECe (dS/m)	Salinity Class	Concrete Grade[1]
<2	Non-saline	N20
2-4	Slightly saline	N20
4-8	Moderately saline	N25
8-16	Very saline	N32
>16	Highly saline	≥N40

Note:

1 - Concrete Grade for Salinity Class has been adopted from CCAA 2018

5.7 Recommendations for Durability with Reference to AS2159-2009

In designing for durability, reference should be made to the requirements listed in the AS2159-2009. The exposure classification for concrete and steel piles and foundations is outlined in the following tables.

Table 5-6: Exposure Classification for Concrete Piles

Exposure Conditions				**Exposure Classification**	
Sulphate (expressed as SO_4)		pH	Chlorides in Groundwater (ppm)	Soil Conditions A[1]	Soil Conditions B[2]
In Soil (ppm)	In Groundwater (ppm)				
<5,000	<1,000	>5.5	<6,000	Mild	Non-aggressive
5,000-10,000	1,000-3,000	4.5-5.5	6,000-12,000	Moderate	Mild
10,000-20,000	3,000-10,000	4-4.5	12,000-30,000	Severe	Moderate
>20,000	>10,000	<4	>30,000	Very severe	Severe

Notes:

1 - High permeability soils (eg sands and gravels) which are in groundwater

2 – Low permeability soils (eg silts and clays) or all soils above groundwater

Table 5-7: Exposure Classification for Steel Piles

Exposure Conditions				**Exposure Classifications**	
pH	**Chlorides**		**Resistivity (ohm.cm)**	**Soil Conditions A[1]**	**Soil Conditions B[2]**
	In Soil (ppm)	**In Groundwater (ppm)**			
>5	<5,000	<1,000	>5,000	Non-aggressive	Non-aggressive
4-5	5,000-20,000	1,000-10,000	2,000-5,000	Mild	Non-aggressive
3-4	20,000-50,000	10,000-20,000	1,000-2,000	Moderate	Mild
<3	>50,000	>20,000	<1,000	Severe	Moderate

Notes:

1 - High permeability soils (e.g. sands and gravels) which are in groundwater

2 – Low permeability soils (e.g. silts and clays) or all soils above groundwater

6 INVESTIGATION RESULTS

6.1 Subsurface Conditions

A summary of the subsurface conditions encountered during the investigation is presented in the table below. Reference should be made to the borehole logs attached in the appendices for further details.

Table 6-1: Summary of Subsurface Conditions

Profile	Description (metres below ground level - mBGL)
Pavement	Asphaltic concrete pavement, approximately 30mm thick, was encountered in BH106.
Fill	Fill material was encountered at the surface or beneath the pavement in all boreholes and extended to depths of approximately 0.8m to 4m. The fill typically comprised silty clay, with the exception of shallow fill in BH102 that included silty sand and gravel. The fill contained inclusions of sandstone, igneous and ironstone gravel and root fibres.
Natural Soil	Silty clay was encountered beneath the fill in all boreholes and extended to depths of approximately 2.7m to 6.7m. BH104 was terminated in natural soil at a depth of approximately 6m. The natural soil was typically grey and orange-brown with a trace of ironstone gravel.
Bedrock	Siltstone bedrock was encountered beneath the natural soil in all boreholes, except BH104, and extended to the termination of the boreholes at a maximum of approximately 9m. The siltstone was typically dark grey.
Groundwater	Groundwater seepage was not encountered in the boreholes during drilling. All boreholes remained dry on completion of drilling and a short time after. A monitoring well was installed in BH103 to a depth of 6m and was dry approximately six days after installation.

6.2 Laboratory Results

A summary of the results is presented below.

Table 6-2: Summary of Laboratory Results

Analyte	Results
EC & ECe	The EC results ranged from 49µS/m to 870µS/m. The ECe results ranged from <2dS/m to 6.1dS/m.
Resistivity	Resistivity values were calculated based on the raw EC values. The resistivity values for the soil samples ranged from 1,149ohm.cm to 20,408ohm.cm.
pH	The results of the analysis ranged from 4.9 to 9.6.
CEC	The results of the analysis ranged from: • CEC – 10meq/100g to 18meq/100g; • Exchangeable Na – <0.1meq/100g to 1.9meq/100g;

Analyte	Results
	• Exchangeable K – 0.2meq/100g to 1.5meq/100g; • Exchangeable Ca – 0.8meq/100g to 14meq/100g; and • Exchangeable Mg – 3.4meq/100g to 8.5meq/100g.
Sulphate	The results ranged from <10mg/kg to 850mg/kg.
Chloride	The results ranged from <10mg/kg to 1,000mg/kg.

Note:

Na – Sodium, K – Potassium, Ca – Calcium, Mg – Magnesium

7 RESULTS INTERPRETATION

The soil laboratory results are compared to the relevant SAC in the attached report tables. Interpretation of the results against the SAC is provided in the following table.

Table 7-1: Interpretation of Laboratory Results

Parameter	Notes
Soil Salinity and Plant Growth	The ECe results generally ranged from <2dS/m to 6.1dS/m. The majority of the samples were classed as slightly saline to moderately saline. The majority of surface samples were non-saline and the salinity of deeper samples was variable.
Soil pH and Plant Growth	The soil pH results ranged from 4.9 to 9.6 and are classed as very strongly acidic to strongly alkaline. The majority of the results were generally within the optimum range for plant growth. The acidic conditions varied with depth. The proposed excavations will generally expose acidic soils and may require treatment with lime or gypsum in order to make the soils suitable for plant growth.
CEC in Soil	The CEC values ranged from 10meq/100g to 18meq/100g in the low to moderate range. The majority of the samples were within the moderate range which is typical of the soil formation encountered at the site and are generally indicative of the low levels of organic matter within the soils.
Ratio of Calcium to Magnesium	The results indicate that the soils generally have more calcium than magnesium. The CEC of the soil is generally low to moderate. Lime and gypsum can be used to stabilise the soil which will improve soil structure for both engineering and fertility purposes.
ESP%	The ESP% values of the samples ranged from 0.6% to 19% and were classed as non-sodic to highly sodic. The majority of the ESP results were below the 5% threshold and were classed as non-sodic.
Concrete Slabs and Footings in Saline Soils (CCAA 2018)	The proposed earthworks are anticipated to expose soils generally classed as non-saline to moderately saline. The CCAA 2018 recommended concrete grade for slabs and footings in moderately saline soils is N25. Reference should also be made to AS2159-2009 for minimum concrete strengths and reinforcement cover for concrete piles/foundations.
Soil Conditions for Exposure Classification (AS2159-2009)	The boreholes drilled for the investigation have indicated that the subsurface conditions at the site generally comprise of low permeability soils (i.e. silts and clays). Based on this, the exposure classification outlined under 'Soil Conditions B' has been adopted for the assessment.
Exposure Classification for Concrete Piles/Foundations (AS2159-2009)	The soil pH results indicate that the soils are generally non-aggressive to mildly aggressive towards buried concrete. The sulphate results indicate that the soils are non-aggressive to buried concrete.
Exposure Classification for Steel Piles/Foundations (AS2159-2009)	The soil pH and chloride results indicate that the soils are generally non-aggressive towards buried steel. The soil resistivity results indicate that the soils are generally mildly aggressive to buried steel.

8 CONCLUSIONS AND RECOMMENDATIONS

The preliminary salinity investigation included soil sampling from six boreholes and installation of one groundwater monitoring well. The boreholes generally encountered silty clay fill overlying residual silty clay and siltstone bedrock. The monitoring well was found to be dry approximately six days after installation, therefore no groundwater sampling and analysis was undertaken.

The investigation encountered saline soils across the proposed development area with levels of salinity that varied with depth. Conditions were found to be mildly aggressive to buried concrete and steel. This information must be considered in the design of the footings etc and structures in contact with the soils.

JKE recommend that a salinity management plan should be prepared in accordance with the amended Salinity Code of Practice to outline measures to be implemented to reduce the risks associated with salinity at the site. The equates to a Level 3 salinity management response which is applicable for larger developments.

9 LIMITATIONS

The report limitations are outlined below:

- Salinity is a natural phenomenon and can change over time based on site conditions and climatic variations. Changes to existing drainage patters can also impact the salinity at the site. The results outlined in this report are a snap shot of conditions present at the time of the investigation and is bound to change over time;
- JKE accepts no responsibility for any unidentified salinity issues at the site. Any unexpected problems/subsurface features that may be encountered during development works should be inspected by an environmental consultant as soon as possible;
- JKE accepts no responsibility for non-compliance of salinity management recommends outlined in this report;
- This report has been prepared based on site conditions which existed at the time of the investigation; scope of work and limitation outlined in the JKE proposal; and terms of contract between JKE and the client (as applicable);
- The conclusions presented in this report are based on investigation of conditions at specific locations, chosen to be as representative as possible under the given circumstances, visual observations of the site and immediate surrounds and documents reviewed as described in the report;
- Subsurface soil and rock conditions encountered between investigation locations may be found to be different from those expected. Groundwater conditions may also vary, especially after climatic changes;
- The investigation and preparation of this report have been undertaken in accordance with accepted practice for environmental consultants, with reference to applicable environmental regulatory authority and industry standards, guidelines and the assessment criteria outlined in the report;
- Where information has been provided by third parties, JKE has not undertaken any verification process, except where specifically stated in the report;
- JKE has not undertaken any assessment of off-site areas that may be potential salinity sources or may have been impacted by adverse salinity conditions, except where specifically stated in the report;
- JKE accept no responsibility for potentially asbestos containing materials that may exist at the site. These materials may be associated with demolition of pre-1990 constructed buildings or fill material at the site;
- JKE have not and will not make any determination regarding finances associated with the site;
- Additional investigation work may be required in the event of changes to the proposed development or land use. JKE should be contacted immediately in such circumstances;
- Material considered to be suitable from a geotechnical point of view may be unsatisfactory from a salinity viewpoint, and vice versa;
- This report has been prepared for the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose;
- Copyright in this report is the property of JKE. JKE has used a degree of care, skill and diligence normally exercised by consulting professionals in similar circumstances and locality. No other warranty expressed or implied is made or intended. Subject to payment of all fees due for the investigation, the client alone shall have a licence to use this report;

- If the client, or any person, provides a copy of this report to any third party, such third party must not rely on this report except with the express written consent of JKE; and
- Any third party who seeks to rely on this report without the express written consent of JKE does so entirely at their own risk and to the fullest extent permitted by law, JKE accepts no liability whatsoever, in respect of any loss or damage suffered by any such third party.

Important Information About This Report

These notes have been prepared by JKE to assist with the assessment and interpretation of this report.

The Report is based on a Unique Set of Project Specific Factors
This report has been prepared in response to specific project requirements as stated in the JKE proposal document which may have been limited by instructions from the client. This report should be reviewed, and if necessary, revised if any of the following occur:

- The proposed land use is altered;
- The defined subject site is increased or sub-divided;
- The proposed development details including size, configuration, location, orientation of the structures or landscaped areas are modified;
- The proposed development levels are altered, eg addition of basement levels; or
- Ownership of the site changes.

JKE will not accept any responsibility whatsoever for situations where one or more of the above factors have changed since completion of the assessment. If the subject site is sold, ownership of the assessment report should be transferred by JKE to the new site owners who will be informed of the conditions and limitations under which the assessment was undertaken. No person should apply an assessment for any purpose other than that originally intended without first conferring with the consultant.

Changes in Subsurface Conditions
Subsurface conditions are influenced by natural geological and hydrogeological process and human activities. Groundwater conditions are likely to vary over time with changes in climatic conditions and human activities within the catchment (e.g. water extraction for irrigation or industrial uses, subsurface waste water disposal, construction related dewatering). Soil and groundwater salinity concentrations may also vary over time through migration and accumulation of salts, importation of materials, construction and landscaping. The conclusions of an assessment report may have been affected by the above factors if a significant period of time has elapsed prior to commencement of the proposed development.

This Report is based on Professional Interpretations of Factual Data
Site assessments identify actual subsurface conditions at the actual sampling locations at the time of the investigation. Data obtained from the sampling and subsequent laboratory analyses, available site history information and published regional information is interpreted by geologists, engineers or environmental scientists and opinions are drawn about the overall subsurface conditions, the nature and extent of salinity, the likely impact on the proposed development and appropriate management measures.

Actual conditions may differ from those inferred, because no professional, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than an assessment indicates. Actual conditions in areas not sampled may differ from predictions. Nothing can be done to prevent the unanticipated, but steps can be taken to help minimise the impact. For this reason, site owners should retain the services of their consultants throughout the development stage of the project, to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

Assessment Limitations
The assessment is designed to identify major salinity risks at the site. Implementing the management recommends can minimise the risks. No assessment can identify all risks as salinity is a natural phenomenon which can change over time. Even a rigorous professional assessment may not detect all potential salinity impacts on a site. Salinity may be present in areas that were not surveyed or sampled, or may accumulate in areas which showed no signs of salinity when sampled.

