ENVIRONMENTAL INVESTIGATION SERVICES

REPORT

TO

KMT CONSTRUCTIONS PTY LTD

ON

SALINITY ASSESSMENT AND MANAGEMENT PLAN

FOR

PROPOSED RESIDENTIAL DEVELOPMENT

AT

5 RYNAN AVENUE, EDMONDSON PARK

27 AUGUST 2014 **REF: E27532KHrpt-SAL**

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EXECUTIVE SUMMARY

Joshua Farkash & Associates Pty Ltd, on behalf of KMT Constructions Pty Ltd (the 'client'), commissioned Environmental Investigation Services (EIS)[1] to undertake a salinity assessment and prepare a salinity management plan for the proposed residential development at 5 Rynan Avenue, Edmondson Park ('the site'). The site is identified as Lot 1 in DP77470.

EIS understand that the existing rural/residential houses will be demolished and that the proposed development includes:

- Construction of small lot residential housing in the west section, excluding an existing transmission line easement;
- Public parkland in the central section; and
- Construction of residential apartments in the east section.

The housing in the west section will include up to 7 detached single family dwellings. The proposed apartment buildings in the east section will include a single level basement and will be up to 5 storeys high.

The site is located in a predominantly residential area of Edmondson Park. The site is located on the south-western side of the intersection between Camden Valley Way and Rynan Avenue. Cabramatta Creek extends through the site, in a north-south orientation, and approximately bisects the site. The proposed housing area is referred to as the Western Site and the proposed apartment area is referred to as the Eastern Site.

Salinity Conditions

Western Site

The upper soil profile (less than 1m deep) is classed as moderately saline soil and is generally non-aggressive towards buried concrete. Soil deeper than 1m is classed as very saline.

The groundwater is classed as mildly aggressive towards buried concrete. The appropriate concrete strength and corrosion allowance outlined in the AS2159-2009 should be adopted.

The CCAA 2005 publication recommends a concrete grade of N25 for residential slabs and footings exposed to moderately saline soil (i.e soil less than 1m deep). N32 grade concrete is recommended for very saline soils (i.e. those encountered greater than 1m deep).

The soils are classed as mildly to moderately aggressive towards buried steel. The groundwater is classed as non-aggressive towards buried steel. Appropriate corrosion allowance for steel outlined in the AS2159-2009 should be adopted.

Eastern Site

The soils are classed as moderately saline to at least 4m deep and are generally non-aggressive towards buried concrete. The groundwater is classed as non-aggressive towards buried concrete. The appropriate concrete strength and corrosion allowance outlined in the AS2159-2009 should be adopted.

The CCAA 2005 publication recommends a concrete grade of N25 for residential slabs and footings exposed to moderately saline soil.

The soils are classed as mildly aggressive towards buried steel. The groundwater is classed as non-aggressive towards buried steel. The appropriate corrosion allowance for steel outlined in the AS2159-2009 should be adopted.

[1] Environmental consulting division of Jeffery & Katauskas Pty Ltd (J&K)

Further information on salinity conditions and management measures is presented to the body of the report. The conclusions and recommendations should be read in conjunction with the limitations presented in the body of the report.

TABLE OF CONTENTS

TABLE OF CONTENTS

1 INTRODUCTION

Joshua Farkash & Associates Pty Ltd, on behalf of KMT Constructions Pty Ltd (the 'client'), commissioned Environmental Investigation Services (EIS)[2] to undertake a salinity assessment and prepare a salinity management plan for the proposed residential development at 5 Rynan Avenue, Edmondson Park ('the site').

The site is identified as Lot 1 in DP77470. The site location is shown on Figure 1 and the assessment was confined to the site boundaries as shown on Figure 2.

The assessment was undertaken generally in accordance with an EIS proposal (Ref: EP8033KH) of 21 May 2014 and written acceptance from the client of 28 July 2014.

1.1 Proposed Development Details

EIS understand that the existing rural/residential houses will be demolished and that the proposed development includes:

- Construction of small lot residential housing in the west section, excluding an existing transmission line easement;
- Public parkland in the central section; and
- Construction of residential apartments in the east section.

The housing in the west section will include up to 7 detached single family dwellings. The proposed apartment buildings in the east section will include a single level basement and will be up to 5 storeys high.

1.2 Objectives

The objectives of the assessment are to:

- Assess the soil salinity conditions at the site;
- Assess the groundwater salinity conditions at the site;
- Provide salinity management recommendations with reference to the amended Salinity Code of Practice 2004[3]; and
- Outline any ongoing salinity management requirements for the site.

1.3 Scope of Work

The scope of work included:

- Review site information including topography, soils maps, regional geology and hydro-geology in the vicinity of the site;

[2] Environmental consulting division of Jeffery & Katauskas Pty Ltd (J&K)

[3] *Western Sydney Salinity Code of Practice,* WSROC Ltd and DIPNR, 2003 [amended 2004] (amended Salinity Code of Practice 2004)

- 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;
- Preparation of a report presenting the results of the assessment; and
- Preparation of a site specific salinity management plan for the proposed development at the site.

The scope of work was designed with reference to the regulations/guidelines/documents outlined in the table below. Individual documents/guidelines applicable for this investigation are also referenced within the text of the report (as applicable).

Table 1-1: Guidelines/Regulations/Documents

Guidelines/Regulations/Documents
Site Investigations for Urban Salinity (2002[4])
Managing Urban Stormwater – Soil and Construction (2004, 4th Ed[5])
Salinity Potential in Western Sydney Map (2002[6])
Western Sydney Salinity Code of Practice (March 2003 [amended January 2004])
AS2159-2009[7]
T56: Guide to Residential Slabs and Footings in Saline Environments (2005[8])

[4] *Site Investigations for Urban Salinity,* Department of Land and Water Conservation (DLWC), 2002 (DLWC 2002)

[5] *Managing Urban Stormwater – Soil and Construction*, NSW Government/Landcom, 2004 (4th Ed) (Blue Book 2004)

[6] *1:100,000 Map – Salinity Potential in Western Sydney*, Department of Infrastructure, Planning and Natural Resources (DIPNR), 2002 (Salinity Potential Map 2002)

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

[8] *T56: Guide to Residential Slabs and Footings in Saline Environments,* CCAA, 2005 (CCAA 2005)

2 BACKGROUND ON SALINITY

2.1 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.

2.2 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.

2.3 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.

2.4 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.

3 SITE INFORMATION AND PHYSICAL SETTING

3.1 Site Identification

Table 3-1: Site Identification Information

Site Owner:	Michael Taouk and Amal Taouk
Site Address:	5 Rynan Avenue, Edmondson Park, NSW
Lot & Deposited Plan:	Lot 1 in DP774700
Current Land Use:	Rural/Residential
Proposed Land Use:	Residential
Local Government Authority:	Liverpool
Site Area (m^2):	2ha
RL (AHD in m) (approx.):	45
Geographical Location (MGA) (approx.):	N: 6241060 E: 301220
Site Location Plan:	Figure 1
Borehole Location Plan:	Figure 2

3.2 Site Location and Setting

The site is located in a predominantly residential area of Edmondson Park. The site is located on the south-western side of the intersection between Camden Valley Way and Rynan Avenue. Cabramatta Creek extends through the site, in a north-south orientation, and approximately bisects the site.

3.3 Topography

The regional topography is characterised by undulating hill slopes that generally fall to the east and west. The overall topography of the site falls towards Cabramatta Creek, located in the central section of the site.

3.4 Site Inspection

A walkover inspection of the site and immediate surrounds was undertaken on 6 August 2014. The inspection was limited to accessible areas of the site and did not include an internal inspection of buildings.

At the time of the inspection, a residential property with a two storey brick house was located in the south east corner of the site. Another residential property with a single storey fibro house was located in the north east corner of the site. A gravel surfaced driveway separated the two residential properties and extended from Rynan Avenue towards a single storey brick shed and a gravel surfaced yard area. The yard area was used for storage of construction materials including timber and scaffolding. Potential Asbestos Containing Material (ACM) was observed scattered across the gravel driveway and the gravel surfaced yard area.

Cabramatta Creek was located in the centre of the site and was lined by small and medium sized trees and shrubs. Some trees that lined the creek showed signs of die back.

A vacant, level and grassed paddock, which appeared to be used to graze sheep, was located in the west section of the site. A small dilapidated metal shed was located in the south-west section of the paddock. A previously installed groundwater monitoring well was located in the south east corner of the paddock. Indicator markers for fibre optic cables were observed running in a north/south direction within this rea of the site. Stockpiled timber logs and a soil stockpile were located towards the centre of the paddock area. The soil stockpile contained potential ACM at the surface. Scattered bare patches were observed across the grassed surface in this area.

3.5 Surrounding Land Use

Camden Valley Way was located to the north of the site, with a school and a place of worship located further to the north of Camden Valley Way. Rynan Avenue was located east of the site, with residential and rural properties located further to the east of Rynan Avenue. New subdivision construction sites were located further east of these properties. Rural and residential properties were located to the south of the site. Some minor dieback was observed in the trees located close to the south site boundary. Residential properties were located to the west of the site. Cabramatta Creek extended beyond the site boundaries, to the north and south of the site.

3.6 Regional Geology

The regional geological map of Penrith (1991[9]) indicates the site to be underlain by Hawkesbury Sandstone, which typically consists of medium to coarse grained quartz sandstone with minor shale and laminite lenses. The area surrounding Cabramatta Creek is underlain by Quaternary aged deposits of medium grained sand, clay and silt.

3.7 Soil

The Soil Landscape Map of Penrith (1990[10]) indicates that the site is located within the Blacktown soil landscape, except for areas immediately surrounding Cabramatta Creek, which are within the South Creek soil landscape. Blacktown soils are characterised by moderate erodibility with some higher local occurrences, low dispersivity and localised areas of moderate salinity. South Creek soils are characterised by high to severe and widespread erodibility, moderate dispersivity and high salinity.

[9] *1:100,000 Geological Map of Penrith (Series 9030),* Department of Mineral Resources (1991)

[10] *1:100,000 Map - Soil Landscapes of the Penrith Sheet 9030,* Soil Conservation Service of NSW, 1990 (Soil Landscapes Map 1990)

3.8 Salinity Hazard Map

The site is located within the area of Western Sydney included in the Salinity Potential Map 2002. 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.

Areas of high potential occur where soil, geology, topography and groundwater conditions predispose a site to salinity. These areas most commonly occur on lower slopes and drainage systems where water accumulation is high. These areas are most likely to occur in lower slopes, foot slopes, floodplains and creek lines where run-off is high, resulting in seasonally high water tables and soil saturation.

3.9 Hydrogeology

A search of the groundwater bore summary records available on the NSW Office of Water[11] website was undertaken for the assessment. The search was limited to registered bores located within approximately 1km of the site. The search did not reveal any registered bores within this radius from the site.

The stratigraphy of the majority of the site is expected to consist of residual clayey soils overlying relatively shallow bedrock. Based on these conditions and the results of the groundwater bore search, groundwater is not considered to be a significant resource for abstraction purposes in the immediate vicinity of the site.

A perched groundwater table condition may occur in the vicinity of Cabramatta Creek especially during prolonged wet conditions. This perched aquifer located in the shallow subsurface is not considered to be a resource due to high salinity, poor water quality and low yield.