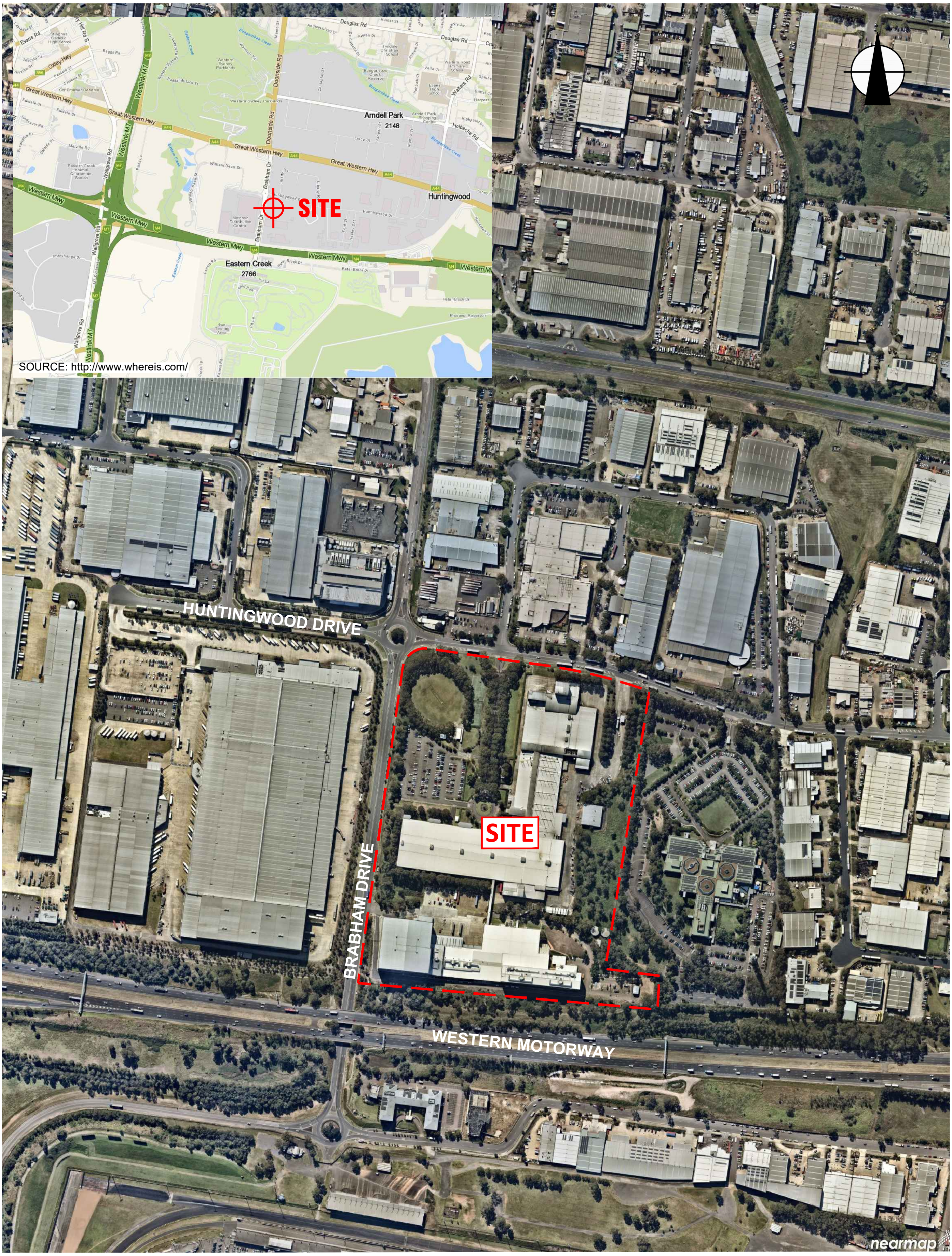
Misinterpretation of Site Assessments by Design Professionals
Costly problems can occur when other design professionals develop plans based on misinterpretation of an assessment report. To minimise problems associated with misinterpretations, the environmental consultant should be retained to work with appropriate professionals to explain relevant findings and to review the adequacy of plans and specifications relevant to contamination issues.

Logs Should not be Separated from the Assessment Report
Borehole and test pit logs are prepared by environmental scientists, engineers or geologists based upon interpretation of field conditions and laboratory evaluation of field samples. Logs are normally provided in our reports and these should not be re-drawn for inclusion in site management or other design drawings, as subtle but significant drafting errors or omissions may occur in the transfer process. Photographic reproduction can eliminate this problem, however contractors can still misinterpret the logs during bid preparation if separated from the text of the assessment. If this occurs, delays, disputes and unanticipated costs may result. In all cases it is necessary to refer to the rest of the report to obtain a proper understanding of the assessment. Please note that logs with the 'Environmental Log' header are not suitable for geotechnical purposes as they have not been peer reviewed by a Senior Geotechnical Engineer.

To reduce the likelihood of borehole and test pit log misinterpretation, the complete assessment should be available to persons or organisations involved in the project, such as contractors, for their use. Denial of such access and disclaiming responsibility for the accuracy of subsurface information does not insulate an owner from the attendant liability. It is critical that the site owner provides all available site information to persons and organisations such as contractors.

Read Responsibility Clauses Closely
Because an environmental site assessment is based extensively on judgement and opinion, it is necessarily less exact than other disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, model clauses have been developed for use in written transmittals. These are definitive clauses designed to indicate consultant responsibility. Their use helps all parties involved recognise individual responsibilities and formulate appropriate action. Some of these definitive clauses are likely to appear in the environmental site assessment, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to any questions.

Appendix A: Report Figures



AERIAL IMAGE SOURCE: MAPS.AU.NEARMAP.COM

This plan should be read in conjunction with the Environmental report.

Title:	**SITE LOCATION PLAN**
Location:	65 HUNTINGWOOD DRIVE, HUNTINGWOOD, NSW
Project No:	E34067P
Figure No:	1

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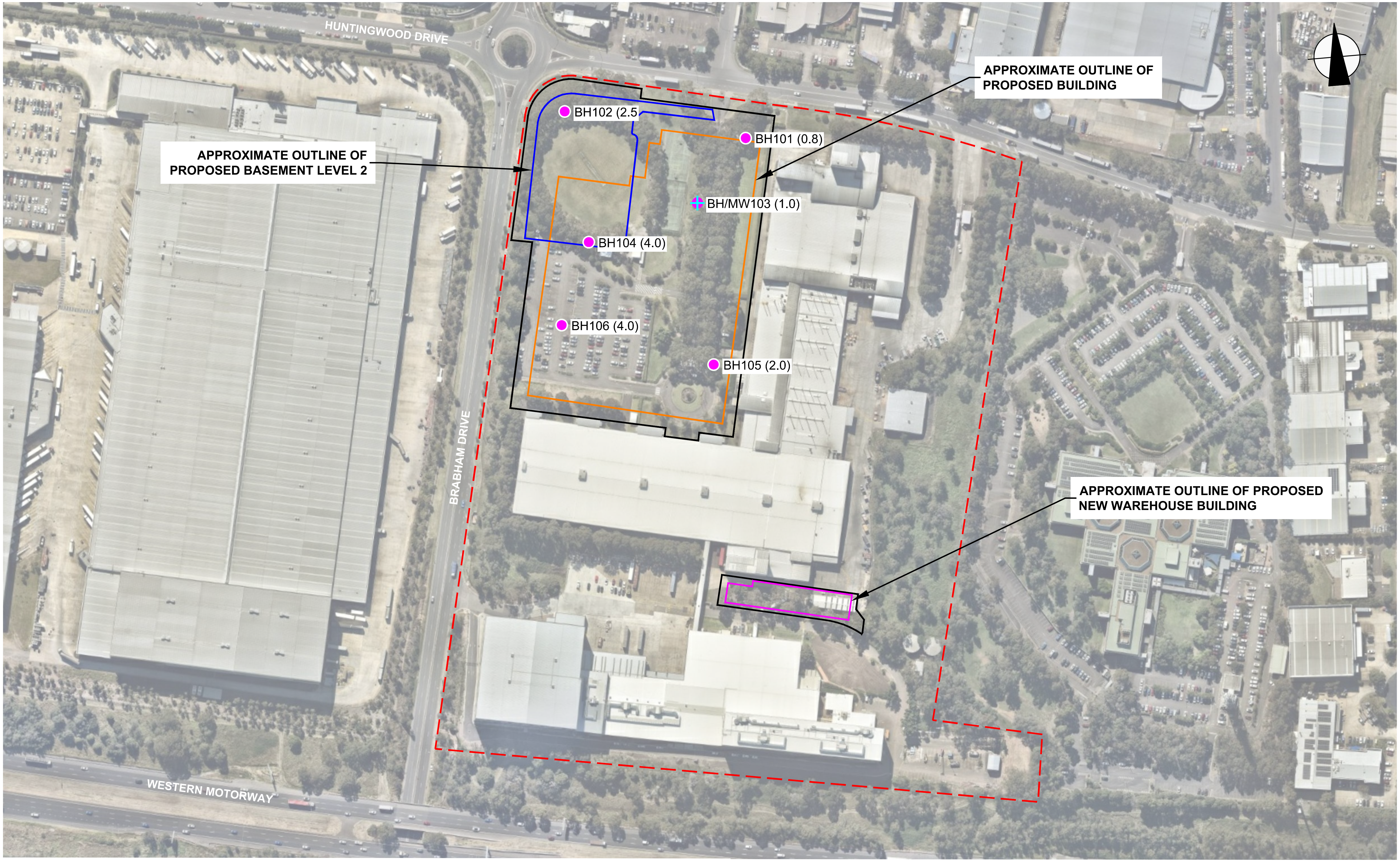
PLOT DATE: 8/06/2021 5:00:35 PM DWG FILE: Z:\5 EIS\5C EIS JOBS\34000'S\E34067P HUNTINGWOOD\CAD\E34067P.DWG



LEGEND

(red dashed line)	APPROXIMATE SITE BOUNDARY
BH(Fill Depth)	BOREHOLE LOCATION, NUMBER AND DEPTH OF FILL (m)
BH/MW(Fill Depth)	BOREHOLE AND GROUNDWATER MONITORING WELL LOCATION, NUMBER AND DEPTH OF FILL (m)
(black line)	APPROXIMATE OUTLINE OF PROPOSED DEVELOPMENT AREA

0 25 50 75 100 125
SCALE 1:2500 @A3 METRES

This plan should be read in conjunction with the Environmental report.

Title: **SAMPLE LOCATION PLAN**

Location: 65 HUNTINGWOOD DRIVE, HUNTINGWOOD, NSW

Project No: E34067P

Figure No: 2

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PLOT DATE: 8/06/2021 5:18:19 PM DWG FILE: Z:\5 EIS\5C EIS JOBS\34000'S\E34067P HUNTINGWOOD\CAD\E34067P.DWG

Appendix B: Laboratory Results Summary Tables

ABBREVIATIONS AND EXPLANATIONS FOR SALINITY TABLES

Abbreviations used in the Tables:

Ca	Calcium
CEC	Cation Exchange Capacity
DO	Dissolved Oxygen
EC	Electrical Conductivity
ECe	Extract Electrical Conductivity
Eh	Redox Potential
ESP	Exchangeable Sodium Percentage (Each Na/CEC)
K	Potassium
Mg	Magnesium
Na	Sodium
SWL	Standing Water Level

Units used in the Tables

°C	Degrees Celsius
dS/m	deciSiemens per metre
m	meters
meq/100g	milliequivalents per 100 grams
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
mV	millivolts
ohm.cm	ohm centimetre
µS/cm	microSiemens per centimetre

Notes on Specific Tables

SUMMARY OF SOIL LABORATORY RESULTS - EC and ECe
- The salinity Class has been adopted from 'Site Investigations for Urban Salinity' DLWC 2002.
- The chart function assumes an ECe value of 1.9 for values that are less than the practical quatitation limit.

SUMMARY OF RESISTIVITY CALCULATION ON SOIL EC RESULTS
- The resistivity values have been calculated on the laboratory EC values.
- The classification has been derived from the Australian Standard 2159-2009 Piling Design and Installation (Table 6.5.2 [A] & [C])
- Table 6.5.2 [A] of Australian Standard 2159-2009 recommends using a Moderate Exposure Classification for Steel Piles in Fresh Water - Soft Running Water

SUMMARY OF SOIL LABORATORY RESULTS - pH
- The pH Classification has been derived from the Australian Standard 2159-2009 Piling Design and Installation (Tables 6.4.2 [C] & 6.5.2 [C])
- Table 6.5.2 [A] of Australian Standard 2159-2009 recommends using a Moderate Exposure Classification for Steel Piles in Fresh Water - Soft Running Water

SUMMARY OF SOIL LABORATORY RESULTS - SULFATE & CHLORIDES
- The classification has been derived from the Australian Standard 2159-2009 Piling Design and Installation (Table 6.5.2 [A] & [C])
- The chart function assumes an concentration of 0.5mg/kg for values that are less than the practical quatitation

SUMMARY OF SOIL LABORATORY RESULTS - CEC & ESP
- The Sodicity rating has been adopted from the publication 'Site Investigations for Urban Salinity' DLWC 2002.