3.10 Surface Water Run-off

Based on the site and surrounding topography, surface water flows would be expected to flow towards Cabramatta Creek which flows to the north

[11] http://www.waterinfo.nsw.gov.au/gw/, visited on 20 August 2014

The vegetation observed adjacent to Cabramatta Creek suggested that this may be a permanent surface water feature. The water levels in this area are expected to be influenced by runoff and flooding.

During rain events, excess surface water flows would be expected towards the centre of the site.

4 ASSESSMENT CRITERIA

4.1 Overview

The Salinity Potential Map 2002 provides local government and state agencies with information to develop a salinity management response. The map indicates the distribution and potential severity of salinity at a 1:100,000 scale based on the current understanding of the factors that may lead to the development of saline conditions.

Western Sydney Salinity Code of Practice 2004 document was developed by the Regional Organisation of Councils Ltd (WSROC) in conjunction with DIPNR (now EPA) as a management tool to assist individual councils to develop policy to address salinity at the local government level.

Government departments (now under EPA) have also released a series of documents under the Local Government Salinity Initiative providing information on salinity in urban areas. This series includes the DLWC 2002 document which provides a frame work for undertaking salinity investigations for urban development.

Salinity management recommendations outlined in this report have been designed generally in accordance with the amended Salinity Code of Practice 2004. The recommendations have been designed with reference to various levels of salinity management response outlined in the publication.

4.2 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 4-1: 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

4.3 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[12]) presented below:

Table 4-2: Plant Response to Soil pH

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

4.4 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[13]) developed a set of ratings for effective CEC and the most abundant cations. These are summarised below (values are in meq/100g):

[12] *Analytical Methods and Interpretations used by the Agricultural Chemistry Branch for Soil and Land Use Surveys,* Bruce, R.C. and Rayment, G.E., 1982 (Bruce and Rayment 1982)
[13] *Methods of Chemical Analysis for Soil Survey Samples,* Metson, A.J, 1961 (Metson 1961)

Table 4-3: 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

Note:
CEC – Cation Exchange Capacity
Na – Sodium
K – Potassium
Ca – Calcium
Mg – Magnesium

4.4.1 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[14]). 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.

4.5 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[15]) indicate that a soil is generally considered sodic if the ESP exceeds 6% and extremely sodic if the ESP exceeds 15%.

[14] *Soil Test Interpretation: Basic Cation Saturation Ratios and Sufficiency Levels*, Eckert, D.J, 1987 (Eckert 1987)

[15] *Soils: Their Management and Properties,* Charman, P.E.V and Murphy, B.W (eds), 2000 (Charman and Murphy 2000)

4.6 Groundwater Salinity

EC values in groundwater are dependent on numerous factors and can vary with changes in temperature and pH conditions. Suttar (1990[16]) has classed water into different types based on EC values as outlined in the table below.

Table 4-4: 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

4.7 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 2005. 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 2005 publication for future information:

Table 4-5: 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 2005

4.8 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.

[16] Suttar, S., 1990, *Ribbons of Blue Handbook, Scitech*, Victoria (Suttar 1990)

Table 4-6: 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 4-7: 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 (eg sands and gravels) which are in groundwater

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

5 INVESTIGATION PROCEDURE

5.1 Soil Sampling Rationale

The investigation included soil sampling from 8 locations placed on a regular grid pattern as shown on Figure 2. This density is approximately 4 sampling points per hectare (the area of the site is approximately 2 hectares) and meets the requirements for an 'initial site investigation' recommended in the DLWC 2002 document for 'moderately intensive construction'. The density was considered adequate to identify large areas of salinity impacted soils at the site.

Soil sampling for this assessment was confined to the depth of approximately 6m below existing ground level. This was considered adequate as the proposed development includes excavation for a single basement level.

The following areas were excluded from the assessment:

Table 5-1: Exclusion Areas

Area	Description
Buildings	Sampling was not undertaken beneath the existing buildings at the site as access was not possible during the field investigation.
Treed area along Cabramatta Creek	Sampling was not undertaken in the immediate proximity of Cabramatta Creek as access was not possible during the field investigation.

5.2 Soil Sampling Methods

Fieldwork for this investigation was undertaken on 6 August 2014. Sampling locations were set out using a hand held GPS unit. Locations were marked using spray paint. The sampling locations were cleared for underground services prior to drilling.

The sample locations were drilled using a track 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 Appendix A.

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 Appendix D.

5.3 Groundwater Sampling Rationale

The assessment included the installation of 3 groundwater monitoring wells in selected boreholes spread across the site as shown on Figure 2. One well was located in each of the proposed development areas (east and west of the site) and one well was located in the central section near Cabramatta Creek.

5.4 Monitoring Well Installation

The monitoring well construction details are documented on appropriate borehole logs presented in Appendix A.

The well construction details are summarised in the following table:

Table 5-2: Monitoring Well Construction Details

Borehole Ref / Well Number	Installation Depth (BGL) (m)	Surface RL[1] (m)	Casing & Screen[2] Depths (m)	Finishing Details (BGL) (m)
BH2 / MW2	5.7	Na	- Casing from 2.7m to 5.7m - Screen from 0m to 2.7m	- Sand filter pack from 1m to 5.7m - Bentonite seal/plug from 0.3m to 1m - Finished with 0.3m standpipe surrounded by concrete grout.
BH4 / MW4	5.7	Na	- Casing from 2.7m to 5.7m - Screen from 0m to 2.7m	- Sand filter pack from 1m to 5.7m - Bentonite seal/plug from 0.3m to 1m - Finished with 0.3m standpipe surrounded by concrete grout.
BH6 / MW6	5.7	Na	- Casing from 2.7m to 5.7m - Screen from 0m to 2.7m	- Sand filter pack from 1m to 5.7m - Bentonite seal/plug from 0.3m to 1m - Finished with 0.3m standpipe surrounded by concrete grout.

Notes:

[1] RL: Reduced Level (AHD)

[2] 50mm diameter Class 18 PVC has been used for the wells

Na – information not available

A detailed survey of the well heads was outside the scope of the assessment.

5.5 Monitoring Well Development and Groundwater Sampling

The monitoring wells were developed using a submersible electric pump on 6 August 2014.

Groundwater samples were obtained from the monitoring wells using a peristaltic pump on 13 August 2014.

The pH, temperature, electrical conductivity (EC), dissolved oxygen (DO) and redox potential (Eh) were monitored during sampling using calibrated field instruments. The sampling data sheets are attached in Appendix C. The samples were preserved in accordance with the requirements detailed in AS/NZS 5667.1-1998[17] and placed in an insulated container with ice.

On completion of the fieldwork, the samples were delivered in an insulated sample container to a NATA registered laboratory for analysis under standard chain of custody procedures.

5.6 Laboratory Analysis

Samples were analysed by Envirolab Services Pty Ltd (NATA accreditation number 2901) using the analytical methods detailed in Schedule B(3) of NEPM (1999[18]). Reference should be made to the laboratory reports (Ref: 114272 and 114557) attached in Appendix B for further details.

[17] *Water Quality – Part 1: Sampling, Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples,* Standards Australia, 1998 (AS/NZS 5667.1:1998)

[18] *Guideline on Laboratory Analysis of Potentially Contaminated Soils*, Schedule B(3), NEPM, 1999 (Schedule B(3))

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 Appendix A for further details.

Table 6-1: Summary of Subsurface Conditions

Profile	Depth Range (mBGL[1])	Description
Fill	Extends to depths of 0.2m to 0.6m	Fill material was encountered at the surface in BH1, BH2 and BH5 to BH8. The fill typically comprised silty clay or silty gravel. The fill contained inclusions of igneous, shale and sandstone gravel and concrete fragments.
Natural Soil	Extends to depths of 2.5m to 5m	Silty clay and gravelly silty clay was encountered at the surface or beneath the fill in all boreholes. The natural soil was typically grey or brown and contained traces of ironstone gravel. BH1, BH3, BH5, BH7 and BH8 were terminated in the natural soil at a maximum depth of approximately 4.2m.
Bedrock	Extends to a termination depth of 5.7m	Grey shale bedrock was encountered beneath the natural soil in BH2, BH4 and BH6.
Groundwater	1.68m to 2.77m	Groundwater monitoring wells were installed in BH2, BH4 and BH6. The standing water levels were measured approximately 1 week after installation to be 1.79m, 2.77m and 1.68m in BH2, BH4 and BH6, respectively.

Note:
1 – Metres below ground level

6.2 Summary of Laboratory Results

The laboratory results are presented in Table B to Table F attached to the report. The laboratory reports are presented in Appendix B. A summary of the results is presented below.

Table 6-2: Summary of Laboratory Results

Analyte	Number of Samples Analysed	Results
EC & EC_e	24 selected samples	The EC results ranged from 0.5μS/m to 1,800μS/m. The ECe results ranged from 0dS/m to 15dS/m.
Resistivity	24 selected	Resistivity values were calculated based on the raw EC values.

Analyte	Number of Samples Analysed	Results
	samples	The resistivity values for the soil samples ranged from 556ohm.cm to 2,000,000ohm.cm.
pH	24 selected samples	The results of the analysis ranged from 4.6 to 9.1.
CEC	16 selected samples	The results of the analysis ranged from: • CEC – 6.9meq/100g to 25meq/100g; • Exchangeable Na – 0.53meq/100g to 3.7meq/100g; • Exchangeable K – 0.1meq/100g to 0.2meq/100g; • Exchangeable Ca – 0.05meq/100g to 7.4meq/100g; and • Exchangeable Mg – 4.3meq/100g to 16meq/100g.
Sulphate	24 selected samples	The results ranged from 5mg/kg to 330mg/kg.
Chloride	24 selected samples	The results ranged from 5mg/kg to 1,400mg/kg.
Groundwater	3 samples	The results of the analysis ranged from: • pH – 7.4 to 7.5; • EC – 4,300μS/cm to 22,000μS/cm; • Chloride - 660mg/L to 8,000mg/L; and • Sulphate - 180mg/L to 400mg/L.

Note:
Na – Sodium
K – Potassium
Ca – Calcium
Mg – Magnesium

7 INTERPRETATION OF LABORATORY RESULTS

The laboratory results have been assessed against the criteria outlined in **Section 4**.

Table 7-1: Interpretation of Laboratory Results

Parameter	Notes
Soil Salinity and Plant Growth	The ECe results generally ranged from 0dS/m to 15dS/m. The majority of the samples were classed as slightly to moderately saline. Soil samples BH5 (1.5-1.7m), BH5 (4-4.2m), BH6 (2.5-2.7m), BH6 (4-4.2m) and BH8 (2.5-2.7m) were classed as very saline.
Soil pH and Plant Growth	The soil pH results ranged from 4.6 to 9.1 and are classed as Very strongly acidic to Very strongly alkaline. The majority of the surficial soils were generally within the optimum range for plant growth or slightly alkaline. The alkaline conditions generally increased with depth. The proposed excavations will generally expose alkaline soils and may require treatment in order to make the soils suitable for plant growth.
CEC in Soil	The CEC values ranged from 6.9meq/100g to 25meq/100g and the majority were in the 69meq/100g to 13meq/100g range. The majority of the samples were within the low 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 have more magnesium than calcium. The CEC of the soil is generally very low to low. 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 3.06% to 31.88%. The majority of the ESP results were above the 15% threshold and were classed as Highly Sodic.
Groundwater Salinity	The laboratory results indicate that the groundwater is generally saline and within the 'brackish' to 'saline' water types.
Concrete Slabs and Footings in Saline Soils (CCAA 2005)	The proposed earthworks are anticipated to expose soils generally classed as slightly to moderately saline with areas of very saline soils in the section of the site to the west of Cabramatta Creek. The CCAA 2005 recommended concrete grade for slabs and footings in moderately saline soils is N25. N32 graded concrete may be more appropriate in the west section of the site due to the presence of very saline soils.

Parameter	Notes
	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 and sulphate results indicate that the soils are generally non-aggressive towards buried concrete. The groundwater pH, sulphate and chloride results indicate that the groundwater is generally non-aggressive to mildly aggressive towards buried concrete.
Exposure Classification for Steel Piles/Foundations (AS2159-2009)	The soil resistivity, pH and chloride results indicate that the soils are mildly to moderately aggressive towards buried steel. The groundwater pH and chloride results indicate that the groundwater is non-aggressive towards buried steel.

8 SALINITY MANAGEMENT PLAN

Salinity management recommendations outlined in this section have been designed generally in accordance with the amended Salinity Code of Practice 2004. These recommendations should be reviewed in the event of any changes to the proposed development at the site.

Reference should also be made to the recommendations outlined in the following documents:

- Local council salinity control/management plans;
- Council DA approval conditions; and
- Geotechnical, landscaping and other recommendations provided for the site.

EIS note that the proposed developments vary from the east and west sections of the site. Therefore, varying management recommendations will be applicable for each separate area as detailed below.

8.1 Earthwork Recommendations

8.1.1 Western Site (Housing)

The earthwork recommendations are summarised in the table below:

Table 8-1: Earthwork Recommendations

Aspect	Recommendations
Earthworks Contractor	The salinity conditions and recommendations outlined in this section of the report should be reviewed by the earthworks contractor prior to the commencement of development works.
Bulk Earthwork Overview	Minor cut and fill earthworks are anticipated for the proposed 7 house development. No specific details have been provided to EIS, however, we have assumed that the development will include cuts to depths of no more than 1m and minor filling works to create level building platforms. EIS anticipate that the cut material will be used as fill in order to minimise the amount of material required for importation from an external source.
Cuts	As the salinity in this section of the site was found to be relatively consistent at shallow depths (i.e. the soils are moderately saline for the upper 1m), no specific change in concrete strength is considered to be required for cuts up to 1m deep. Cuts beyond a depth of 1m may expose very saline soils. An appropriate concrete strength should be used for infrastructure which comes into contact with very saline soils exposed by cuts deeper than 1m.

Aspect	Recommendations
Filling	Minor filling may be required to achieve final development levels. Fill material taken from less than 1m in the west section of the site should not require any additional management measures. Fill material sourced from areas of deep cuts (>1m) should be placed back at depth so as to minimise adverse salinity conditions associated with very saline soils. Fill material imported onto the site should meet the importation criteria for salinity as outlined in **Section 9.**
Staging of Works	Earthworks, including the stripping of vegetation and topsoil (if present) should be staged (where possible) to reduce the time of exposure of subsoils to erosion by wind and rain.
Erosion and Sediment Control	An erosion and sediment control plan should be prepared prior to the commencement of earthworks. The plan should be implemented during the development to manage and control sediment discharge from the site. The plan should remain in place during the earthworks phase until the pavement construction works are completed. All batter slopes should be stabilised to control erosion during development and post earthworks (refer to the Blue Book 2004). Erosion control for stockpiles and disturbed areas should be planned during the development including the grading and sealing of partially completed earthwork surfaces during construction (refer to the Blue Book 2004).
Gypsum and/or Lime Treatment	Sodic and highly dispersive soils can be treated by gypsum and/or lime. This will increase the proportion of exchangeable calcium in the soil and reduce the degree of sodicity (and thereby dispersivity) in areas where cut faces will be exposed. The amount of lime/gypsum to be added will vary with the soil and tests should be undertaken prior to, and during, the proposed earthworks to assess the appropriate quantity of lime/gypsum.

8.1.2 Eastern Site (Apartments)

The earthwork recommendations are summarised in the table below:

Table 8-2: Earthwork Recommendations

Aspect	Recommendations
Earthworks Contractor	The salinity conditions and recommendations outlined in this section of the report should be reviewed by the earthworks contractor prior to the commencement of development works.
Bulk Earthwork Overview	Excavation up to approximately 3m below the existing ground levels will be required for the proposed basement car park for each apartment building. Minor filling may be required for garden beds or site levelling works. EIS anticipate that the cut material will be used as fill in order to minimise the amount of material required for importation from an external source.
Cuts	Excavation in the east section of the site will generally expose slightly to moderately saline soils from the surface to a depth of at least 4m. An appropriate concrete strength should be used for infrastructure which comes into contact with moderately saline soils exposed by cuts.
Filling	Localised filling may be required to achieve final development levels for yard and garden areas. Fill material sourced from the basement excavations is considered to include similar levels of salinity to surface soils in the east section of the site. Fill material imported onto the site should meet the importation criteria for salinity as outlined in **Section 9.**
Staging of Works	Earthworks, including the stripping of vegetation and topsoil (if present) should be staged (where possible) to reduce the time of exposure of subsoils to erosion by wind and rain.
Erosion and Sediment Control	An erosion and sediment control plan should be prepared prior to the commencement of earthworks. The plan should be implemented during the development to manage and control sediment discharge from the site. The plan should remain in place during the earthworks phase until the pavement construction works are completed. All batter slopes should be stabilised to control erosion during development and post earthworks (refer to the Blue Book 2004). Erosion control for stockpiles and disturbed areas should be planned during the development including the grading and sealing of partially completed earthwork surfaces during construction (refer to the Blue Book 2004).
Gypsum and/or Lime Treatment	Sodic and highly dispersive soils can be treated by gypsum and/or lime. This will increase the proportion of exchangeable calcium in the soil and reduce the degree of sodicity (and thereby dispersivity) in areas where cut faces will be

Aspect	Recommendations
	exposed. The amount of lime/gypsum to be added will vary with the soil and tests should be undertaken prior to, and during, the proposed earthworks to assess the appropriate quantity of lime/gypsum.

8.2 Site Drainage, Surface Water and Storm Water Run-off

The recommendations for site drainage are summarised in the table below:

Table 8-3: Recommendations for Site Drainage

Aspect	Recommendations
Earthworks Contractor	The salinity conditions and recommendations outlined in this section of the report should be reviewed by the earthworks contractor prior to the commencement of development works.
Drainage Patterns	The proposed earthworks should be designed to minimise disturbance of the natural site drainage patterns. Where these patterns are altered, appropriate artificial drainage should be installed in order to minimise water logging and localised flooding.
Installation of Sub-soil Drains	Subsoil drains should be provided in areas where seepage discharge from the underlying natural soil may occur, such as retained cuts, cut slopes, low lying areas or significant changes in grade, basements, etc. Slabs, foundations and retaining walls should be designed with subsoil drains and good drainage to avoid water logging.
Surface water and Storm water run-off	Stormwater should be managed appropriately in order to reduce infiltration. Stormwater infrastructure should be designed to minimise leakage. Guttering and down pipes should be properly connected and maintained at all times. Surface water runoff should be directed around all stockpiles and work areas.

8.3 Water Retention/Detention Basins

As a minimum requirement, the design of temporary and permanent water retention/detention basins should include the following:

Table 8-4: Recommendations for Water Retention/Detention Basins

Aspect	Recommendations
Earthworks Contractor	The salinity conditions and recommendations outlined in this section of the report should be reviewed by the earthworks contractor prior to the commencement of development works.
Cuts	Cuts proposed for any proposed water retention/detention basins to depths of greater than 1m in the west section of the site will generally expose very saline soils. Cuts in the east section of the site to a maximum depth of 4m will expose slightly to moderately saline soils. An impermeable liner should be installed at the base and walls of the basins to minimise water logging, infiltration and potential recharge of the underlying perched aquifer. The liner will also assist in maintaining a constant level of water during dry periods.
Liner Selection	Soil conditions in the vicinity of detention basins should be investigated in detail and assessed in relation to liner requirements and other design parameters. A synthetic liner is recommended and should be assessed in accordance with the manufacturer's recommendations. The use of a synthetic liner rather than compacted clay soil is considered appropriate due to the following: • Highly dispersive and shrink-swell nature of the clayey subsoils which may result in cracking of a clay liner in dry periods; • Potential for cloudy suspensions in the water column associated with dispersion of a clay liner; • Erosion/tunnelling in high flow entry/exit points to the basins; and • Potential for the basin excavations to intersect the soil-shale interface where saline seepage may occur during wet periods.
Design and Construction of Wetlands/Basins	The construction of wetlands/basins should incorporate sediment and erosion control and other recommendations outlined in the Blue Book 2004. The batters along the facilities should be vegetated and appropriately designed in order to minimise soil erosion and dispersion.
Design of Landscaped Areas	Landscaped areas in the vicinity of wetlands/basins should be designed as outlined in **Section 8.4.2.**

8.4 Design of Built Structures

8.4.1 Western Site (Housing)

The design of built structures in the western section of the site should incorporate the following:

Table 8-5: Recommendations for Built Structures

Aspect	Recommendations
Structural Advice	The salinity conditions and recommendations outlined in this section of the report should be reviewed by a qualified structural/civil engineer prior to the commencement of development.
Damp Proof Course (DPC)	Appropriate damp proof course (DPC) and moisture barriers should be used as outlined in the WSROC document '*Western Sydney Salinity Code of Practice, June 2003*' and other relevant building industry standards. The DPC must consist of polyethylene or polyethylene coated metal and should be correctly placed (South Australia [SA] Building Code of Australia [BCA] 3.3.4.4).
Exposure Class Masonry and Admixtures	Exposure class masonry must be used below the DPC including for strip footings (clause 3.3.1.5 (b) and Table 3.3.1.1 of the BCA). This is especially important in areas where landscaping is located adjacent to built structures. An appropriate mortar and mixing ratio must be used with exposure class masonry (clause 3.3.1.6 and Table 3.3.1.2 of the BCA). Admixtures for waterproofing and/or corrosion prevention should be used where necessary.
Adequate Drainage around Built Structures	Care should be taken to check that the infrastructure design process considers the existing patterns of surface and subsurface water movement through the site during both dry and wet periods. Construction of infrastructure, which may cause an increase in areas of surficial water logging through poor surface drainage, may cause the groundwater table to rise.
Durability of Concrete Piles/Foundations	The upper soil profile (less than 1m deep) is classed as generally non-aggressive towards buried concrete. The groundwater is classed as mildly aggressive towards buried concrete. The appropriate concrete strength and corrosion allowance outlined in the AS2159-2009 should be adopted. The CCAA 2005 publication recommends a concrete grade of N25 for residential slabs and footings exposed to moderately saline soil (i.e soil less than 1m deep). N32 grade concrete is recommended for very saline soils (i.e. those encountered greater than 1m deep).

Aspect	Recommendations
Durability of Steel Piles/Foundations	The soils are classed as mildly to moderately aggressive towards buried steel. The groundwater is classed as non-aggressive towards buried steel. Appropriate corrosion allowance for steel outlined in the AS2159-2009 should be adopted.