SUMMARY OF GROUNDWATER LABORATORY RESULTS
- The classification has been derived from the Australian Standard 2159-2009 Piling Design and Installation (Table 6.5.2 [A] & [C]) .
- Table 6.4.2 [A] recommends using a Mild Exposure Classification for Concrete Piles in Fresh Water - Treat as in Soil Condition 'A'.
- Table 6.5.2 [A] recommends using a Moderate Exposure Classification for Steel Piles in Fresh Water - Soft Running Water.

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TABLE B
SUMMARY OF SOIL LABORATORY RESULTS - EC and ECe

Borehole Number	Sample Depth (m)	Sample Description	EC (µS/cm)	ECe (dS/m)	Salinity Class
BH101	0-0.2	Fill: Silty clay	50	<2	NON SALINE
BH101	1.5-1.95	Silty clay	470	3.3	SLIGHTLY SALINE
BH101	3.8-4.0	Siltstone	540	4.8	MODERATELY SALINE
BH102	0-0.2	Fill: Silty sand	49	<2	NON SALINE
BH102	1.5-1.95	Fill: Silty clay	660	4.6	MODERATELY SALINE
BH102	2.8-3.0	Silty clay	550	3.9	SLIGHTLY SALINE
BH103	0-0.2	Fill: Silty clay	65	<2	NON SALINE
BH103	1.5-1.8	Silty clay	360	2.5	SLIGHTLY SALINE
BH103	2.8-3.0	Siltstone	520	4.7	MODERATELY SALINE
BH104	0-0.2	Fill: Silty clay	64	<2	NON SALINE
BH104	1.5-1.95	Fill: Silty clay	560	5	MODERATELY SALINE
BH104	1.5-1.95	LAB DUPLICATE	530		
BH104	4.8-5.0	Silty clay	650	4.6	MODERATELY SALINE
BH105	0-0.2	Fill: Silty clay	140	<2	NON SALINE
BH105	1.5-1.95	Fill: Silty clay	840	5.9	MODERATELY SALINE
BH105	3.8-4.0	Silty clay	570	4	SLIGHTLY SALINE
BH106	0.03-0.2	Fill: Silty clay	340	2.9	SLIGHTLY SALINE
BH106	1.5-1.95	Fill: Silty clay	670	4.7	MODERATELY SALINE
BH106	1.5-1.95	LAB DUPLICATE	660		
BH106	4.0-4.2	Silty clay	760	5.3	MODERATELY SALINE
BH106	5.8-6.0	Silty clay	870	6.1	MODERATELY SALINE
Text1					
Total Number of Samples			21	21	-
Minimum Value			49	<PQL	-
Maximum Value			870	6.1	-

ECe Values (dS/m)	**Salinity Class**
<2	NON SALINE
2 to 4	SLIGHTLY SALINE
4 to 8	MODERATELY SALINE
8 to 16	VERY SALINE
>16	HIGHLY SALINE

TABLE C
SUMMARY OF RESISTIVITY CALCULATION ON SOIL EC RESULTS

Borehole Number	Sample Depth (m)	Sample Description	EC (µS/cm)	Resistivity (ohm.cm)	Classification Condition B
BH101	0-0.2	Fill: Silty clay	50	20,000	Non Aggressive
BH101	1.5-1.95	Silty clay	470	2,128	Non Aggressive
BH101	3.8-4.0	Siltstone	540	1,852	Mildly Aggressive
BH102	0-0.2	Fill: Silty sand	49	20,408	Non Aggressive
BH102	1.5-1.95	Fill: Silty clay	660	1,515	Mildly Aggressive
BH102	2.8-3.0	Silty clay	550	1,818	Mildly Aggressive
BH103	0-0.2	Fill: Silty clay	65	15,385	Non Aggressive
BH103	1.5-1.8	Silty clay	360	2,778	Non Aggressive
BH103	2.8-3.0	Siltstone	520	1,923	Mildly Aggressive
BH104	0-0.2	Fill: Silty clay	64	15,625	Non Aggressive
BH104	1.5-1.95	Fill: Silty clay	560	1,786	Mildly Aggressive
BH104	1.5-1.95	LAB DUPLICATE	530	1,887	Mildly Aggressive
BH104	4.8-5.0	Silty clay	650	1,538	Mildly Aggressive
BH105	0-0.2	Fill: Silty clay	140	7,143	Non Aggressive
BH105	1.5-1.95	Fill: Silty clay	840	1,190	Mildly Aggressive
BH105	3.8-4.0	Silty clay	570	1,754	Mildly Aggressive
BH106	0.03-0.2	Fill: Silty clay	340	2,941	Non Aggressive
BH106	1.5-1.95	Fill: Silty clay	670	1,493	Mildly Aggressive
BH106	1.5-1.95	LAB DUPLICATE	660	1,515	Mildly Aggressive
BH106	4.0-4.2	Silty clay	760	1,316	Mildly Aggressive
BH106	5.8-6.0	Silty clay	870	1,149	Mildly Aggressive
Total Number of Samples			21	21	-
Minimum Value			49	1,149	-
Maximum Value			870	20,408	-

Classification is based on Soil condition 'B' - low permeability soils (e.g. silts & clays) or all soils above groundwater.

Resistivity Values (ohm.cm)	Classification for Steel Piles
>5,000	Non-Aggressive
2,000 - 5,000	Non-Aggressive
1,000 - 2,000	Mildly Aggressive
<1,000	Moderately Aggressive

TABLE D
SUMMARY OF SOIL LABORATORY RESULTS - pH

Borehole Number	Sample Depth (m)	Sample Description	pH	Classification for Concrete Piles Condition B	Classification for Steel Piles Condition B
BH101	0-0.2	Fill: Silty clay	6.3	Non-Aggressive	Non-Aggressive
BH101	1.5-1.95	Silty clay	5.9	Non-Aggressive	Non-Aggressive
BH101	3.8-4.0	Siltstone	7	Non-Aggressive	Non-Aggressive
BH102	0-0.2	Fill: Silty sand	6.4	Non-Aggressive	Non-Aggressive
BH102	1.5-1.95	Fill: Silty clay	4.9	Mildly Aggressive	Non-Aggressive
BH102	2.8-3.0	Silty clay	5.5	Mildly Aggressive	Non-Aggressive
BH103	0-0.2	Fill: Silty clay	6.2	Non-Aggressive	Non-Aggressive
BH103	1.5-1.8	Silty clay	5.9	Non-Aggressive	Non-Aggressive
BH103	2.8-3.0	Siltstone	6.1	Non-Aggressive	Non-Aggressive
BH104	0-0.2	Fill: Silty clay	6.2	Non-Aggressive	Non-Aggressive
BH104	1.5-1.95	Fill: Silty clay	5.9	Non-Aggressive	Non-Aggressive
BH104	1.5-1.95	LAB DUPLICATE	6	Non-Aggressive	Non-Aggressive
BH104	4.8-5.0	Silty clay	5.9	Non-Aggressive	Non-Aggressive
BH105	0-0.2	Fill: Silty clay	6.3	Non-Aggressive	Non-Aggressive
BH105	1.5-1.95	Fill: Silty clay	7.6	Non-Aggressive	Non-Aggressive
BH105	3.8-4.0	Silty clay	5.5	Mildly Aggressive	Non-Aggressive
BH106	0.03-0.2	Fill: Silty clay	9.6	Non-Aggressive	Non-Aggressive
BH106	1.5-1.95	Fill: Silty clay	5.2	Mildly Aggressive	Non-Aggressive
BH106	1.5-1.95	LAB DUPLICATE	5.2	Mildly Aggressive	Non-Aggressive
BH106	4.0-4.2	Silty clay	5.3	Mildly Aggressive	Non-Aggressive
BH106	5.8-6.0	Silty clay	5.8	Non-Aggressive	Non-Aggressive
Total Number of Samples			21	-	-
Minimum Value			4.9	-	-
Maximum Value			9.6	-	-

Classification is based on Soil condition 'B' - low permeability soils (e.g. silts & clays) or all soils above groundwater.

	Classification for Concrete Piles	pH Value	Classification for Steel Piles
>5.5	Non-Aggressive	>5	Non-Aggressive
4.5 - 5.5	Mildly Aggressive	4.0 - 5.0	Non-Aggressive
4 - 4.5	Moderately Aggressive	3.0 - 4.0	Mildly Aggressive
<4	Severely Aggressive	<3	Moderately Aggressive

TABLE E
SUMMARY OF SOIL LABORATORY RESULTS - SULPHATE & CHLORIDES

Borehole Number	Sample Depth (m)	Sample Description	Chloride (mg/kg)	Sulphate (mg/kg)	Classification for Concrete Piles Sulfate - Condition B	Classification for Steel Piles Chloride - Condition B
BH101	0-0.2	Fill: Silty clay	10	<10	Non-Aggressive	Non-Aggressive
BH101	0-0.2	LAB DUPLICATE	<10	<10	Non-Aggressive	Non-Aggressive
BH101	1.5-1.95	Silty clay	400	270	Non-Aggressive	Non-Aggressive
BH101	3.8-4.0	Siltstone	530	310	Non-Aggressive	Non-Aggressive
BH102	0-0.2	Fill: Silty sand	<10	10	Non-Aggressive	Non-Aggressive
BH102	1.5-1.95	Fill: Silty clay	610	570	Non-Aggressive	Non-Aggressive
BH102	1.5-1.95	LAB DUPLICATE	610	640	Non-Aggressive	Non-Aggressive
BH102	2.8-3.0	Silty clay	520	560	Non-Aggressive	Non-Aggressive
BH103	0-0.2	Fill: Silty clay	20	28	Non-Aggressive	Non-Aggressive
BH103	1.5-1.8	Silty clay	230	260	Non-Aggressive	Non-Aggressive
BH103	2.8-3.0	Siltstone	390	350	Non-Aggressive	Non-Aggressive
BH104	0-0.2	Fill: Silty clay	10	22	Non-Aggressive	Non-Aggressive
BH104	1.5-1.95	Fill: Silty clay	430	780	Non-Aggressive	Non-Aggressive
BH104	4.8-5.0	Silty clay	420	660	Non-Aggressive	Non-Aggressive
BH105	0-0.2	Fill: Silty clay	10	22	Non-Aggressive	Non-Aggressive
BH105	1.5-1.95	Fill: Silty clay	390	610	Non-Aggressive	Non-Aggressive
BH105	3.8-4.0	Silty clay	480	370	Non-Aggressive	Non-Aggressive
BH106	0.03-0.2	Fill: Silty clay	52	75	Non-Aggressive	Non-Aggressive
BH106	1.5-1.95	Fill: Silty clay	610	640	Non-Aggressive	Non-Aggressive
BH106	1.5-1.95	LAB DUPLICATE	600	510	Non-Aggressive	Non-Aggressive
BH106	4.0-4.2	Silty clay	740	850	Non-Aggressive	Non-Aggressive
BH106	5.8-6.0	Silty clay	1000	850	Non-Aggressive	Non-Aggressive
Total Number of Samples			22	22	-	-
Minimum Value			<PQL	<PQL	-	-
Maximum Value			1000	850	-	-

Classification is based on Soil condition 'B' - low permeability soils (e.g. silts & clays) or all soils above groundwater.

Sulfate Values	Classification for Concrete Piles
<5,000	Non-Aggressive
5,000 - 10,000	Mildly Aggressive
10,000 - 20,000	Moderately Aggressive
>20,000	Severely Aggressive

Chloride Values	Classification for Steel Piles
<5,000	Non-Aggressive
5,000 - 20,000	Non-Aggressive
20,000 - 50,000	Mildly Aggressive
>50,000	Moderately Aggressive

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TABLE F
SUMMARY OF SOIL LABORATORY RESULTS - CEC & ESP

Borehole Number	Sample Depth (m)	Sample Description	Exchangeable Ca	Exchangeable K	Exchangeable Mg	Exchangeable Na	CEC	ESP	Ca:Mg
			(meq/100g)					%	
BH101	0-0.2	Fill: Silty clay	7.6	1.5	6.4	0.17	16	1.1%	1.19:1
BH101	0-0.2	LAB DUPLICATE	7.5	1.5	6.6	0.16	16	1.0%	1.14:1
BH103	1.5-1.8	Silty clay	0.8	0.2	7.4	1.9	10	19.0%	0.11:1
BH105	0-0.2	Fill: Silty clay	14	0.9	3.4	<0.1	18	0.6%	4.12:1
BH106	1.5-1.95	Fill: Silty clay	2.1	0.3	8.5	1.9	13	14.6%	0.25:1
Total Number of Samples			5	5	5	5	5	5	5
Minimum Value			0.80	0.20	3.40	<PQL	10.0	0.6%	0.11 :1
Maximum Value			14.00	1.50	8.50	1.90	18.0	19.0%	4.12 :1

ESP Value	**Sodicity Rating**
< 5%	Non-Sodic
5% to 15%	Sodic
> 15%	Highly Sodic

Appendix C: Background on Salinity

Background on Salinity

A. General Information on Salinity

Salinity is the accumulation and concentration of salt at or near the ground surface or within surface water bodies. Salt is naturally present in the landscape through deposition of salt from the ocean in coastal areas and through weathering of bedrock that contains salt, accumulated during deposition of original sediments in a prehistoric marine environment. The salts are commonly soluble chlorides, sulphates or carbonates of sodium and magnesium.