8.4.2 Eastern Site (Apartments)

The design of built structures should incorporate the following:

Table 8-6: Recommendations for Built Structures

Aspect	Recommendations
Structural Advice	The salinity conditions and recommendations outlined in this section of the report should be reviewed by a qualified structural/civil engineer prior to the commencement of development.
Damp Proof Course (DPC)	Appropriate damp proof course (DPC) and moisture barriers should be used as outlined in the WSROC document '*Western Sydney Salinity Code of Practice, June 2003*' and other relevant building industry standards. The DPC must consist of polyethylene or polyethylene coated metal and should be correctly placed (South Australia [SA] Building Code of Australia [BCA] 3.3.4.4).
Exposure Class Masonry and Admixtures	Exposure class masonry must be used below the DPC including for strip footings (clause 3.3.1.5 (b) and Table 3.3.1.1 of the BCA). This is especially important in areas where landscaping is located adjacent to built structures. An appropriate mortar and mixing ratio must be used with exposure class masonry (clause 3.3.1.6 and Table 3.3.1.2 of the BCA). Admixtures for waterproofing and/or corrosion prevention should be used where necessary.
Adequate Drainage around Built Structures	Care should be taken to check that the infrastructure design process considers the existing patterns of surface and subsurface water movement through the site during both dry and wet periods. Construction of infrastructure, which may cause an increase in areas of surficial water logging through poor surface drainage, may cause the groundwater table to rise.
Durability of Concrete Piles/Foundations	The soils are classed as generally non-aggressive towards buried concrete. The groundwater is classed as non-aggressive towards buried concrete. The appropriate concrete strength and corrosion allowance outlined in the

Aspect	Recommendations
	AS2159-2009 should be adopted. The CCAA 2005 publication recommends a concrete grade of N25 for residential slabs and footings exposed to moderately saline soil.
Durability of Steel Piles/Foundations	The soils are classed as mildly aggressive towards buried steel. The groundwater is classed as non-aggressive towards buried steel. The appropriate corrosion allowance for steel outlined in the AS2159-2009 should be adopted.

8.5 Gardens and Landscaped Areas

8.5.1 Western Site (Housing)

The recommendations for the design of gardens and landscaped areas are summarised in the table below:

Table 8-7: Recommendations for Gardens and Landscaped Areas

Aspect	Recommendations
Arborist Advice	The salinity conditions and recommendations outlined in this section of the report should be reviewed by a qualified Arborist/landscape designer prior to the commencement of development.
Retention of Existing Vegetation	Areas of established vegetation especially deep rooted trees should be retained. Deep rooted trees generally draw water from the underlying natural soils and possibly the deeper groundwater system. Hence preventing the groundwater table from rising. Consideration should be made to plant deep rooted native trees in areas predisposed to salinity.
Selection of Plants and Topsoil	The topsoil/fill at the site is generally moderately saline. Cuts beyond 1m deep will expose very saline soil. These conditions are not considered favourable for plant growth. Nutrient rich topsoil should be used to promote plant growth in landscaped areas. Special attention should be paid to soil fertility to promote optimal conditions for successful revegetation. Suitable native plant species which require minimal watering should be established in landscaped areas. Topsoil imported onto the site should, as a minimum, meet the importation criteria for salinity as outlined in **Section 9**.
Landscape Design	Landscaped areas and garden beds should not be located adjacent to built structures. Excessive watering of such areas can lead to rising damp in the

Aspect	Recommendations
	adjacent structures resulting in potential damage to bricks, concrete, steel etc. In the event this is unavoidable, the landscaped areas and garden beds should be lowered such that soil in contact with built structures is below the damp proof course (DPC). Exposure grade bricks should be used below the DPC to minimise rising damp and potential damage.
Irrigation of Landscaped and Garden Areas	The use of potable water for irrigation should be kept to a minimum. This can be achieved by incorporating 'waterwise' gardening principles which include using sprinklers and drip irrigation system activated by timers etc. Irrigation systems should be periodically checked to ensure there is no leakage.
Subsoil Drains	Subsoil drains should be installed beneath any other areas which may require intense irrigation to maintain grass/turf cover. Such facilities should be designed with adequate grading to prevent water ponding and to channel excess run-off into the subsoil drains. Water collected in the drains should be disposed of appropriately. Alternatively it can be collected in water retention facilities and re-used on site.
Use of 'Grey' water	Many new subdivisions are encouraged to use recycled water or 'grey' water for irrigation purposes. Recycled water (grey water) is generally more saline than potable water and excessive use may result in increasing soil and groundwater salinity. In order to minimise potential plant dieback, consideration should be given to planting native salt tolerant plant species which require minimal watering. Advice from a qualified Arborist should be obtained for the conditions encountered at the site.

8.5.2 Eastern Site (Apartments)

Table 8-8: Recommendations for Gardens and Landscaped Areas

Aspect	Recommendations
Arborist Advice	The salinity conditions and recommendations outlined in this section of the report should be reviewed by a qualified Arborist/landscape designer prior to the commencement of development.
Retention of Existing Vegetation	Areas of established vegetation especially deep rooted trees should be retained. Deep rooted trees generally draw water from the underlying natural soils and possibly the deeper groundwater system. Hence preventing the groundwater table from rising. Consideration should be made to plant deep rooted native trees in areas

Aspect	Recommendations
	predisposed to salinity.
Selection of Plants and Topsoil	The topsoil/fill at the site is generally slightly to moderately saline. Deeper soil was found to contain similar levels of salinity. These conditions are not considered favourable for plant growth. Nutrient rich topsoil should be used to promote plant growth in landscaped areas. Special attention should be paid to soil fertility to promote optimal conditions for successful revegetation. Suitable native plant species which require minimal watering should be established in landscaped areas. Topsoil imported onto the site should, as a minimum, meet the importation criteria for salinity as outlined in **Section 9**.
Landscape Design	Landscaped areas and garden beds should not be located adjacent to built structures. Excessive watering of such areas can lead to rising damp in the adjacent structures resulting in potential damage to bricks, concrete, steel etc. In the event this is unavoidable, the landscaped areas and garden beds should be lowered such that soil in contact with built structures is below the damp proof course (DPC). Exposure grade bricks should be used below the DPC to minimise damp rise and potential damage.
Irrigation of Landscaped and Garden Areas	The use of potable water for irrigation should be kept to a minimum. This can be achieved by incorporating 'waterwise' gardening principles which include using sprinklers and drip irrigation system activated by timers etc. Irrigation systems should be periodically checked to ensure there is no leakage.
Subsoil Drains	Subsoil drains should be installed beneath any other areas which may require intense irrigation to maintain grass/turf cover. Such facilities should be designed with adequate grading to prevent water ponding and to channel excess run-off into the subsoil drains. Water collected in the drains should be disposed of appropriately. Alternatively it can be collected in water retention facilities and re-used on site.
Use of 'Grey' water	Many new subdivisions are encouraged to use recycled water or 'grey' water for irrigation purposes. Recycled water (grey water) is generally more saline than potable water and excessive use may result in increasing soil and groundwater salinity. In order to minimise potential plant dieback, consideration should be given to planting native salt tolerant plant species which require minimal watering. Advice from a qualified Arborist should be obtained for the conditions encountered at the site.

8.6 Roads, Footpaths and Hardstand Areas

The recommendations for the design of road, footpaths and hardstand areas are summarised in the table below:

Table 8-9: Recommendations for Roads, Footpaths and Hardstand Areas

Aspect	Recommendations
Earthworks Contractor	The salinity conditions and recommendations outlined in this section of the report should be reviewed by the earthworks contractor prior to the commencement of development works.
Graded Surfaces	All roads, pavements, footpaths and hardstand areas should be graded to prevent surface water ponding. Subsoil drains should be provided in all such areas to collect stormwater and surface water run-off.
Corrosion of Concrete and Steel	Concrete and steel used in footpaths, road side kerbs, gutters etc. should be designed to withstand the saline and aggressive conditions encountered at the site. Reference should be made to **Sections 7 and 8.4** for further information.
Installation of Services	Services should be installed in joint trenches and conduits. The conduits should be installed under and across roads at the time of construction of the road and associated roadside landscaping to reduce future works within the road corridor.
Design of Landscaped Areas	Landscaped areas in the vicinity of roads, car parks and hardstands should be designed as outlined in **Section 8.5.**

8.7 Ongoing Management

Salinity is a natural phenomenon which can change over time especially during extreme dry and wet periods. Regular inspections and maintenance of facilities should be undertaken in order to identify issues at an early stage. Early detection and prevention of adverse salinity conditions is important to ongoing management. A few key ongoing management aspects are discussed in the table below.

Table 8-10: Key Ongoing Management Aspects

Aspect	Recommendations
Groundwater Management	A rising groundwater table may lead to adverse salinity conditions as the groundwater is considered to be very saline, in particular in the west section. Planning and design should involve management of factors that could lead to a rise in the groundwater table level. Such measures include reducing the importation of potable water to the site, reduction of irrigation requirements,

Aspect	Recommendations
	avoiding the use of infiltration pits to disperse surface water and preventing leakage from wetland and bioretention basins. Watering activities associated with the proposed landscaped areas will tend to increase groundwater recharge. Subsoil drains should be installed in these areas so as to avoid excessive recharge of the groundwater system, reduce the potential for water logging and also increase the potential for on-site water re-cycling. Reference should be made to the salinity, erosion and sediment control management strategy is presented in the attached Table A.
Salinity Compliance	Salinity compliance is required to ensure that the recommendations outlined in this report are implemented. A site specific compliance check list is presented in Tables H-1 (Western Site) and H-2 (Eastern Site) which are attached to this report. The check list should be completed by the relevant contractors (i.e. earthworks, structural design, landscape, architects etc) after the completion of each stage of the development.
Routine Inspections	Routine inspections of drainage facilities, landscaped areas, water detention/retention basins, batter slopes, cut faces, roads, walkways, pavements and hardstand areas should be undertaken by property owner or strata body as applicable. A checklist of adverse salinity indicators should be maintained during the inspections. A qualified environmental consultant should be contacted in the event any of the salinity indicators are identified at the site.

9 SOIL SALINITY IMPORTATION CRITERIA

The proposed development may include importation of fill/topsoil to achieve the desired finished levels or create gardens/landscaped areas. The salinity, corrosion and contamination conditions of the material should be checked prior to importation. The recommended salinity importation criteria are outlined in the following table:

Table 9-1: Salinity Importation Criteria

Parameter (units)	Acceptable Range	Potential Re-use Implications
pH[1]	>5.5 - 7	Material in this range will generally be non-aggressive towards built structures and within the optimal range for plant growth.
ECe[2] (dS/m)	<2 - 4	Material in this range is non-saline to slightly saline and generally considered acceptable for plant growth. CCAA 2005 recommends a concrete grade of N20 for slabs and footings for these conditions.
CEC[3] (meq/100g)	12 - 25	Material in this range is generally considered acceptable for plant growth.
ESP[4] (%)	<5	Material in this range is generally less dispersive.
Sulphate and Chloride[1] (mg/kg)	<5,000	Material in this range will generally be non-aggressive towards piles/foundations.
Resistivity[1] (ohm.cm)	>5,000	Material in this range will generally be non-aggressive towards piles/foundations.

Note:
1 – Adopted from AS2159-2009
2 – Adopted from DLWC 2002
3 – Adopted from Metson 1961
4 – Adopted from Charman and Murphy 2000

10 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;
- EIS 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;
- EIS 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 EIS proposal; and terms of contract between EIS 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, EIS has not undertaken any verification process, except where specifically stated in the report;
- EIS 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;
- EIS 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;
- EIS 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 landuse. EIS 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 EIS. EIS 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 EIS; and
- Any third party who seeks to rely on this report without the express written consent of EIS does so entirely at their own risk and to the fullest extent permitted by law, EIS accepts no liability whatsoever, in respect of any loss or damage suffered by any such third party.

LIST OF IN-TEXT TABLES:

IMPORTANT INFORMATION ABOUT THIS REPORT

These notes have been prepared by EIS 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 EIS 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 are modified;
- the proposed development levels are altered, eg addition of basement levels; or
- ownership of the site changes.

EIS 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 EIS 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 (eg. water extraction for irrigation or industrial uses, subsurface waste water disposal, construction related dewatering). Soil and groundwater salinity conditions may also vary over time. 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 conditions, 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 the salinity conditions and salinity management issues.

Logs Should not be Separated from the Assessment Report

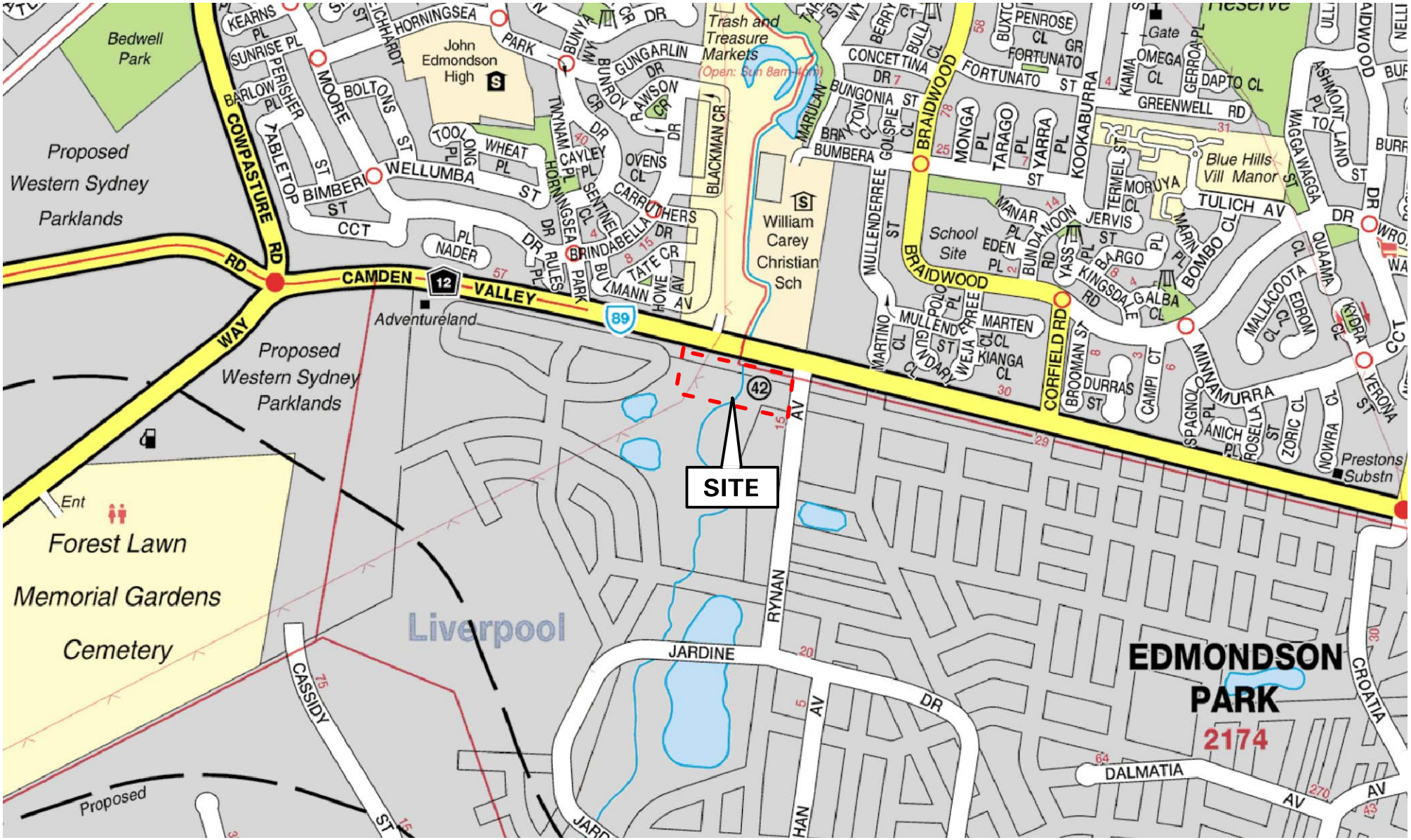
Borehole and test pit logs are prepared by environmental scientists, engineers or geologists based upon interpretation of field conditions and laboratory evaluation of field samples. Logs are normally provided in our reports and these should not be re-drawn for inclusion in site management or other design 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 test 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 a salinity 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 assessment report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to any questions.

REPORT FIGURES

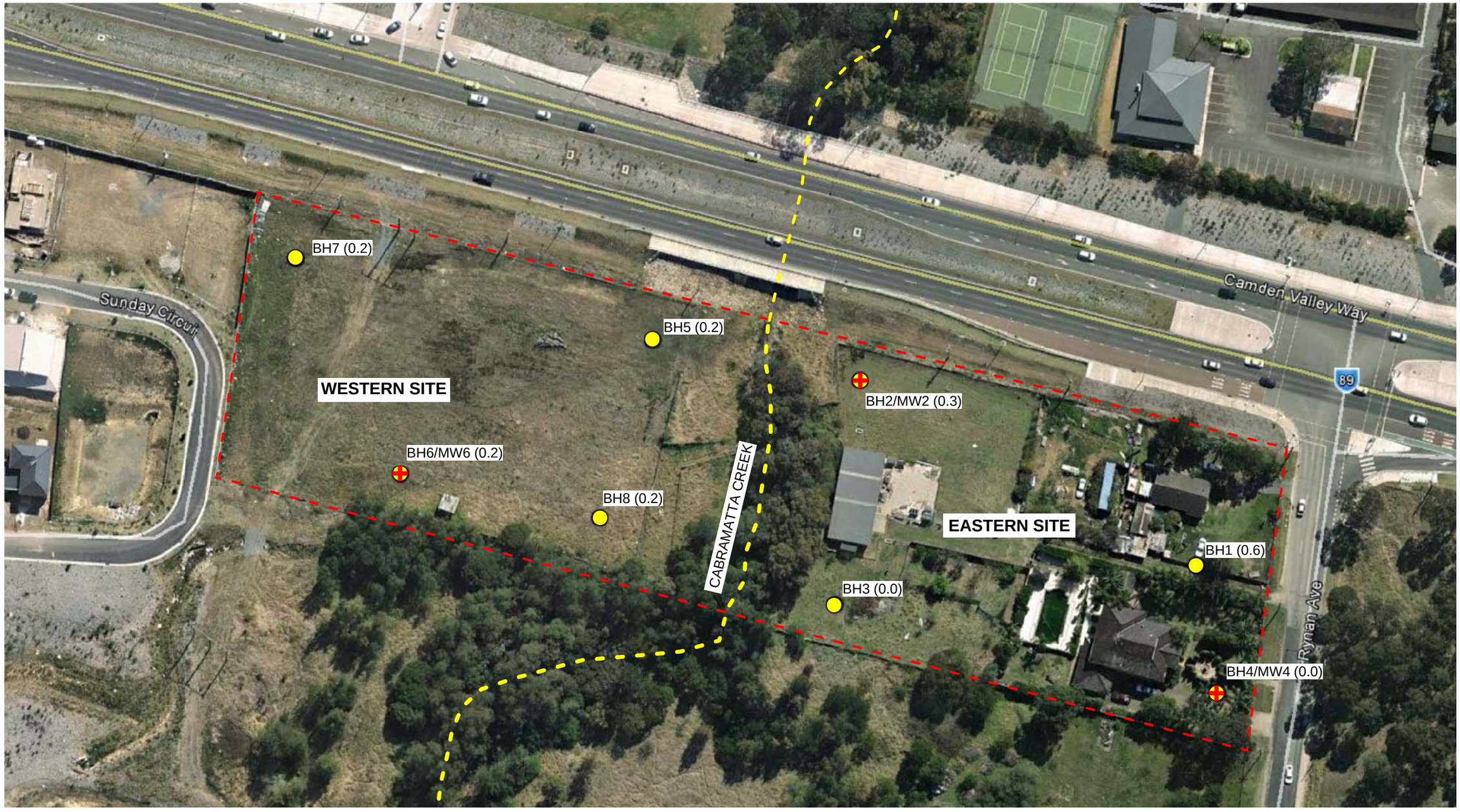


NOTES:
Figure 1 has been recreated from UBD on disc (version 5.0). Figure is not to scale.

UBD Map ref: 287 G1

Reference should be made to the report text for a full understanding of this plan.

ENVIRONMENTAL INVESTIGATION SERVICES	Project Number: E27532KH	Title: SITE LOCATION PLAN
	Figure: 1	Address: 5 RYNAN AVENUE, EDMONDSON PARK, NSW



LEGEND:

- **Approximate site boundary**
- **BH1 (0.2) Borehole location, number and depth of fill (m)**
- **Groundwater monitoring well location**

NOTES:
Figure 2 has been recreated from the latest Google Earth Pro image

The borehole locations presented on this plan have been established from site measurements only and should not be construed as survey points.

Reference should be made to the report text for a full understanding of this plan.

Approximate Scale (m): 0 10 20 30 40 50

ENVIRONMENTAL INVESTIGATION SERVICES

Project Number:	Title:
E27532KH	**BOREHOLE LOCATION PLAN**
Figure: **2**	Address: **5 RYNAN AVENUE, EDMONDSON PARK, NSW**