In Sydney, salinity issues are typically associated with the Wianamatta Group shales and their derived soil landscapes. The natural vegetation of western Sydney is dominated by large isolated trees with deep root systems that remove subsurface moisture. Slow rates of percolation through the relatively impermeable clay soil and uptake of a large proportion of rainfall by the trees results in limited recharge of the groundwater system by rainfall. The depth to groundwater has developed a natural equilibrium and there is little tendency for salt contained in the groundwater or subsoils to rise to the surface.

B. Salinity and Urban Development

Salinity becomes a problem in urban areas when changes in the land use result in changes to the way water moves through the environment. This can result in vegetation die-back, decrease in water quality and damage to urban infrastructure.

Removal of deep rooted tree species during development and replacement with urban infrastructure, houses and industrial developments reduces the mechanism for the removal of subsurface moisture.

The development of urban salinity is commonly associated with changes in the hydrological cycle through the environment (rainfall, surface run-off, water infiltration and groundwater system). An increase in the quantity of water reaching the groundwater table as a result of vegetation clearance, irrigation of parklands, leaking water infrastructure and changes in drainage patterns, can cause a relatively rapid rise in the groundwater table. Earthworks that include excavation of natural soil profiles and exposure of more saline subsurface soils or shale bedrock may also result in an increase in salt concentrations at the ground surface.

Construction of roads, pipelines and buildings commonly results in removal of topsoil leading to exposure of the subsoils and interception of surficial and shallow subsurface drainage. In addition, over-irrigation of urban gardens, leaking water infrastructure and concentrated drainage patterns can result in increased water movement through the subsoil to the groundwater system leading to a relatively rapid rise in the groundwater table.

A rise in groundwater levels and impediments to subsurface drainage patterns can transport salt formerly stored in the bedrock to the surficial soil profile. This may result in salt encrustation of exposed soils, building foundations, roads, drainage infrastructure and corrosion of metal, concrete and other building materials. Increasing salt concentrations in surficial soils (and consequently in surface waters) may also result in die-off of the existing vegetation, further reducing the hydrological load on the groundwater system and resulting in further groundwater table rises.

C. Potential Salinity Impacts on Urban Development

Some of the adverse impacts that can arise from saline conditions include:

- Salt scalds caused by a rise in the subsoil moisture content that mobilises salt to the ground surface;
- Salt scalds caused by modification of former drainage patterns which leads to the day lighting of subsurface seepage (either perched water or groundwater) in areas lower in the catchment, either at breaks in the slope or within drainage lines;
- A rise in groundwater table or accumulation of salt rich seepage leading to corrosion of subsurface facilities including concrete structures, metal pipework, cables, foundations, underground services, etc;
- Rising damp, where salt rich moisture is drawn into building and pavement materials by capillary action leading to deterioration of brick, mortar and concrete;
- Structural cracking, damage or building collapse which may occur as a result of shifting and or sinking foundations;
- Plant die-back associated with a rise in groundwater table level that mobilises excess salt to the plant root zone; and
- Subsurface water discharge and subsequent pollution of streams and drainage channels.

D. Soils and Groundwater Planning Strategy in Western Sydney

The aim of the DLWC 2002 document is to provide a framework for the sustainable development and management of new developments in the western region of Sydney. In relation to salinity management, the development should be designed and constructed such that there is no significant increase in the water table level and no adverse salinity impacts.

The proposed development controls that relate to soils and groundwater issues are summarised below:

1. A water management strategy should be prepared to address the following:
    - Reduction of potable water usage onsite;
    - Development of best practice measures for stormwater reuse for open space irrigation;
    - Reduction of potable water demand;
    - Reduction of adverse impacts on local groundwater regimes;
    - Reduction of change in local flow regimes; and
    - Preparation of water maintenance and a monitoring management system.
2. A salinity management plan should be prepared that includes a groundwater management strategy related to:
    - Adoption of small landscaped areas to reduce irrigation requirements;
    - Use of native and other low water requirement plants;
    - Use of mulch cover (not in drainage lines);
    - Use of low flow watering facilities for landscaped areas;
    - Implementation of a tree planting program, especially in high recharge areas, of native, deep rooted, large growing species to assist retention of the groundwater at existing levels;

- Retention of existing native tree cover where possible; and
- Not permitting infiltration pits or tanks to disperse surface water.

3. An assessment of soil and rock conditions at the site, including erosion, expansive and dispersive soil conditions, and plant growth potential should be undertaken.
4. Use of the Blue Book (2004) as a guide to prepare soil and water management plans. The approved plan and subsequent works are to be supervised by appropriately qualified experienced personnel.

Appendix D: Borehole Logs

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BOREHOLE LOG

Borehole No. **101**

1/1

Client: FDC CONSTRUCTION (NSW) PTY LTD

Project: PROPOSED ADDITIONS

Location: 65 HUNTINGWOOD DRIVE, HUNTINGWOOD, NSW

Job No.: 34067BC **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 62.3m

Date: 14/05/2021 **Datum:** AHD

Plant Type: JK305 **Logged/Checked by:** A.C.K./T.C.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLET-ION	N = 16 4,9,7	0		FILL: Silty clay, medium plasticity, dark grey brown, trace of fine to medium grained sandstone gravel.	w<PL		>600	APPEARS WELL COMPACTED
	N = 14 5,6,8	1	CH	Silty CLAY: high plasticity, light grey and orange brown, trace of fine to medium grained ironstone gravel.	w>PL	Hd	425 420 465	RESIDUAL
		2						
		3	-	SILTSTONE: dark grey brown, with iron indurated seams and clay seams.	DW	VL-L		BRINGELLY SHALE VERY LOW TO LOW 'TC' BIT RESISTANCE
		4		SILTSTONE: dark grey.		L		LOW TO MODERATE RESISTANCE
		5			SW	M-H		MODERATE TO HIGH RESISTANCE
		6		END OF BOREHOLE AT 6.0m				
		7						

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BOREHOLE LOG

Borehole No.
102
1/1

Client: FDC CONSTRUCTION (NSW) PTY LTD
Project: PROPOSED ADDITIONS
Location: 65 HUNTINGWOOD DRIVE, HUNTINGWOOD, NSW

Job No.: 34067BC **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 59.3m
Date: 14/05/2021 **Datum:** AHD
Plant Type: JK305 **Logged/Checked by:** A.C.K./T.C.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION		0		FILL: Silty sand, fine to medium grained, dark brown.	M			GRASS COVER
	N = 9 4,4,5			FILL: Gravel, medium grained igneous, with clay fines and nodules.				APPEARS MODERATELY COMPACTED
	N = 10 4,4,6	1		FILL: Silty clay, medium to high plasticity, grey brown mottled various colours, trace of fine to medium grained ironstone gravel.	w>PL			
	N = 22 5,8,14	2	CH	Silty CLAY: high plasticity, light grey, trace of fine to medium grained ironstone gravel.	w<PL	Hd	410 580 570	RESIDUAL
		4	-	SILTSTONE: dark grey brown.	DW	L		BRINGELLY SHALE LOW 'TC' BIT RESISTANCE
				SILTSTONE: dark grey, with very low strength seams.		M		MODERATE RESISTANCE WITH LOW BANDS
		6		END OF BOREHOLE AT 6.0m				
		7						

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BOREHOLE LOG

Borehole No.
103
1/1

Client: FDC CONSTRUCTION (NSW) PTY LTD
Project: PROPOSED ADDITIONS
Location: 65 HUNTINGWOOD DRIVE, HUNTINGWOOD, NSW

Job No.: 34067BC | **Method:** SPIRAL AUGER | **R.L. Surface:** ≈ 62.4m
Date: 14/05/2021 | **Datum:** AHD
Plant Type: JK305 | **Logged/Checked by:** A.C.K./T.C.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION AND AFTER 6 DAYS	N = 16 8,8,8	0		FILL: Silty clay, medium plasticity, dark grey brown, trace of fine to medium grained ironstone gravel and igneous gravel and root fibres.	w<PL			GRASS COVER APPEARS WELL COMPACTED
	N > 14 9,14/ 150mm REFUSAL	1	CH	Silty CLAY: high plasticity, light grey mottled orange brown and red brown, trace of fine grained sand and fine to medium grained ironstone gravel.	w<PL	Hd	>600	RESIDUAL
		2.7	-	SILTSTONE: dark grey brown, with iron indurated seams and clay bands.	DW	VL-L		BRINGELLY SHALE LOW 'TC' BIT RESISTANCE WITH VERY LOW BANDS Groundwater monitoring well installed to 6.0m. Class 18 machine slotted 50mm dia. PVC standpipe 3.2m to 6.0m. Casing 0.0m to 3.2m. 2mm sand filter pack 3.0m to 6.0m. Bentonite seal 2.2m to 3.0m. Backfilled with sand and cuttings to the surface. Completed with a concreted gatic cover
		5.2		SILTSTONE: dark grey, with extremely weathered seams and iron indurated seams.		L-M		LOW TO MODERATE RESISTANCE
				SILTSTONE: dark grey, with iron indurated seams.	SW	H		MODERATE TO HIGH RESISTANCE
		6		END OF BOREHOLE AT 6.0m				
		7						

Samples: ES, U50, DB, DS

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BOREHOLE LOG

Borehole No.
104
1/1

Client: FDC CONSTRUCTION (NSW) PTY LTD
Project: PROPOSED ADDITIONS
Location: 65 HUNTINGWOOD DRIVE, HUNTINGWOOD, NSW

Job No.: 34067BC **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 62.5m
Date: 14/05/2021 **Datum:** AHD
Plant Type: JK305 **Logged/Checked by:** A.C.K./T.C.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION		0		FILL: Silty clay, medium plasticity, dark grey brown, trace of fine to medium grained ironstone gravel.	w≈PL			GRASS COVER
	N = 11 5,4,7						300 530 >600	APPEARS MODERATELY TO WELL COMPACTED
		1						
	N = 16 7,8,8			FILL: Silty clay, medium plasticity, grey brown, trace of fine to medium grained siltstone gravel.				
		2						
	N = 2 2,1,1	3						APPEARS POORLY COMPACTED
		4	CH	Silty CLAY: high plasticity, light grey mottled orange brown, and red brown, trace of fine to medium grained ironstone gravel.	w<PL	Hd		RESIDUAL
	N = 27 4,13,14						>600	
		5	-	Extremely Weathered siltstone: silty CLAY, medium to high plasticity, light grey mottled red brown, with very low strength bands.	XW	Hd		BRINGELLY SHALE
	N = SPT 13/100mm REFUSAL	6		END OF BOREHOLE AT 6.1m				
		7						

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BOREHOLE LOG

Borehole No.
105
1/2

Client: FDC CONSTRUCTION (NSW) PTY LTD
Project: PROPOSED ADDITIONS
Location: 65 HUNTINGWOOD DRIVE, HUNTINGWOOD, NSW

Job No.: 34067BC **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 65.6m
Date: 14/05/2021 **Datum:** AHD
Plant Type: JK305 **Logged/Checked by:** A.C.K./T.C.

Groundwater Record	Field Tests	Depth (m)	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLETION		0		FILL: Silty clay, medium plasticity, dark grey brown, trace of fine to medium grained ironstone gravel and root fibres.	w<PL			GRASS COVER
	N = 9 5,5,4			FILL: Silty clay, high plasticity, light grey brown mottled various colours, trace of fine to medium grained igneous gravel and ironstone gravel.			310 400 360	APPEARS MODERATELY TO WELL COMPACTED
		1						
	N = 12 5,5,7						430 350 580	
		2	CH	Silty CLAY: high plasticity, light grey mottled orange brown and red brown, trace of fine to medium grained ironstone gravel.	w≈PL	VSt-Hd		RESIDUAL
	N = 11 3,5,6	3					430 270 340	
		4						
	N = 27 4,8,19				w<PL	Hd	>600 >600 >600	
		5	-	SILTSTONE: grey brown, with iron indurated seams and extremely weathered seams.	DW	VL		BRINGELLY SHALE
				as above, but dark grey.		L		VERY LOW TO LOW 'TC' BIT RESISTANCE
		6				L-M		LOW RESISTANCE WITH VERY LOW BANDS
								MODERATE RESISTANCE WITH LOW BANDS
		7						

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BOREHOLE LOG

Borehole No.
105
2/2

Client: FDC CONSTRUCTION (NSW) PTY LTD
Project: PROPOSED ADDITIONS
Location: 65 HUNTINGWOOD DRIVE, HUNTINGWOOD, NSW

Job No.: 34067BC **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 65.6m
Date: 14/05/2021 **Datum:** AHD
Plant Type: JK305 **Logged/Checked by:** A.C.K./T.C.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
	■								SILTSTONE: dark grey, with iron indurated seams and extremely weathered seams.	DW	L-M		
									END OF BOREHOLE AT 7.5m				
						8							
						9							
						10							
						11							
						12							
						13							
						14							

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BOREHOLE LOG

Borehole No.
106
1/2

Client: FDC CONSTRUCTION (NSW) PTY LTD
Project: PROPOSED ADDITIONS
Location: 65 HUNTINGWOOD DRIVE, HUNTINGWOOD, NSW

Job No.: 34067BC **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 62.4m
Date: 14/05/2021 **Datum:** AHD
Plant Type: JK305 **Logged/Checked by:** A.C.K./T.C.