REPORT TABLES

TABLE A
SUMMARY OF SALINITY, EROSION & SEDIMENT CONTROL MANAGEMENT STRATEGY

Salinity Control	Benefit	Control	Details	Monitoring Method	Trigger for Action	Management Method
Minimise Groundwater Recharge	Prevent Rising Groundwater Table Level & Development of Saline Conditions	Minimise Importation & Use of Potable Water on Site	Reuse Stormwater for Irrigation	Evidence of Stormwater Catchment/Retention	No Evidence of Stormwater Retention or Re-use	1). Ensure Stormwater is being used Appropriately
			Minimise Potable Water Use	Evidence of Stormwater Re-use		2). Design and Construct Appropriately Sized Lawns
		Reduce Irrigation Requirement	Adopt Small Gardens and Lawns	Check Size and Design of Gardens/Lawns	Absence of Small Gardens/Lawns	3). Replace Non-native Plants with Native Species
			Establish Plants which require Less Water	Check Plant Selection against Accepted List	Absence of Appropriate Plants & Mulch Cover	4). Encourage use of Mulch in Landscaped Areas
			Use Mulch Cover	Evidence of Mulch Cover	Absence of Low Flow Water Equipment	5). Design & Install Low Flow Water Equipment
			Use Low Flow Watering Facilities	Presence of Low Flow Water Equipment		6). Ensure Liners are Installed in all Water Retention Structures & Wetlands
		Avoid use of Infiltration Pits to Disperse Surface Water	Design Stormwater System to Negate the Need for Site Stormwater Storage Disposal	Check Design & Actual Construction of Stormwater Storage & Disposal System	Absence of Stormwater Storage & Disposal System	7). Monitor Groundwater Levels Periodically
			Connect all Downpipes Directly to Stormwater	Check if all Downpipes are Connected to the Stormwater	Absence of Downpipe Connections to the Stormwater	8). Regular Inspections of Vegetation & Infrastructure including Buildings
		Prevent Leakage from Wetlands & Drainage Facilities	Line all Permanent Water Retention Structures & Wetlands	Check Design Drawings for Liner Installation Details	Absence of Liner in Design Drawings	
				Monitor Liner Installation During Earthworks	Elevated Groundwater Levels Due to Seepage	
Encourage use of Groundwater as a Resource	Maintain or Lower Groundwater Table Level	Encourage Tree Planting & Retention, Especially in Areas of Higher Recharge	Use/Retain Native, Deep-Rooted, Large Growing Species	Check Landscape Design Drawings to Ensure Selection of Native Plants & Deep-Rooted Trees	Absence of Native Plants & Deep-Rooted Trees in Landscaped Areas	Design and Construction of Appropriately sized Nature Strips to Ensure Growth of Native Plants & Deep-Rooted Trees
				Check The Planting & Progress of Deep-Rooted Trees & Native Plants	Plant Die Back in Landscaped Areas	
Erosion Control	Prevents Siltation Problems in Drainage Facilities & Damage that Could Result from Erosion	Design all Works to Limit Generation of Potential Erosion Surfaces & Stabilise Disturbed Areas as soon as possible	Stabilise Disturbed Surfaces	Undertake Regular Inspections of all Construction Activities	Absence of Silt Control Fence	1). Regular Inspection Reports to be Submitted to Consent Authority
			Conserve Topsoil by Stockpiling for later use	Perform Regular Inspection of Vegetation Conditions in Development Area	Absence of Mulch and Grass Cover	2). Appropriate Grass & Mulch Cover to be Maintained at all times
			Use Fast Growing Grass Species	Maintain Silt Control Fence in Drainage Channels	Exposed Stockpiles	3). Re-Installation of Silt Control Fence
			Use Temporary Ground Cover for Areas to be re-disturbed	Maintain Mulch and Grass Cover	Presence of Erosion Gullies on Exposed Batters & Surfaces	
			Minimise area of Disturbance		Presence of Silt in Wetlands & Water Retention Structures	
			Cover Stockpiles			
			Use Lime Stabilisation During Earthworks to Improve Subgrade & Reduce Dispersibility			
Sediment Control	Control Sediment Generated by Construction & Other Activities	Include Sediment Control Considerations In all Designs	Project Stockpiles from Erosion by Run-off from upslope	Undertake Regular Inspections of all Construction Activities	Exposed Stockpiles	1). Regular Inspection Reports to be Submitted to Controlling Authority
			Use Temporary Sediment Basins to Maximise Effectiveness & Minimise Sediment Transport	Perform Regular Inspection of Vegetation Condition in Development Area	Absence of Temporary Sediment Basins	2). Stockpiles to be Covered at all Times
			Use Specific Soil Stabilisation Measures in Areas of High Soil Erosion Potential		Presence of Erosion Gullies on Exposed Batters & Surfaces	3). Re-Installation of Temporary Sediment Basins

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[1]
BH1	0.7-0.95	Silty clay	310	2	Slightly Saline
BH1	1.8-2.0	Silty clay	570	5	Moderately Saline
BH1	2.8-3.0	Silty clay	500	4	Moderately Saline
BH2	0.5-0.95	Silty clay	0.5	0	Non-saline
BH2	1.5-1.95	Silty clay	240	2	Slightly Saline
BH2	4-4.2	Silty clay	230	2	Slightly Saline
BH3	0-0.2	Silty clay	360	4	Moderately Saline
BH3	0.5-0.95	Silty clay	470	3	Slightly Saline
BH3	4-4.2	Silty clay	340	3	Slightly Saline
BH4	0.5-0.95	Silty clay	260	2	Slightly Saline
BH4	1.5-1.95	Silty clay	940	7	Moderately Saline
BH4	4-4.2	Shale	190	2	Slightly Saline
BH5	0-0.2	Fill: silty clay	600	6	Moderately Saline
BH5	1.5-1.7	Silty clay	1800	15	Very Saline
BH5	4-4.2	Gravelly silty clay	1100	9	Very Saline
BH6	0.5-0.95	Silty clay	920	7	Moderately Saline
BH6	2.5-2.7	Gravelly silty clay	1600	13	Very Saline
BH6	4-4.2	Silty clay	950	8	Very Saline
BH7	0.5-0.95	Silty clay	1000	7	Moderately Saline
BH7	1.5-1.7	Silty clay	640	5	Moderately Saline
BH7	2.5-2.7	Gravelly silty clay	860	7	Moderately Saline
BH8	0.5-0.95	Silty clay	400	3	Slightly Saline
BH8	1.5-1.7	Silty clay	750	6	Moderately Saline
BH8	2.5-2.7	Gravelly silty clay	1200	10	Very Saline
Total Number of Samples			24	24	-
Minimum Value			0.5	0	-
Maximum Value			1800	15	-

Explanation

1 - Salinity Class has been adopted from '*Site Investigations for Urban Salinity*' DLWC 2002.

(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

Abbreviations

EC - Electrical Conductivity
ECe - Extract Electrical Conductivity

TABLE C
SUMMARY OF RESISTIVITY CALCULATION ON SOIL EC RESULTS

Borehole Number	Sample Depth (m)	Sample Description	EC (μS/cm)	Resistivity[1] (ohm.cm)	Classification[2] Condition B
BH1	0.7-0.95	Silty clay	310	3,226	Non-Aggressive
BH1	1.8-2.0	Silty clay	570	1,754	**Mildly Aggressive**
BH1	2.8-3.0	Silty clay	500	2,000	**Mildly Aggressive**
BH2	0.5-0.95	Silty clay	0.5	2,000,000	Non-Aggressive
BH2	1.5-1.95	Silty clay	240	4,167	Non-Aggressive
BH2	4-4.2	Silty clay	230	4,348	Non-Aggressive
BH3	0-0.2	Silty clay	360	2,778	Non-Aggressive
BH3	0.5-0.95	Silty clay	470	2,128	Non-Aggressive
BH3	4-4.2	Silty clay	340	2,941	Non-Aggressive
BH4	0.5-0.95	Silty clay	260	3,846	Non-Aggressive
BH4	1.5-1.95	Silty clay	940	1,064	**Mildly Aggressive**
BH4	4-4.2	Shale	190	5,263	Non-Aggressive
BH5	0-0.2	Fill: silty clay	600	1,667	**Mildly Aggressive**
BH5	1.5-1.7	Silty clay	1800	556	**Moderately Aggressive**
BH5	4-4.2	Gravelly silty clay	1100	909	**Moderately Aggressive**
BH6	0.5-0.95	Silty clay	920	1,087	**Mildly Aggressive**
BH6	2.5-2.7	Gravelly silty clay	1600	625	**Moderately Aggressive**
BH6	4-4.2	Silty clay	950	1,053	**Mildly Aggressive**
BH7	0.5-0.95	Silty clay	1000	1,000	**Moderately Aggressive**
BH7	1.5-1.7	Silty clay	640	1,563	**Mildly Aggressive**
BH7	2.5-2.7	Gravelly silty clay	860	1,163	**Mildly Aggressive**
BH8	0.5-0.95	Silty clay	400	2,500	Non-Aggressive
BH8	1.5-1.7	Silty clay	750	1,333	**Mildly Aggressive**
BH8	2.5-2.7	Gravelly silty clay	1200	833	**Moderately Aggressive**
Total Number of Samples			24	24	-
Minimum Value			0.5	556	-
Maximum Value			1800	2,000,000	-

Explanation

1 - Resistivity values have been calculated on the laboratory EC values presented in Table B

2 - 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**

Abbreviations

EC - Electrical Conductivity

NA -Not Applicable

TABLE D
SUMMARY OF SOIL LABORATORY RESULTS - pH

Borehole Number	Sample Depth (m)	Sample Description	pH	Classification for Concrete Piles[1] Soil Condition B[3]	Classification for Steel Piles[1] Soil Condition B[3]
BH1	0.7-0.95	Silty clay	8.4	Non-Aggressive	Non-Aggressive
BH1	1.8-2.0	Silty clay	8.3	Non-Aggressive	Non-Aggressive
BH1	2.8-3.0	Silty clay	8.2	Non-Aggressive	Non-Aggressive
BH2	0.5-0.95	Silty clay	4.6	Mildly Aggressive	Non-Aggressive
BH2	1.5-1.95	Silty clay	7.8	Non-Aggressive	Non-Aggressive
BH2	4-4.2	Silty clay	8.7	Non-Aggressive	Non-Aggressive
BH3	0-0.2	Silty clay	6.2	Non-Aggressive	Non-Aggressive
BH3	0.5-0.95	Silty clay	7	Non-Aggressive	Non-Aggressive
BH3	4-4.2	Silty clay	9.1	Non-Aggressive	Non-Aggressive
BH4	0.5-0.95	Silty clay	6.9	Non-Aggressive	Non-Aggressive
BH4	1.5-1.95	Silty clay	7.4	Non-Aggressive	Non-Aggressive
BH4	4-4.2	Shale	8.3	Non-Aggressive	Non-Aggressive
BH5	0-0.2	Fill: silty clay	7.5	Non-Aggressive	Non-Aggressive
BH5	1.5-1.7	Silty clay	8.6	Non-Aggressive	Non-Aggressive
BH5	4-4.2	Gravelly silty clay	8.4	Non-Aggressive	Non-Aggressive
BH6	0.5-0.95	Silty clay	7.5	Non-Aggressive	Non-Aggressive
BH6	2.5-2.7	Gravelly silty clay	8.4	Non-Aggressive	Non-Aggressive
BH6	4-4.2	Silty clay	8.3	Non-Aggressive	Non-Aggressive
BH7	0.5-0.95	Silty clay	5.4	Mildly Aggressive	Non-Aggressive
BH7	1.5-1.7	Silty clay	8	Non-Aggressive	Non-Aggressive
BH7	2.5-2.7	Gravelly silty clay	8.2	Non-Aggressive	Non-Aggressive
BH8	0.5-0.95	Silty clay	7	Non-Aggressive	Non-Aggressive
BH8	1.5-1.7	Silty clay	8.3	Non-Aggressive	Non-Aggressive
BH8	2.5-2.7	Gravelly silty clay	8.4	Non-Aggressive	Non-Aggressive
Total Number of Samples			24	-	-
Minimum Value			4.6	-	-
Maximum Value			9.1	-	-

Explanation

1 - pH Classification 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] recommends using a Moderate Exposure Classification for Steel Piles in Fresh Water - Soft Running Water

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

pH Value	Classification for Concrete Piles
> 5.5	Non-Aggressive
4.5 - 5.5	Mildly Aggressive
4 - 4.5	Moderately Aggressive
< 4	Severely Aggressive

pH Value	Classification for Steel Piles
> 5	Non-Aggressive
4.0 - 5.0	Non-Aggressive
3.0 - 4.0	Mildly Aggressive
< 3	Moderately Aggressive