Groundwater Record	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
DRY ON COMPLET-ION		0		-	ASPHALTIC CONCRETE: 30mm.t	w≈PL			
					FILL: Silty clay, medium plasticity, dark grey brown, trace of fine to medium grained ironstone and sandstone gravel.	w>PL			
	N = 5 3,2,3				FILL: Silty clay, low to medium plasticity, light grey brown mottled various colours, trace of fine to medium grained igneous and ironstone gravel.				
		1				w<PL			
	N = 15 5,6,9							480 320 >600	APPEARS WELL COMPACTED
		2							
	N = 25 6,8,17	3						425 580 600	
		4		CH	Silty CLAY: high plasticity, light grey and mottled orange brown and red brown, trace of fine to medium grained ironstone gravel.	w≈PL	VSt- Hd		RESIDUAL
	N = 14 3,5,9							420 420 345	
		5				w<PL	Hd		
	N > 24 16,8/50mm REFUSAL	6						>600 >600	
				-	SILTSTONE: grey brown, with iron indurated seams.	DW	L-M		BRINGELLY SHALE
		7							

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BOREHOLE LOG

Client: FDC CONSTRUCTION (NSW) PTY LTD
Project: PROPOSED ADDITIONS
Location: 65 HUNTINGWOOD DRIVE, HUNTINGWOOD, NSW

Job No.: 34067BC **Method:** SPIRAL AUGER **R.L. Surface:** ≈ 62.4m
Date: 14/05/2021 **Datum:** AHD
Plant Type: JK305 **Logged/Checked by:** A.C.K./T.C.

Groundwater Record	SAMPLES ES	U50	DB	DS	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						8			SILTSTONE: grey brown, with iron indurated seams.	DW	L-M		LOW 'TC' BIT RESISTANCE LOW RESISTANCE WITH MODERATE BANDS
						9 – 14			END OF BOREHOLE AT 9.0m				

ENVIRONMENTAL LOGS EXPLANATION NOTES

INTRODUCTION

These notes have been provided to amplify the environmental report in regard to classification methods, field procedures and certain matters relating to the logging of soil and rock. Not all notes are necessarily relevant to all reports.

Where geotechnical borehole logs are utilised for environmental purpose, reference should also be made to the explanatory notes included in the geotechnical report. Environmental logs are not suitable for geotechnical purposes.

The ground is a product of continuing natural and man-made processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Environmental studies include gathering and assimilating limited facts about these characteristics and properties in order to understand or predict the behaviour of the ground on a particular site under certain conditions. This report may contain such facts obtained by inspection, excavation, probing, sampling, testing or other means of investigation. If so, they are directly relevant only to the ground at the place where and time when the investigation was carried out.

DESCRIPTION AND CLASSIFICATION METHODS

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726:2017 *'Geotechnical Site Investigations'*. In general, descriptions cover the following properties – soil or rock type, colour, structure, strength or density, and inclusions. Identification and classification of soil and rock involves judgement and the Company infers accuracy only to the extent that is common in current geoenvironmental practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached soil classification table qualified by the grading of other particles present (eg. sandy clay) as set out below:

Soil Classification	Particle Size
Clay	< 0.002mm
Silt	0.002 to 0.075mm
Sand	0.075 to 2.36mm
Gravel	2.36 to 63mm
Cobbles	63 to 200mm
Boulders	> 200mm

Non-cohesive soils are classified on the basis of relative density, generally from the results of Standard Penetration Test (SPT) as below:

Relative Density	SPT 'N' Value (blows/300mm)
Very loose (VL)	< 4
Loose (L)	4 to 10
Medium dense (MD)	10 to 30
Dense (D)	30 to 50
Very Dense (VD)	> 50

Cohesive soils are classified on the basis of strength (consistency) either by use of a hand penetrometer, vane shear, laboratory testing and/or tactile engineering examination. The strength terms are defined as follows.

Classification	Unconfined Compressive Strength (kPa)	Indicative Undrained Shear Strength (kPa)
Very Soft (VS)	≤ 25	≤ 12
Soft (S)	> 25 and ≤ 50	> 12 and ≤ 25
Firm (F)	> 50 and ≤ 100	> 25 and ≤ 50
Stiff (St)	> 100 and ≤ 200	> 50 and ≤ 100
Very Stiff (VSt)	> 200 and ≤ 400	> 100 and ≤ 200
Hard (Hd)	> 400	> 200
Friable (Fr)	Strength not attainable – soil crumbles	

Rock types are classified by their geological names, together with descriptive terms regarding weathering, strength, defects, etc. Where relevant, further information regarding rock classification is given in the text of the report. In the Sydney Basin, 'shale' is used to describe fissile mudstone, with a weakness parallel to bedding. Rocks with alternating inter-laminations of different grain size (eg. siltstone/claystone and siltstone/fine grained sandstone) are referred to as 'laminite'.

INVESTIGATION METHODS

The following is a brief summary of investigation methods currently adopted by the Company and some comments on their use and application. All methods except test pits, hand auger drilling and portable Dynamic Cone Penetrometers require the use of a mechanical rig which is commonly mounted on a truck chassis or track base.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the insitu soils and 'weaker' bedrock if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for a large excavator. Limitations of test pits are the problems associated with disturbance and difficulty of reinstatement and the consequent effects on close-by structures. Care must be taken if construction is to be carried out near test pit locations to either properly recompact the backfill during construction or to design and construct the structure so as not to be adversely affected by poorly compacted backfill at the test pit location.

Hand Auger Drilling: A borehole of 50mm to 100mm diameter is advanced by manually operated equipment. Refusal of the hand auger can occur on a variety of materials such as obstructions within any fill, tree roots, hard clay, gravel or ironstone, cobbles and boulders, and does not necessarily indicate rock level.

Continuous Spiral Flight Augers: The borehole is advanced using 75mm to 115mm diameter continuous spiral flight augers, which are withdrawn at intervals to allow sampling and insitu testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface by the flights or may be collected after withdrawal of the auger flights, but they can be very disturbed and layers may become mixed. Information from the auger sampling (as distinct from specific sampling by SPTs or undisturbed samples) is of limited reliability due to mixing or softening of samples by groundwater, or uncertainties as to the original depth of the samples. Augering below the groundwater table is of even lesser reliability than augering above the water table.

Rock Augering: Use can be made of a Tungsten Carbide (TC) bit for auger drilling into rock to indicate rock quality and continuity by variation in drilling resistance and from examination of recovered rock cuttings. This method of investigation is quick and relatively inexpensive but provides only an indication of the likely rock strength and predicted values may be in error by a strength order. Where rock strengths may have a significant impact on construction feasibility or costs, then further investigation by means of cored boreholes may be warranted.

Wash Boring: The borehole is usually advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be assessed from the cuttings, together with some information from "feel" and rate of penetration.

Mud Stabilised Drilling: Either Wash Boring or Continuous Core Drilling can use drilling mud as a circulating fluid to stabilise the borehole. The term 'mud' encompasses a range of products ranging from bentonite to polymers. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (eg. from SPT and U50 samples) or from rock coring, etc.

Continuous Core Drilling: A continuous core sample is obtained using a diamond tipped core barrel. Provided full core recovery is achieved (which is not always possible in very low strength rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation. In rocks, NMLC or HQ triple tube core barrels, which give a core of about 50mm and 61mm diameter, respectively, is usually used with water flush. The length of core recovered is compared to the length drilled and any length not recovered is shown as NO CORE. The location of NO CORE recovery is determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the bottom of the drill run.

Standard Penetration Tests: Standard Penetration Tests (SPT) are used mainly in non-cohesive soils, but can also be used in cohesive soils, as a means of indicating density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289.6.3.1–2004 (R2016) *'Methods of Testing Soils for Engineering Purposes, Soil Strength and Consolidation Tests – Determination of the Penetration Resistance of a Soil – Standard Penetration Test (SPT)'*.

The test is carried out in a borehole by driving a 50mm diameter split sample tube with a tapered shoe, under the impact of a 63.5kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

- In the case where full penetration is obtained with successive blow counts for each 150mm of, say, 4, 6 and 7 blows, as

  N = 13
  4, 6, 7

- In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm, as

  N > 30
  15, 30/40mm

The results of the test can be related empirically to the engineering properties of the soil.

A modification to the SPT is where the same driving system is used with a solid 60° tipped steel cone of the same diameter as the SPT hollow sampler. The solid cone can be continuously driven for some distance in soft clays or loose sands, or may be used where damage would otherwise occur to the SPT. The results of this Solid Cone Penetration Test (SCPT) are shown as 'N_c' on the borehole logs, together with the number of blows per 150mm penetration.

LOGS

The borehole or test pit logs presented herein are an interpretation of the subsurface conditions, and their reliability will depend to some extent on the frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will enable the most reliable assessment, but is not always practicable or possible to justify on economic grounds. In any case, the boreholes or test pits represent only a very small sample of the total subsurface conditions.

The terms and symbols used in preparation of the logs are defined in the following pages.

Interpretation of the information shown on the logs, and its application to design and construction, should therefore take into account the spacing of boreholes or test pits, the method of drilling or excavation, the frequency of sampling and testing and the possibility of other than 'straight line' variations between the boreholes or test pits. Subsurface conditions between boreholes or test pits may vary significantly from conditions encountered at the borehole or test pit locations.

GROUNDWATER

Where groundwater levels are measured in boreholes, there are several potential problems:

- Although groundwater may be present, in low permeability soils it may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes and may not be the same at the time of construction.
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must be washed out of the hole or 'reverted' chemically if reliable water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after the groundwater level has stabilised at intervals ranging from several days to perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from perched water tables or surface water.

FILL

The presence of fill materials can often be determined only by the inclusion of foreign objects (eg. bricks, steel, etc) or by distinctly unusual colour, texture or fabric. Identification of the extent of fill materials will also depend on investigation methods and frequency. Where natural soils similar to those at the site are used for fill, it may be difficult with limited testing and sampling to reliably assess the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density and material type is much greater than with natural soil deposits. Consequently, there is an increased risk of adverse environmental characteristics or behaviour. If the volume and nature of fill is of importance to a project, then frequent test pit excavations are preferable to boreholes.

LABORATORY TESTING

Laboratory testing has not been undertaken to confirm the soil classification and rock strengths indicated on the environmental logs unless noted in the report.

SYMBOL LEGENDS

SOIL

- FILL
- TOPSOIL
- CLAY (CL, CI, CH)
- SILT (ML, MH)
- SAND (SP, SW)
- GRAVEL (GP, GW)
- SANDY CLAY (CL, CI, CH)
- SILTY CLAY (CL, CI, CH)
- CLAYEY SAND (SC)
- SILTY SAND (SM)
- GRAVELLY CLAY (CL, CI, CH)
- CLAYEY GRAVEL (GC)
- SANDY SILT (ML, MH)
- PEAT AND HIGHLY ORGANIC SOILS (Pt)

ROCK

- CONGLOMERATE
- SANDSTONE
- SHALE/MUDSTONE
- SILTSTONE
- CLAYSTONE
- COAL
- LAMINITE
- LIMESTONE
- PHYLLITE, SCHIST
- TUFF
- GRANITE, GABBRO
- DOLERITE, DIORITE
- BASALT, ANDESITE
- QUARTZITE

OTHER MATERIALS

- BRICKS OR PAVERS
- CONCRETE
- ASPHALTIC CONCRETE

CLASSIFICATION OF COARSE AND FINE GRAINED SOILS

Major Divisions		Group Symbol	Typical Names	Field Classification of Sand and Gravel	Laboratory Classification	
Coarse grained soil (more than 65% of soil excluding oversize fraction is greater than 0.075mm)	GRAVEL (more than half of coarse fraction is larger than 2.36mm	GW	Gravel and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 4$ $1 < C_c < 3$
		GP	Gravel and gravel-sand mixtures, little or no fines, uniform gravels	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		GM	Gravel-silt mixtures and gravel-sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	Fines behave as silt
		GC	Gravel-clay mixtures and gravel-sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	Fines behave as clay
	SAND (more than half of coarse fraction is smaller than 2.36mm)	SW	Sand and gravel-sand mixtures, little or no fines	Wide range in grain size and substantial amounts of all intermediate sizes, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	$C_u > 6$ $1 < C_c < 3$
		SP	Sand and gravel-sand mixtures, little or no fines	Predominantly one size or range of sizes with some intermediate sizes missing, not enough fines to bind coarse grains, no dry strength	≤ 5% fines	Fails to comply with above
		SM	Sand-silt mixtures	'Dirty' materials with excess of non-plastic fines, zero to medium dry strength	≥ 12% fines, fines are silty	N/A
		SC	Sand-clay mixtures	'Dirty' materials with excess of plastic fines, medium to high dry strength	≥ 12% fines, fines are clayey	

Major Divisions		Group Symbol	Typical Names	Field Classification of Silt and Clay			Laboratory Classification
				Dry Strength	Dilatancy	Toughness	% < 0.075mm
ine grained soils (more than 35% of soil excluding oversize fraction is less than 0.075mm)	SILT and CLAY (low to medium plasticity)	ML	Inorganic silt and very fine sand, rock flour, silty or clayey fine sand or silt with low plasticity	None to low	Slow to rapid	Low	Below A line
		CL, CI	Inorganic clay of low to medium plasticity, gravelly clay, sandy clay	Medium to high	None to slow	Medium	Above A line
		OL	Organic silt	Low to medium	Slow	Low	Below A line
	SILT and CLAY (high plasticity)	MH	Inorganic silt	Low to medium	None to slow	Low to medium	Below A line
		CH	Inorganic clay of high plasticity	High to very high	None	High	Above A line
		OH	Organic clay of medium to high plasticity, organic silt	Medium to high	None to very slow	Low to medium	Below A line
	Highly organic soil	Pt	Peat, highly organic soil	–	–	–	–

Laboratory Classification Criteria

A well graded coarse grained soil is one for which the coefficient of uniformity $Cu > 4$ and the coefficient of curvature $1 < C_c < 3$. Otherwise, the soil is poorly graded. These coefficients are given by:

$$C_U = \frac{D_{60}}{D_{10}} \qquad and \qquad C_C = \frac{(D_{30})^2}{D_{10}\,D_{60}}$$

Where D_{10}, D_{30} and D_{60} are those grain sizes for which 10%, 30% and 60% of the soil grains, respectively, are smaller.