Abbreviations

NA -Not Applicable

TABLE E
SUMMARY OF SOIL LABORATORY RESULTS - SULPHATE & CHLORIDES

Borehole Number	Sample Depth (m)	Sample Description	Sulphate (mg/kg)	Chloride (mg/kg)	Classification for Concrete Piles[1] SO4 - Soil Condition B[3]	Classification for Steel Piles[1] Cl - Soil Condition B[3]
BH1	0.7-0.95	Silty clay	120	65	Non-Aggressive	Non-Aggressive
BH1	1.8-2.0	Silty clay	330	350	Non-Aggressive	Non-Aggressive
BH1	2.8-3.0	Silty clay	180	290	Non-Aggressive	Non-Aggressive
BH2	0.5-0.95	Silty clay	150	100	Non-Aggressive	Non-Aggressive
BH2	1.5-1.95	Silty clay	95	140	Non-Aggressive	Non-Aggressive
BH2	4-4.2	Silty clay	74	79	Non-Aggressive	Non-Aggressive
BH3	0-0.2	Silty clay	22	38	Non-Aggressive	Non-Aggressive
BH3	0.5-0.95	Silty clay	230	240	Non-Aggressive	Non-Aggressive
BH3	4-4.2	Silty clay	66	160	Non-Aggressive	Non-Aggressive
BH4	0.5-0.95	Silty clay	110	88	Non-Aggressive	Non-Aggressive
BH4	1.5-1.95	Silty clay	300	800	Non-Aggressive	Non-Aggressive
BH4	4-4.2	Shale	51	32	Non-Aggressive	Non-Aggressive
BH5	0-0.2	Fill: silty clay	120	480	Non-Aggressive	Non-Aggressive
BH5	1.5-1.7	Silty clay	130	1100	Non-Aggressive	Non-Aggressive
BH5	4-4.2	Gravelly silty clay	220	850	Non-Aggressive	Non-Aggressive
BH6	0.5-0.95	Silty clay	160	760	Non-Aggressive	Non-Aggressive
BH6	2.5-2.7	Gravelly silty clay	160	1400	Non-Aggressive	Non-Aggressive
BH6	4-4.2	Silty clay	5	5	Non-Aggressive	Non-Aggressive
BH7	0.5-0.95	Silty clay	250	930	Non-Aggressive	Non-Aggressive
BH7	1.5-1.7	Silty clay	98	610	Non-Aggressive	Non-Aggressive
BH7	2.5-2.7	Gravelly silty clay	180	760	Non-Aggressive	Non-Aggressive
BH8	0.5-0.95	Silty clay	140	200	Non-Aggressive	Non-Aggressive
BH8	1.5-1.7	Silty clay	140	310	Non-Aggressive	Non-Aggressive
BH8	2.5-2.7	Gravelly silty clay	140	1000	Non-Aggressive	Non-Aggressive
Total Number of Samples			24	24	-	-
Minimum Value			5	5	-	-
Maximum Value			330	1400	-	-

Explanation

1 - Classification 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] recommends using a Moderate Exposure Classification for Steel Piles in Fresh Water - Soft Running Water
2 - Classification is based on Soil condition 'B' - low permeability soils (e.g. silts & clays) or all soils above groundwater.

Sulphate (SO4) Values	Classification for Concrete Piles	Chloride (Cl) Values	Classification for Steel Piles
<5,000	Non-Aggressive	<5,000	Non-Aggressive
5,000 - 10,000	Mildly Aggressive	5,000 - 20,000	Non-Aggressive
10,000 - 20,000	Moderately Aggressive	20,000 - 50,000	Mildly Aggressive
>20,000	Severely Aggressive	>50,000	Moderately Aggressive

Abbreviations

NA -Not Applicable

TABLE F
SUMMARY OF SOIL LABORATORY RESULTS - CEC & ESP

Borehole Number	Sample Depth (m)	Sample Description	Total CEC	Ca	K	Mg	Na	ESP[1]
			(meq/100g)					%
BH1	1.8-2.0	Silty clay	9.1	1.8	0.2	6.6	0.53	5.8
BH1	2.8-3.0	Silty clay	7.4	0.8	0.2	4.9	1.4	18.9
BH2	0.5-0.95	Silty clay	18	7.4	0.1	9.9	0.55	3.1
BH2	4-4.2	Silty clay	9.8	2.7	0.2	4.9	2	20.4
BH3	0.5-0.95	Silty clay	25	5.8	0.1	16	2.7	10.8
BH3	4-4.2	Silty clay	8.2	1.3	0.2	4.4	2.3	28.0
BH4	0.5-0.95	Silty clay	12	1.1	0.1	9.8	1.3	10.8
BH4	1.5-1.95	Silty clay	6.9	0.05	0.1	4.5	2.2	31.9
BH5	1.5-1.7	Silty clay	7.7	0.6	0.1	4.8	2.2	28.6
BH5	4-4.2	Gravelly silty clay	7.4	0.8	0.2	4.5	1.9	25.7
BH6	0.5-0.95	Silty clay	9.6	0.5	<0.1	7	2.1	21.9
BH6	2.5-2.7	Gravelly silty clay	11	1.1	0.2	7	2.8	25.5
BH7	0.5-0.95	Silty clay	13	1.4	0.1	9.3	1.9	14.6
BH7	2.5-2.7	Gravelly silty clay	7.4	0.7	0.1	4.3	2.3	31.1
BH8	1.5-1.7	Silty clay	13	0.9	0.2	7.9	3.7	28.5
BH8	2.5-2.7	Gravelly silty clay	7.6	0.7	0.1	4.8	1.9	25.0
Total Number of Samples			16	16	15	16	16	16
Minimum Value			6.90	0.05	0.10	4.30	0.53	3.06
Maximum Value			25.00	7.40	0.20	16.00	3.70	31.88

Explanation

1 - Sodicity rating has been adopted from the publication *'Site Investigations for Urban Salinity' DLWC* 2002.

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

Abbreviation

CEC: Cation Exchange Capacity
ESP: Exchangeable Sodium Percentage (Each Na/CEC)
Mg: Exchangeable Magnesium
Na: Exchangeable Sodium
K: Exchangeable Potassium
Ca: Exchangeable Calcium

TABLE G
SUMMARY OF GROUNDWATER LABORATORY RESULTS

Sample Reference	Field Measurements[1]						Laboratory Results				Classification for Concrete Piles[2] Soil Condition B[3]	Classification for Steel Piles[2] Soil Condition B[3]
	SWL (m)	pH	EC (µS/cm)	Temp (°C)	Eh (mV)	DO (mg/L)	pH	EC (µS/cm)	SO4 (mg/L)	Cl (mg/L)		
MW2	1.79	7.56	3864	17.9	106.9	4	7.4	4300	240	870	Non-Aggressive	Non-Aggressive
MW4	2.77	7.99	3997	18.7	131.5	3.6	7.4	4300	180	660	Non-Aggressive	Non-Aggressive
MW6	1.68	7.54	20664	16.5	132.1	4.3	7.5	22000	400	8000	Mildly Aggressive	Non-Aggressive
Total Number of Samples	3	3	3	3	3	3	3	3	3	3	-	-
Minimum Value	1.68	7.54	3864	16.5	106.9	3.6	7.4	4300	180	660	-	-
Maximum Value	2.77	7.99	20664	18.7	132.1	4.3	7.5	22000	400	8000	-	-

Explanation
1 - Field Measurements were obtained on 13 August 2014

Exposure Classification for Concrete Piles
2 - Classification derived from the Australian Standard 2159-2009 Piling Design and Installation (Tables 6.4.2 [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'
3 - Classification is based on Soil condition 'B' - low permeability soils (e.g. silts and clays) or all soils above groundwater.

pH	Sulphate (mg/L)	Chloride (mg/L)	Classification
> 5.5	<1,000	<6,000	Non-Aggressive
4.5 - 5.5	1,000 - 3,000	6,000 - 12,000	Mildly Aggressive
4.0 - 4.5	3,000 - 10,000	12,000 - 30,000	Moderately Aggressive
< 4	>10,000	>30,000	Severely Aggressive

Exposure Classification for Steel Piles
2 - Classification derived from the Australian Standard 2159-2009 Piling Design and Installation (Tables 6.5.2 [A] & [C])
Table 6.5.2 [A] recommends using a Moderate Exposure Classification for Steel Piles in Fresh Water - Soft Running Water
3 - Classification is based on Soil condition 'B' - low permeability soils (e.g. silts and clays) or all soils above groundwater.

pH	Chloride (mg/L)	Classification
> 5	<1,000	Non-Aggressive
4.0 - 5.0	1,000 - 10,000	Non-Aggressive
3.0 - 4.0	10,000 - 20,000	Mildly Aggressive
<3	>20,000	Moderately Aggressive

Abbreviation
SWL - Standing Water Level
EC - Electrical Conductivity
Eh - Redox Potential
SO4 - Sulphate
Cl - Chloride
DO - Dissolved Oxygen

APPENDIX A

Borehole Logs and Explanatory Notes

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. **1** **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: KMT CONSTRUCTIONS

Project: PROPOSED RESIDENTIAL DEVELOPMENT

Location: 5 RYNAN AVENUE, EDMONDSON PARK, NSW

Job No. E27532KH **Method:** SPIRAL AUGER JK308 **R.L. Surface:** N/A

Date: 6-8-14 **Datum:**

Logged/Checked by: G.F./T.H.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	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			FILL: Silty gravel, fine to coarse grained igneous, grey and brown, trace of fine to coarse grained sandstone gravel occasional cobble sized.	D MC≈PL			
					N = 18 4,8,10	1		CL-CH	FILL: Silty clay, medium plasticity, brown, light brown and grey, trace of fibre cement fragments, ash and fine to medium grained ironstone and igneous gravel.	MC>PL			
						2			SILTY CLAY: medium to high plasticity, dark orange brown mottled light brown.				
						3		CL	SILTY CLAY: medium plasticity, light brown and light grey, with fine to medium grained ironstone gravel.				
						4			END OF BOREHOLE AT 3.0m				
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. **2** **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: KMT CONSTRUCTIONS

Project: PROPOSED RESIDENTIAL DEVELOPMENT

Location: 5 RYNAN AVENUE, EDMONDSON PARK, NSW

Job No. E27532KH **Method:** SPIRAL AUGER JK308 **R.L. Surface:** N/A

Date: 6-8-14 **Datum:**

Logged/Checked by: G.F./T.H.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty clay, low to medium plasticity, brown and light brown, trace of root fibres and fine to medium grained ironstone, igneous and shale gravel.	MC<PL			GRASS COVER
					N = 18 4,8,10			CH	SILTY CLAY: high plasticity, light brown, trace of root fibres.	MC>PL			
						1							
								CL	SILTY CLAY: low plasticity, light brown and orange brown, trace of fine grained sand.				
▼ 13-8-14					N = 8 3,4,4								
▼ AFTER 4 HRS						2							
					N = 31 4,14,17				GRAVELLY SILTY CLAY: low to medium plasticity, light brown, fine to medium grained ironstone gravel.	MC>PL			
						3							
									SILTY CLAY: medium plasticity, light brown, fine to medium grained ironstone gravel.				MONITORING WELL INSTALLED TO 5.7m, CLASS 18 50mm DIA. MACHINE SLOTTED PVC FROM 5.7m TO 2.7m, CASING FROM 2.7m TO SURFACE, 2mm SAND FILTER PACK FROM 5.7m TO 1.0m, BENTONITE SEAL FROM 1.0 TO 0.3m, BACKFILLED WITH SAND (AND/OR CUTTINGS) TO SURFACE AND COMPLETED AS A STANDPIPE
						4							
						5		-	SHALE: grey.	DW	VL-L		
						6			END OF BOREHOLE AT 5.7m				
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. **3** **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: KMT CONSTRUCTIONS