NOTES:

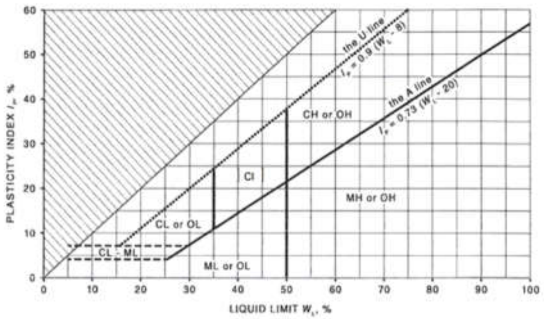
1 For a coarse grained soil with a fines content between 5% and 12%, the soil is given a dual classification comprising the two group symbols separated by a dash; for example, for a poorly graded gravel with between 5% and 12% silt fines, the classification is GP-GM.

2 Where the grading is determined from laboratory tests, it is defined by coefficients of curvature (C_c) and uniformity (C_u) derived from the particle size distribution curve.

3 Clay soils with liquid limits > 35% and ≤ 50% may be classified as being of medium plasticity.

4 The U line on the Modified Casagrande Chart is an approximate upper bound for most natural soils.

Modified Casagrande Chart for Classifying Silts and Clays according to their Behaviour



JKEnvironments

LOG SYMBOLS

Log Column	Symbol	Definition
Groundwater Record	▼	Standing water level. Time delay following completion of drilling/excavation may be shown.
	C	Extent of borehole/test pit collapse shortly after drilling/excavation.
	▶	Groundwater seepage into borehole or test pit noted during drilling or excavation.
Samples	ES	Sample taken over depth indicated, for environmental analysis.
	U50	Undisturbed 50mm diameter tube sample taken over depth indicated.
	DB	Bulk disturbed sample taken over depth indicated.
	DS	Small disturbed bag sample taken over depth indicated.
	ASB	Soil sample taken over depth indicated, for asbestos analysis.
	ASS	Soil sample taken over depth indicated, for acid sulfate soil analysis.
	SAL	Soil sample taken over depth indicated, for salinity analysis.
	PFAS	Soil sample taken over depth indicated, for analysis of Per- and Polyfluoroalkyl Substances.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration. 'Refusal' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	N_c = 5 7 3R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60° solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25	Vane shear reading in kPa of undrained shear strength.
	PID = 100	Photoionisation detector reading in ppm (soil sample headspace test).
Moisture Condition (Fine Grained Soils)	w > PL	Moisture content estimated to be greater than plastic limit.
	w ≈ PL	Moisture content estimated to be approximately equal to plastic limit.
	w < PL	Moisture content estimated to be less than plastic limit.
	w ≈ LL	Moisture content estimated to be near liquid limit.
	w > LL	Moisture content estimated to be wet of liquid limit.
(Coarse Grained Soils)	D	DRY – runs freely through fingers.
	M	MOIST – does not run freely but no free water visible on soil surface.
	W	WET – free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS	VERY SOFT – unconfined compressive strength ≤ 25kPa.
	S	SOFT – unconfined compressive strength > 25kPa and ≤ 50kPa.
	F	FIRM – unconfined compressive strength > 50kPa and ≤ 100kPa.
	St	STIFF – unconfined compressive strength > 100kPa and ≤ 200kPa.
	VSt	VERY STIFF – unconfined compressive strength > 200kPa and ≤ 400kPa.
	Hd	HARD – unconfined compressive strength > 400kPa.
	Fr	FRIABLE – strength not attainable, soil crumbles.
	( )	Bracketed symbol indicates estimated consistency based on tactile examination or other assessment.

Log Column	Symbol	Definition	Density Index (I_D) Range (%)	SPT 'N' Value Range (Blows/300mm)
Density Index/ Relative Density (Cohesionless Soils)	VL	VERY LOOSE	≤ 15	0 – 4
	L	LOOSE	> 15 and ≤ 35	4 – 10
	MD	MEDIUM DENSE	> 35 and ≤ 65	10 – 30
	D	DENSE	> 65 and ≤ 85	30 – 50
	VD	VERY DENSE	> 85	> 50
	( )	Bracketed symbol indicates estimated density based on ease of drilling or other assessment.		

Log Column	Symbol	Definition
Hand Penetrometer Readings	300 250	Measures reading in kPa of unconfined compressive strength. Numbers indicate individual test results on representative undisturbed material unless noted otherwise.
Remarks	'V' bit	Hardened steel 'V' shaped bit.
	'TC' bit	Twin pronged tungsten carbide bit.
	T_{60}	Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.
	Soil Origin	The geological origin of the soil can generally be described as: RESIDUAL – soil formed directly from insitu weathering of the underlying rock. No visible structure or fabric of the parent rock. EXTREMELY WEATHERED – soil formed directly from insitu weathering of the underlying rock. Material is of soil strength but retains the structure and/or fabric of the parent rock. ALLUVIAL – soil deposited by creeks and rivers. ESTUARINE – soil deposited in coastal estuaries, including sediments caused by inflowing creeks and rivers, and tidal currents. MARINE – soil deposited in a marine environment. AEOLIAN – soil carried and deposited by wind. COLLUVIAL – soil and rock debris transported downslope by gravity, with or without the assistance of flowing water. Colluvium is usually a thick deposit formed from a landslide. The description 'slopewash' is used for thinner surficial deposits. LITTORAL – beach deposited soil.

Classification of Material Weathering

<table>
<tr><th colspan="2">Term</th><th colspan="2">Abbreviation</th><th>Definition</th></tr>
<tr><td colspan="2">Residual Soil</td><td colspan="2">RS</td><td>Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are no longer visible, but the soil has not been significantly transported.</td></tr>
<tr><td colspan="2">Extremely Weathered</td><td colspan="2">XW</td><td>Material is weathered to such an extent that it has soil properties. Mass structure and material texture and fabric of original rock are still visible.</td></tr>
<tr><td>Highly Weathered</td><td rowspan="2">Distinctly Weathered (Note 1)</td><td>HW</td><td rowspan="2">DW</td><td>The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Rock strength is significantly changed by weathering. Some primary minerals have weathered to clay minerals. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores.</td></tr>
<tr><td>Moderately Weathered</td><td>MW</td><td>The whole of the rock material is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable, but shows little or no change of strength from fresh rock.</td></tr>
<tr><td colspan="2">Slightly Weathered</td><td colspan="2">SW</td><td>Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.</td></tr>
<tr><td colspan="2">Fresh</td><td colspan="2">FR</td><td>Rock shows no sign of decomposition of individual minerals or colour changes.</td></tr>
</table>

NOTE 1: The term 'Distinctly Weathered' is used where it is not practicable to distinguish between 'Highly Weathered' and 'Moderately Weathered' rock. 'Distinctly Weathered' is defined as follows: *'Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores'*. There is some change in rock strength.

Rock Material Strength Classification

Term	Abbreviation	Uniaxial Compressive Strength (MPa)	Guide to Strength: Point Load Strength Index $Is_{(50)}$ (MPa)	Guide to Strength: Field Assessment
Very Low Strength	VL	0.6 to 2	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30mm thick can be broken by finger pressure.
Low Strength	L	2 to 6	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show in the specimen with firm blows of the pick point; has dull sound under hammer. A piece of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium Strength	M	6 to 20	0.3 to 1	Scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High Strength	H	20 to 60	1 to 3	A piece of core 150mm long by 50mm diameter cannot be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High Strength	VH	60 to 200	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
Extremely High Strength	EH	> 200	> 10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

Appendix E: Laboratory Report & COC Documents

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CERTIFICATE OF ANALYSIS 269247

Client Details

Client	JK Environments
Attention	Brendan Page
Address	PO Box 976, North Ryde BC, NSW, 1670

Sample Details

Your Reference	**E34067P, Huntingwood**
Number of Samples	47 Soil
Date samples received	17/05/2021
Date completed instructions received	17/05/2021

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	25/05/2021
Date of Issue	26/05/2021
Reissue Details	This report replaces R00 due to the addition of Resistivity results

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

Results Approved By

Diego Bigolin, Team Leader, Inorganics
Hannah Nguyen, Senior Chemist
Nick Sarlamis, Inorganics Supervisor

Authorised By

Nancy Zhang, Laboratory Manager

Misc Inorg - Soil						
Our Reference		269247-1	269247-3	269247-5	269247-8	269247-10
Your Reference	UNITS	BH101	BH101	BH101	BH102	BH102
Depth		0-0.2	1.5-1.95	3.8-4.0	0-0.2	1.5-1.95
Date Sampled		14/05/2021	14/05/2021	14/05/2021	14/05/2021	14/05/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	20/05/2021	20/05/2021	20/05/2021	20/05/2021	20/05/2021
Date analysed	-	20/05/2021	20/05/2021	20/05/2021	20/05/2021	20/05/2021
pH 1:5 soil:water	pH Units	6.3	5.9	7.0	6.4	4.9
Chloride, Cl 1:5 soil:water	mg/kg	10	400	530	<10	610
Sulphate, SO4 1:5 soil:water	mg/kg	<10	270	310	10	570
Resistivity in soil*	ohm m	200	21	19	200	15

Misc Inorg - Soil						
Our Reference		269247-11	269247-15	269247-17	269247-18	269247-22
Your Reference	UNITS	BH102	BH103	BH103	BH103	BH104
Depth		2.8-3.0	0-0.2	1.5-1.8	2.8-3.0	0-0.2
Date Sampled		14/05/2021	14/05/2021	14/05/2021	14/05/2021	14/05/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	20/05/2021	20/05/2021	20/05/2021	20/05/2021	20/05/2021
Date analysed	-	20/05/2021	20/05/2021	20/05/2021	20/05/2021	20/05/2021
pH 1:5 soil:water	pH Units	5.5	6.2	5.9	6.1	6.2
Chloride, Cl 1:5 soil:water	mg/kg	520	20	230	390	10
Sulphate, SO4 1:5 soil:water	mg/kg	560	28	260	350	22
Resistivity in soil*	ohm m	18	150	28	19	160

Misc Inorg - Soil						
Our Reference		269247-24	269247-27	269247-29	269247-31	269247-33
Your Reference	UNITS	BH104	BH104	BH105	BH105	BH105
Depth		1.5-1.95	4.8-5.0	0-0.2	1.5-1.95	3.8-4.0
Date Sampled		14/05/2021	14/05/2021	14/05/2021	14/05/2021	14/05/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	20/05/2021	20/05/2021	20/05/2021	20/05/2021	20/05/2021
Date analysed	-	20/05/2021	20/05/2021	20/05/2021	20/05/2021	20/05/2021
pH 1:5 soil:water	pH Units	5.9	5.9	6.3	7.6	5.5
Chloride, Cl 1:5 soil:water	mg/kg	430	420	10	390	480
Sulphate, SO4 1:5 soil:water	mg/kg	780	660	22	610	370
Resistivity in soil*	ohm m	18	15	73	12	18

Misc Inorg - Soil					
Our Reference		269247-38	269247-40	269247-42	269247-44
Your Reference	UNITS	BH106	BH106	BH106	BH106
Depth		0.03-0.2	1.5-1.95	4.0-4.2	5.8-6.0
Date Sampled		14/05/2021	14/05/2021	14/05/2021	14/05/2021
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	20/05/2021	20/05/2021	20/05/2021	20/05/2021
Date analysed	-	20/05/2021	20/05/2021	20/05/2021	20/05/2021
pH 1:5 soil:water	pH Units	9.6	5.2	5.3	5.8
Chloride, Cl 1:5 soil:water	mg/kg	52	610	740	1,000
Sulphate, SO4 1:5 soil:water	mg/kg	75	640	850	850
Resistivity in soil*	ohm m	29	15	13	11

Texture and Salinity*						
Our Reference		269247-1	269247-3	269247-5	269247-8	269247-10
Your Reference	UNITS	BH101	BH101	BH101	BH102	BH102
Depth		0-0.2	1.5-1.95	3.8-4.0	0-0.2	1.5-1.95
Date Sampled		14/05/2021	14/05/2021	14/05/2021	14/05/2021	14/05/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/05/2021	19/05/2021	19/05/2021	19/05/2021	19/05/2021
Date analysed	-	19/05/2021	19/05/2021	19/05/2021	19/05/2021	19/05/2021
Electrical Conductivity 1:5 soil:water	µS/cm	50	470	540	49	660
Texture Value	-	9.0	7.0	9.0	9.0	7.0
Texture	-	CLAY LOAM	MEDIUM CLAY	CLAY LOAM	CLAY LOAM	MEDIUM CLAY
ECe	dS/m	<2	3.3	4.8	<2	4.6
Class	-	NON SALINE	SLIGHTLY SALINE	MODERATELY SALINE	NON SALINE	MODERATELY SALINE

Texture and Salinity*						
Our Reference		269247-11	269247-15	269247-17	269247-18	269247-22
Your Reference	UNITS	BH102	BH103	BH103	BH103	BH104
Depth		2.8-3.0	0-0.2	1.5-1.8	2.8-3.0	0-0.2
Date Sampled		14/05/2021	14/05/2021	14/05/2021	14/05/2021	14/05/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/05/2021	19/05/2021	19/05/2021	19/05/2021	19/05/2021
Date analysed	-	19/05/2021	19/05/2021	19/05/2021	19/05/2021	19/05/2021
Electrical Conductivity 1:5 soil:water	µS/cm	550	65	360	520	64
Texture Value	-	7.0	9.0	7.0	9.0	9.0
Texture	-	MEDIUM CLAY	CLAY LOAM	MEDIUM CLAY	CLAY LOAM	CLAY LOAM
ECe	dS/m	3.9	<2	2.5	4.7	<2
Class	-	SLIGHTLY SALINE	NON SALINE	SLIGHTLY SALINE	MODERATELY SALINE	NON SALINE

Texture and Salinity*						
Our Reference		269247-24	269247-27	269247-29	269247-31	269247-33
Your Reference	UNITS	BH104	BH104	BH105	BH105	BH105
Depth		1.5-1.95	4.8-5.0	0-0.2	1.5-1.95	3.8-4.0
Date Sampled		14/05/2021	14/05/2021	14/05/2021	14/05/2021	14/05/2021
Type of sample		Soil	Soil	Soil	Soil	Soil
Date prepared	-	19/05/2021	19/05/2021	19/05/2021	19/05/2021	19/05/2021
Date analysed	-	19/05/2021	19/05/2021	19/05/2021	19/05/2021	19/05/2021
Electrical Conductivity 1:5 soil:water	µS/cm	560	650	140	840	570
Texture Value	-	9.0	7.0	9.0	7.0	7.0
Texture	-	CLAY LOAM	MEDIUM CLAY	CLAY LOAM	MEDIUM CLAY	MEDIUM CLAY
ECe	dS/m	5.0	4.6	<2	5.9	4.0
Class	-	MODERATELY SALINE	MODERATELY SALINE	NON SALINE	MODERATELY SALINE	SLIGHTLY SALINE

Texture and Salinity*					
Our Reference		269247-38	269247-40	269247-42	269247-44
Your Reference	UNITS	BH106	BH106	BH106	BH106
Depth		0.03-0.2	1.5-1.95	4.0-4.2	5.8-6.0
Date Sampled		14/05/2021	14/05/2021	14/05/2021	14/05/2021
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	19/05/2021	19/05/2021	19/05/2021	19/05/2021
Date analysed	-	19/05/2021	19/05/2021	19/05/2021	19/05/2021
Electrical Conductivity 1:5 soil:water	µS/cm	340	670	760	870
Texture Value	-	8.5	7.0	7.0	7.0
Texture	-	LIGHT CLAY	MEDIUM CLAY	MEDIUM CLAY	MEDIUM CLAY
ECe	dS/m	2.9	4.7	5.3	6.1
Class	-	SLIGHTLY SALINE	MODERATELY SALINE	MODERATELY SALINE	MODERATELY SALINE

CEC					
Our Reference		269247-1	269247-17	269247-29	269247-40
Your Reference	UNITS	BH101	BH103	BH105	BH106
Depth		0-0.2	1.5-1.8	0-0.2	1.5-1.95
Date Sampled		14/05/2021	14/05/2021	14/05/2021	14/05/2021
Type of sample		Soil	Soil	Soil	Soil
Date prepared	-	24/05/2021	24/05/2021	24/05/2021	24/05/2021
Date analysed	-	24/05/2021	24/05/2021	24/05/2021	24/05/2021
Exchangeable Ca	meq/100g	7.6	0.8	14	2.1
Exchangeable K	meq/100g	1.5	0.2	0.9	0.3
Exchangeable Mg	meq/100g	6.4	7.4	3.4	8.5
Exchangeable Na	meq/100g	0.17	1.9	<0.1	1.9
Cation Exchange Capacity	meq/100g	16	10	18	13

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA latest edition, 4500-H+. 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 at 25°C in accordance with APHA latest edition 2510 and Rayment & Lyons.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons. Resistivity is calculated from Conductivity (non NATA). Resistivity (calculated) may not correlate with results otherwise obtained using Resistivity-Current method, depending on the nature of the soil being analysed.
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-123	Determined using a "Texture by Feel" method.
Metals-020	Determination of exchangeable cations and cation exchange capacity in soils using 1M Ammonium Chloride exchange and ICP-AES analytical finish.

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	269247-17
Date prepared	-			20/05/2021	1	20/05/2021	20/05/2021		20/05/2021	20/05/2021
Date analysed	-			20/05/2021	1	20/05/2021	20/05/2021		20/05/2021	20/05/2021
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	1	6.3	[NT]		101	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	10	<10	0	86	94
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	1	<10	<10	0	88	#
Resistivity in soil*	ohm m	1	Inorg-002	<1	1	200	[NT]		[NT]	[NT]

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	269247-27
Date prepared	-			[NT]	10	20/05/2021	20/05/2021		[NT]	20/05/2021
Date analysed	-			[NT]	10	20/05/2021	20/05/2021		[NT]	20/05/2021
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	10	4.9	[NT]		[NT]	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	10	610	610	0	[NT]	#
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	10	570	640	12	[NT]	#
Resistivity in soil*	ohm m	1	Inorg-002	[NT]	10	15	[NT]		[NT]	[NT]

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	24	20/05/2021	20/05/2021		[NT]	[NT]
Date analysed	-			[NT]	24	20/05/2021	20/05/2021		[NT]	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	24	5.9	6.0	2	[NT]	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	24	430	[NT]		[NT]	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	24	780	[NT]		[NT]	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	[NT]	24	18	19	5	[NT]	[NT]

QUALITY CONTROL: Misc Inorg - Soil					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	40	20/05/2021	20/05/2021		[NT]	[NT]
Date analysed	-			[NT]	40	20/05/2021	20/05/2021		[NT]	[NT]
pH 1:5 soil:water	pH Units		Inorg-001	[NT]	40	5.2	5.2	0	[NT]	[NT]
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	40	610	600	2	[NT]	[NT]
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	[NT]	40	640	510	23	[NT]	[NT]
Resistivity in soil*	ohm m	1	Inorg-002	[NT]	40	15	15	0	[NT]	[NT]

QUALITY CONTROL: Texture and Salinity*						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	[NT]
Date prepared	-			20/05/2021	24	19/05/2021	19/05/2021		20/05/2021	[NT]
Date analysed	-			20/05/2021	24	19/05/2021	19/05/2021		20/05/2021	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	24	560	530	6	105	[NT]
Texture Value	-		INORG-123	[NT]	24	9.0	[NT]		[NT]	[NT]

QUALITY CONTROL: Texture and Salinity*						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	40	19/05/2021	19/05/2021		[NT]	[NT]
Date analysed	-			[NT]	40	19/05/2021	19/05/2021		[NT]	[NT]
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	[NT]	40	670	660	2	[NT]	[NT]
Texture Value	-		INORG-123	[NT]	40	7.0	[NT]		[NT]	[NT]

QUALITY CONTROL: CEC					Duplicate				Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-1	269247-40
Date prepared	-			24/05/2021	1	24/05/2021	24/05/2021		24/05/2021	24/05/2021
Date analysed	-			24/05/2021	1	24/05/2021	24/05/2021		24/05/2021	24/05/2021
Exchangeable Ca	meq/100g	0.1	Metals-020	<0.1	1	7.6	7.5	1	110	106
Exchangeable K	meq/100g	0.1	Metals-020	<0.1	1	1.5	1.5	0	121	98
Exchangeable Mg	meq/100g	0.1	Metals-020	<0.1	1	6.4	6.6	3	113	105
Exchangeable Na	meq/100g	0.1	Metals-020	<0.1	1	0.17	0.16	6	113	91

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.

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
Percent recovery is not possible to report due to the high concentration of the element/s in the sample/s. However an acceptable recovery was obtained for the LCS.

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

SAMPLE RECEIPT ADVICE

Client Details	
Client	JK Environments
Attention	Brendan Page

Sample Login Details	
Your reference	E34067P, Huntingwood
Envirolab Reference	269247
Date Sample Received	17/05/2021
Date Instructions Received	17/05/2021
Date Results Expected to be Reported	25/05/2021

Sample Condition	
Samples received in appropriate condition for analysis	Yes
No. of Samples Provided	47 Soil
Turnaround Time Requested	Standard
Temperature on Receipt (°C)	7.0
Cooling Method	Ice Pack
Sampling Date Provided	YES

Comments
Nil

Please direct any queries to:

Aileen Hie	Jacinta Hurst
Phone: 02 9910 6200	**Phone: 02 9910 6200**
Fax: 02 9910 6201	**Fax: 02 9910 6201**
Email: ahie@envirolab.com.au	**Email: jhurst@envirolab.com.au**

Analysis Underway, details on the following page:

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
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Sample ID	Misc Inorg - Soil	Texture and Salinity*	CEC	On Hold
BH101-0-0.2	✓	✓	✓	
BH101-0.5-0.8				✓
BH101-1.5-1.95	✓	✓		
BH101-2.8-3.0				✓
BH101-3.8-4.0	✓	✓		
BH101-4.8-5.0				✓
BH101-5.8-6.0				✓
BH102-0-0.2	✓	✓		
BH102-0.5-0.95				✓
BH102-1.5-1.95	✓	✓		
BH102-2.8-3.0	✓	✓		
BH102-3.8-4.0				✓
BH102-4.8-5.0				✓
BH102-5.8-6.0				✓
BH103-0-0.2	✓	✓		
BH103-0.5-0.95				✓
BH103-1.5-1.8	✓	✓	✓	
BH103-2.8-3.0	✓	✓		
BH103-3.8-4.0				✓
BH103-4.8-5.0				✓
BH103-5.8-6.0				✓
BH104-0-0.2	✓	✓		
BH104-0.5-0.95				✓
BH104-1.5-1.95	✓	✓		
BH104-2.8-3.0				✓
BH104-3.8-4.0				✓
BH104-4.8-5.0	✓	✓		
BH104-5.8-6.0				✓
BH105-0-0.2	✓	✓	✓	
BH105-0.5-0.95				✓
BH105-1.5-1.95	✓	✓		
BH105-2.8-3.0				✓

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Sample ID	Misc Inorg - Soil	Texture and Salinity*	CEC	On Hold
BH105-3.8-4.0	✓	✓		
BH105-4.8-5.0				✓
BH105-5.2-5.5				✓
BH105-5.8-6.0				✓
BH105-7.4-7.5				✓
BH106-0.03-0.2	✓	✓		
BH106-0.5-0.95				✓
BH106-1.5-1.95	✓	✓	✓	
BH106-2.8-3.0				✓
BH106-4.0-4.2	✓	✓		
BH106-4.8-5.0				✓
BH106-5.8-6.0	✓	✓		
BH106-6.8-7.0				✓
BH106-7.8-8.0				✓
BH106-8.8-9.0				✓

The '✓' indicates the testing you have requested. **THIS IS NOT A REPORT OF THE RESULTS.**

Additional Info
Sample storage - Waters are routinely disposed of approximately 1 month and soils approximately 2 months from receipt.
Requests for longer term sample storage must be received in writing.
Please contact the laboratory immediately if observed settled sediment present in water samples is to be included in the extraction and/or analysis (exceptions include certain Physical Tests (pH/EC/BOD/COD/Apparent Colour etc.), Solids testing, Total Recoverable metals and PFAS analysis where solids are included by default.
TAT for Micro is dependent on incubation. This varies from 3 to 6 days.

SAMPLE AND CHAIN OF CUSTODY FORM

TO:		FROM:
ENVIROLAB SERVICES PTY LTD 12 ASHLEY STREET CHATSWOOD NSW 2067 P: (02) 99106200 F: (02) 99106201 Attention: Aileen	JKE Job Number: E34067P Date Results Required: STANDARD Page: 1 of 2	JKEnvironments REAR OF 115 WICKS ROAD MACQUARIE PARK, NSW 2113 P: 02-9888 5000 F: 02-9888 5001 Attention: Brendan Page

Location: Huntingwood

Sampler: HW/NM

Sample Preserved in Esky on Ice

Tests Required

Date Sampled	Lab Ref:	Sample Number	Depth (m)	Sample Container	Sample Description		Aggressivity	ECe (texture)	CEC
14/05/2021	1	BH101	0-0.2	P	Soil		X	X	X
14/05/2021	2	BH101	0.5-0.8	P	Soil				
14/05/2021	NR	BH101	1.0-1.2	P	Soil				
14/05/2021	3	BH101	1.5-1.95	P	Soil		X	X	
14/05/2021	4	BH101	2.8-3.0	P	Siltstone				
14/05/2021	5	BH101	3.8-4.0	P	Siltstone		X	X	
14/05/2021	6	BH101	4.8-5.0	P	Siltstone				
14/01/2021	7	BH101	5.8-6.0	P	Siltstone				
14/05/2021	8	BH102	0-0.2	P	Soil		X	X	
14/05/2021	9	BH102	0.5-0.95	P	Soil				
14/05/2021	10	BH102	1.5-1.95	P	Soil		X	X	
14/05/2021	11	BH102	2.8-3.0	P	Soil		X	X	
14/05/2021	12	BH102	3.8-4.0	P	Soil				
14/05/2021	13	BH102	4.8-5.0	P	Siltstone				
14/05/2021	14	BH102	5.8-6.0	P	Siltstone				
14/05/2021	15	BH103	0-0.2	P	Soil		X	X	
14/05/2021	16	BH103	0.5-0.95	P	Soil				
14/05/2021	17	BH103	1.5-1.8	P	Soil		X	X	X
14/05/2021	18	BH103	2.8-3.0	P	Siltstone		X	X	
14/05/2021	19	BH103	3.8-4.0	P	Siltstone				
14/05/2021	20	BH103	4.8-5.0	P	Siltstone				
14/05/2021	21	BH103	5.8-6.0	P	Siltstone				
14/05/2021	22	BH104	0-0.2	P	Soil		X	X	
14/05/2021	23	BH104	0.5-0.95	P	Soil				
14/05/2021	24	BH104	1.5-1.95	P	Soil		X	X	
14/05/2021	25	BH104	2.8-3.0	P	Soil				
14/05/2021	26	BH104	3.8-4.0	P	Soil				

Envirolab Services
12 Ashley St
Chatswood NSW 2067
Ph: (02) 9910 6200

ENVIROLAB

Job No: 269247
Date Received: 17/5/21
Time Received: ~~1446~~ 1440
Received By: [illegible]
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Remarks (comments/detection limits required):		Sample Containers: G - 250mg Glass Jar A - Ziplock Asbestos Bag P - Plastic Bag	
Relinquished By: BP	Date: 17.5.21	Time: 240pm 1440.	Received By: Cmullem	Date: 17/5/21

SAMPLE AND CHAIN OF CUSTODY FORM

TO:	JKE Job Number: E34067P	FROM: JKEnvironments
ENVIROLAB SERVICES PTY LTD 12 ASHLEY STREET CHATSWOOD NSW 2067 P: (02) 99106200 F: (02) 99106201	Date Results Required: STANDARD	REAR OF 115 WICKS ROAD MACQUARIE PARK, NSW 2113 P: 02-9888 5000 F: 02-9888 5001
Attention: Aileen	Page: 2 of 2	Attention: Brendan Page

Location: Huntingwood

Sampler: HW/NM

Sample Preserved in Esky on Ice

Tests Required

Date Sampled	Lab Ref:	Sample Number	Depth (m)	Sample Container	Sample Description		Aggressivity	ECe (texture)	CEC								
14/05/2021	27	BH104	4.8-5.0	P	Soil		X	X									
14/05/2021	28	BH104	5.8-6.0	P	Soil												
14/05/2021	29	BH105	0-0.2	P	Soil		X	X	X								
14/05/2021	30	BH105	0.5-0.95	P	Soil												
14/05/2021	31	BH105	1.5-1.95	P	Soil		X	X									
14/05/2021	32	BH105	2.8-3.0	P	Soil												
14/05/2021	33	BH105	3.8-4.0	P	Soil		X	X									
14/05/2021	34	BH105	4.8-5.0	P	Soil												
14/05/2021	35	BH105	5.2-5.5	P	Siltstone												
14/05/2021	36	BH105	5.8-6.0	P	Siltstone												
14/05/2021	37	BH105	7.4-7.5	P	Siltstone												
14/05/2021	38	BH106	0.03-0.2	P	Soil		X	X									
14/05/2021	39	BH106	0.5-0.95	P	Soil												
14/05/2021	40	BH106	1.5-1.95	P	Soil		X	X	X								
14/05/2021	41	BH106	2.8-3.0	P	Soil												
14/05/2021	42	BH106	4.0-4.2	P	Soil		X	X									
14/05/2021	43	BH106	4.8-5.0	P	Soil												
14/05/2021	44	BH106	5.8-6.0	P	Soil		X	X									
14/05/2021	45	BH106	6.8-7.0	P	Siltstone												
14/05/2021	46	BH106	7.8-8.0	P	Siltstone												
14/05/2021	47	BH106	8.8-9.0	P	Siltstone												

Remarks (comments/detection limits required):		Sample Containers: G - 250mg Glass Jar A - Ziplock Asbestos Bag P - Plastic Bag		
Relinquished By: BP	Date: 17.5.21	Time: 240pm	Received By:	Date:

269247

Appendix F: Report Explanatory Notes

Standard Sampling Procedure (SSP)

These protocols specify the basic procedures to be used when sampling soils or groundwater for environmental site assessments undertaken by JKE.

The purpose of these protocols is to provide standard methods for: sampling, decontamination procedures for sampling equipment, sample preservation, sample storage and sample handling. Deviations from these procedures must be recorded.

A. <u>Soil Sampling:</u>

- Prepare a borehole/test pit log or made a note of the sample description for stockpiles.
- Layout sampling equipment on clean plastic sheeting to prevent direct contact with ground surface. The work area should be at a distance from the drill rig/excavator such that the machine can operate in a safe manner.
- Ensure all sampling equipment has been decontaminated prior to use.
- Remove any surface debris from the immediate area of the sampling location.
- Collect samples and place in glass jar with a Teflon seal. This should be undertaken as quickly as possible to prevent the loss of any volatiles. If possible, fill the glass jars completely.
- Collect samples for asbestos analysis and place in a zip-lock plastic bag.
- Label the sampling containers with the JKE job number, sample location (eg. BH1), sampling depth interval and date. If more than one sample container is used, this should also be indicated (eg. 2 = Sample jar 1 of 2 jars).
- Photoionisation detector (PID) screening of volatile organic compounds (VOCs) should be undertaken on samples using the soil sample headspace method. Headspace measurements are taken following equilibration of the headspace gasses in partly filled zip-lock plastic bags. PID headspace data is recorded on the borehole/test pit log and the chain of custody forms.
- Record the lithology of the sample and sample depth on the borehole/test pit log generally in accordance with AS1726-1993[14].
- Store the sample in a sample container cooled with ice or chill packs. On completion of the sampling the sample container should be delivered to the lab immediately or stored in the refrigerator prior to delivery to the lab. All samples are preserved in accordance with the standards outlined in the report.
- Check for the presence of groundwater after completion of each borehole using an electronic dip metre or water whistle. Boreholes should be left open until the end of fieldwork. All groundwater levels in the boreholes should be rechecked on the completion of the fieldwork.
- Backfill the boreholes/test pits with the excavation cuttings or clean sand prior to leaving the site.

B. <u>Decontamination Procedures for Soil Sampling Equipment</u>

- All sampling equipment should be decontaminated between every sampling location. This excludes single use PVC tubing used for push tubes etc. Equipment and materials required for the decontamination include:
  - Phosphate free detergent (Decon 90);
  - Potable water;
  - Stiff brushes; and
  - Plastic sheets.
- Ensure the decontamination materials are clean prior to proceeding with the decontamination.
- Fill both buckets with clean potable water and add phosphate free detergent to one bucket.

[14] Standards Australia, (1993), *Geotechnical Site Investigations.* (AS1726-1993)

- In the bucket containing the detergent, scrub the sampling equipment until all the material attached to the equipment has been removed.
- Rinse sampling equipment in the bucket containing potable water.
- Place cleaned equipment on clean plastic sheets.

If all materials are not removed by this procedure, high-pressure water cleaning is recommended. If any equipment is not completely decontaminated by both these processes, then the equipment should not be used until it has been thoroughly cleaned.

C. Groundwater Sampling

Groundwater samples are more sensitive to contamination than soil samples and therefore adhesion to this protocol is particularly important to obtain reliable, reproducible results. The recommendations detailed in AS/NZS 5667.1:1998 are considered to form a minimum standard.

The basis of this protocol is to maintain the security of the borehole and obtain accurate and representative groundwater samples. The following procedure should be used for collection of groundwater samples from previously installed groundwater monitoring wells.

- After monitoring well installation, at least three bore volumes should be pumped from the monitoring wells (well development) to remove any water introduced during the drilling process and/or the water that is disturbed during installation of the monitoring well. This should be completed prior to purging and sampling.
- Groundwater monitoring wells should then be left to recharge for at least three days before purging and sampling. Prior to purging or sampling, the condition of each well should observed and any anomalies recorded on the field data sheets. The following information should be noted: the condition of the well, noting any signs of damage, tampering or complete destruction; the condition and operation of the well lock; the condition of the protective casing and the cement footing (raised or cracked); and, the presence of water between protective casing and well.
- Take the groundwater level from the collar of the piezometer/monitoring well using an electronic dip meter. The collar level should be taken (if required) during the site visit using a dumpy level and staff.
- Purging and sampling of piezometers/monitoring wells is done on the same site visit when using micro-purge (or other low flow) techniques.
- Layout and organize all equipment associated with groundwater sampling in a location where they will not interfere with the sampling procedure and will not pose a risk of contaminating samples. Equipment generally required includes:
  - Micropore filtration system or Stericup single-use filters (for heavy metals samples);
  - Filter paper for Micropore filtration system; Bucket with volume increments;
  - Sample containers: teflon bottles with 1 ml nitric acid, 75mL glass vials with 1 mL hydrochloric acid, 1 L amber glass bottles;
  - Bucket with volume increments;
  - Flow cell;
  - pH/EC/Eh/T meters;
  - Plastic drums used for transportation of purged water;
  - Esky and ice;
  - Nitrile gloves;
  - Distilled water (for cleaning);
  - Electronic dip meter;
  - Low flow pump pack and associated tubing; and
  - Groundwater sampling forms.

- If single-use stericup filtration is not used, clean the Micropore filtration system thoroughly with distilled water prior to use and between each sample. Filter paper should be changed between samples. 0.45um filter paper should be placed below the glass fibre filter paper in the filtration system.
- Ensure all non-disposable sampling equipment is decontaminated or that new disposable equipment is available prior to any work commencing at a new location. The procedure for decontamination of groundwater equipment is outlined at the end of this section.
- Disposable gloves should be used whenever samples are taken to protect the sampler and to assist in avoidance of contamination.
- Groundwater samples are obtained from the monitoring wells using low flow/micro-purge sampling equipment to reduce the disturbance of the water column and loss of volatiles.
- During pumping to purge the well, the pH, temperature, conductivity, dissolved oxygen, redox potential and groundwater levels are monitored (where possible) using calibrated field instruments to assess the development of steady state conditions. Steady state conditions are generally considered to have been achieved when the difference in the pH measurements was less than 0.2 units and the difference in conductivity was less than 10%.
- All measurements are recorded on specific data sheets.
- Once steady state conditions are considered to have been achieved, groundwater samples are obtained directly from the pump tubing and placed in appropriate glass bottles or plastic bottles.
- All samples are preserved in accordance with water sampling requirements detailed in the NEPM 2013 and placed in an insulated container with ice. Groundwater samples are preserved by immediate storage in an insulated sample container with ice as outlined in the report text.
- Record the sample on the appropriate log in accordance with AS1726:1993. At the end of each water sampling complete a chain of custody form.

D. <u>Decontamination Procedures for Groundwater Sampling Equipment</u>

- All equipment associated with the groundwater sampling procedure (other than single-use items) should be decontaminated between every sampling location.
- The following equipment and materials are required for the decontamination procedure:
  - Phosphate free detergent;
  - Potable water;
  - Distilled water; and
  - Plastic Sheets or bulk bags (plastic bags).
- Fill one bucket with clean potable water and phosphate free detergent, and one bucket with distilled water.
- Flush potable water and detergent through pump head. Wash sampling equipment and pump head using brushes in the bucket containing detergent until all materials attached to the equipment are removed.
- Flush pump head with distilled water.
- Change water and detergent solution after each sampling location.
- Rinse sampling equipment in the bucket containing distilled water.
- Place cleaned equipment on clean plastic sheets.
- If all materials are not removed by this procedure that equipment should not be used until it has been thoroughly cleaned