Project: PROPOSED RESIDENTIAL DEVELOPMENT

Location: 5 RYNAN AVENUE, EDMONDSON PARK, NSW

Job No. E27532KH **Method:** SPIRAL AUGER JK308 **R.L. Surface:** N/A

Date: 6-8-14 **Datum:**

Logged/Checked by: G.F./T.H.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	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		CL	SILTY CLAY: low plasticity, brown, trace of root fibres and fine to medium grained ironstone gravel.	MC<PL			GRASS COVER
								CH	SILTY CLAY: high plasticity, light brown, trace of root fibres.	MC>PL			POSSIBLY FILL
					N = 17 5,8,9	1		CL	SILTY CLAY: low to medium plasticity, light grey, light brown and orange brown, trace of fine to medium grained ironstone gravel and fine grained sand.				
						2			GRAVELLY SILTY CLAY: low to medium plasticity, brown, fine to medium grained ironstone gravel.				
						3			SILTY CLAY: medium plasticity, light grey and orange brown, trace of fine to medium grained ironstone gravel.				
						4			END OF BOREHOLE AT 4.2m				
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. **4** **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: KMT CONSTRUCTIONS

Project: PROPOSED RESIDENTIAL DEVELOPMENT

Location: 5 RYNAN AVENUE, EDMONDSON PARK, NSW

Job No. E27532KH **Method:** SPIRAL AUGER JK308 **R.L. Surface:** N/A

Date: 6-8-14 **Datum:**

Logged/Checked by: G.F./T.H.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0		CL	SILTY CLAY: low plasticity, brown, trace of root fibres and fine to medium grained ironstone gravel.	MC<PL			GRASS COVER POSSIBLY FILL
					N = 26 5,11,15			CH	SILTY CLAY: high plasticity, light brown and red brown, trace of root fibres and fine to medium grained ironstone gravel.	MC>PL			
						1		CL	SILTY CLAY: low to medium plasticity, light grey, light brown and red brown, trace of fine grained sand.				
					N = 19 6,9,10								
						2			SILTY CLAY: medium plasticity, light grey and orange brown, trace of fine to medium grained ironstone gravel.				
▼ 13-8-14					SPT 5/0mm REFUSAL			-	SHALE: light grey.	XW-DW	EL-VL		
						3							
									SHALE: dark grey.				MONITORING WELL INSTALLED TO 5.7m, CLASS 18 50mm DIA. MACHINE SLOTTED PVC FROM 5.7m TO 2.7m, CASING FROM 2.7m TO SURFACE, 2mm SAND FILTER PACK FROM 5.7m TO 1.0m, BENTONITE SEAL FROM 1.0 TO 0.3m, BACKFILLED WITH SAND (AND/OR CUTTINGS) TO SURFACE AND COMPLETED AS A STANDPIPE
						4							
AFTER 2 HRS ▼						5			SHALE: grey.	DW	VL-L		
						6			END OF BOREHOLE AT 5.7m				
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. **5** **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: KMT CONSTRUCTIONS

Project: PROPOSED RESIDENTIAL DEVELOPMENT

Location: 5 RYNAN AVENUE, EDMONDSON PARK, NSW

Job No. E27532KH **Method:** SPIRAL AUGER JK308 **R.L. Surface:** N/A

Date: 6-8-14 **Datum:**

Logged/Checked by: G.F./T.H.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty clay, medium plasticity, brown, trace of fine to medium grained igneous, sandstone and ironstone gravel, concrete fragments and root fibres.	MC<PL			
								CL-CH		MC>PL			
					N = 11 3,5,6				SILTY CLAY: medium to high plasticity, brown and light brown, trace of root fibres.				
						1		CL	SILTY CLAY: medium plasticity, light brown, trace of fine grained sand.				
▼ ON COMPLET-ION						2			GRAVELLY SILTY CLAY: low to medium plasticity, brown, fine to medium grained ironstone gravel.				
						3							
						4			END OF BOREHOLE AT 4.2m				
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. **6** **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: KMT CONSTRUCTIONS

Project: PROPOSED RESIDENTIAL DEVELOPMENT

Location: 5 RYNAN AVENUE, EDMONDSON PARK, NSW

Job No. E27532KH **Method:** SPIRAL AUGER JK308 **R.L. Surface:** N/A

Date: 6-8-14 **Datum:**

Logged/Checked by: G.F./T.H.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty clay, low plasticity, brown, trace of root fibres and fine to medium grained ironstone gravel.	MC<PL			GRASS COVER
								CL-CH	SILTY CLAY: medium to high plasticity, light brown and brown.	MC>PL			(POSSIBLY NATURAL)
					N = 12 4,6,6	1							
▼ 13-8-14						2		CL	GRAVELLY SILTY CLAY: medium plasticity, brown and orange brown, fine to medium grained ironstone gravel.				
						3			SILTY CLAY: medium plasticity, light grey mottled orange brown.				MONITORING WELL INSTALLED TO 5.7m, CLASS 18 50mm DIA. MACHINE SLOTTED PVC FROM 5.7m TO 2. 7m, CASING FROM 2.7m TO SURFACE, 2mm SAND FILTER PACK FROM 5.7m TO 1.0m, BENTONITE SEAL FROM 1.0 TO 0.3m, BACKFILLED WITH SAND (AND/OR CUTTINGS) TO SURFACE AND COMPLETED AS A STANDPIPE
						4							
						5		-	SHALE: grey.	DW	L		
						6			END OF BOREHOLE AT 5.7m				
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. **7** **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: KMT CONSTRUCTIONS

Project: PROPOSED RESIDENTIAL DEVELOPMENT

Location: 5 RYNAN AVENUE, EDMONDSON PARK, NSW

Job No. E27532KH **Method:** SPIRAL AUGER JK308 **R.L. Surface:** N/A

Date: 6-8-14 **Datum:**

Logged/Checked by: G.F./T.H.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
				■		0			FILL: Silty clay, low plasticity, brown, trace of root fibres and fine to medium grained ironstone gravel.	MC<PL			GRASS COVER
								CH		MC>PL			POSSIBLY NATURAL
				■	N = 12 4,5,7				SILTY CLAY: high plasticity, light brown and brown, trace of root fibres.				
						1							
								CL	as above, but low to medium plasticity.				
▼ ON COMPLET-ION				■		2			GRAVELLY SILTY CLAY: medium plasticity, brown, fine to medium grained ironstone gravel.				
									END OF BOREHOLE AT 2.7m				
						3							
						4							
						5							
						6							
						7							

ENVIRONMENTAL INVESTIGATION SERVICES

CONSULTING ENVIRONMENTAL ENGINEERS

ENVIRONMENTAL LOG

Borehole No. **8** **1/1**

Environmental logs are not to be used for geotechnical purposes

Client: KMT CONSTRUCTIONS

Project: PROPOSED RESIDENTIAL DEVELOPMENT

Location: 5 RYNAN AVENUE, EDMONDSON PARK, NSW

Job No. E27532KH **Method:** SPIRAL AUGER JK308 **R.L. Surface:** N/A

Date: 6-8-14 **Datum:**

Logged/Checked by: G.F./T.H.

Groundwater Record	SAMPLES ES	SAMPLES ASS	SAMPLES ASB	SAMPLES SAL	Field Tests	Depth (m)	Graphic Log	Unified Classification	DESCRIPTION	Moisture Condition/ Weathering	Strength/ Rel. Density	Hand Penetrometer Readings (kPa.)	Remarks
						0			FILL: Silty clay, low plasticity, light brown, trace of root fibres and fine to medium grained ironstone gravel.	MC<PL			GRASS COVER POSSIBLY NATURAL
								CL-CH		MC>PL			
				■	N = 14 5,7,7	1			SILTY CLAY: medium to high plasticity, light brown, trace of fine grained sand, root fibres and fine to medium grained ironstone gravel.				
								CL	SILTY CLAY: medium plasticity, light grey and orange brown, trace of fine to medium grained ironstone gravel.				
▼ ON COMPLETION				■		2			GRAVELLY SILTY CLAY: medium plasticity, brown, fine to medium grained ironstone gravel.				
						3			END OF BOREHOLE AT 2.7m				
						4							
						5							
						6							
						7							

EXPLANATORY NOTES – ENVIRONMENTAL LOGS

INTRODUCTION

These notes have been provided to supplement the environmental report with regards to drilling and field logging. 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 manmade processes and therefore exhibits a variety of characteristics and properties which vary from place to place and can change with time. Environmental studies involve gathering and assimilating limited facts about these characteristics and properties in order to understand the ground on a particular site under certain conditions. These conditions 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, the SAA Site Investigation Code. 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 geotechnical practice.

Soil types are described according to the predominating particle size and behaviour as set out in the attached Unified Soil Classification Table qualified by the grading of other particles present (e.g. sandy clay) as set out below (note that unless stated in the report, the soil classification is based on a qualitative field assessment, not laboratory testing):

Soil Classification	Particle Size
Clay	less than 0.002mm
Silt	0.002 to 0.075mm
Sand	0.075 to 2mm
Gravel	2 to 60mm

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	less than 4
Loose	4 – 10
Medium dense	10 – 30
Dense	30 – 50
Very Dense	greater than 50

Cohesive soils are classified on the basis of strength (consistency) either by use of hand penetrometer, laboratory testing or engineering examination. The strength terms are defined as shown in the following table:

Classification	Unconfined Compressive Strength kPa
Very Soft	less than 25
Soft	25 – 50
Firm	50 – 100
Stiff	100 – 200
Very Stiff	200 – 400
Hard	Greater than 400
Friable	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 thinly bedded to laminated siltstone.

DRILLING OR EXCAVATION METHODS

The following is a brief summary of drilling and excavation methods currently adopted by the Company, and some comments on their use and application. All except test pits and hand auger drilling require the use of a mechanical drilling rig.

Test Pits: These are normally excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils if it is safe to descend into the pit. The depth of penetration is limited to approximately 3m for a backhoe and up to 6m for an excavator. Limitations of test pits include problems associated with disturbance and difficulty of reinstatement; and the consequent effects on nearby structures. Care must be taken if construction is to be carried out near test pit locations to either properly re-compact 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. Premature refusal of the hand augers can occur on a variety of materials such as fill, hard clay, gravel or ironstone, 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 in-situ 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 relatively lower 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 fragments. 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 determined 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 such as Revert or Biogel. The mud tends to mask the cuttings and reliable identification is only possible from intermittent intact sampling (e.g. 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, an NMLC triple tube core barrel, which gives a core of about 50mm diameter, 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 CORE LOSS. The locations of losses are determined on site by the supervising engineer; where the location is uncertain, the loss is placed at the top end 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, "Methods of Testing Soils for Engineering Purposes" – Test F3.1.

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 63kg 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. Occasionally, the drop hammer is used to drive 50mm diameter thin walled sample tubes (U50) in clays. In such circumstances, the test results are shown on the borehole logs in brackets.

A modification to the SPT test 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 "Nc" 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 attached explanatory notes define the terms and symbols used in preparation of the logs.

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; and
- 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 water observations are to be made.

More reliable measurements can be made by installing standpipes which are read after stabilising 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 (e.g. bricks, concrete, plastic, slag/ash, 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 determine the extent of the fill.

The presence of fill materials is usually regarded with caution as the possible variation in density, strength and material type is much greater than with natural soil deposits. If the volume and quality 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 classifications and rocks strengths indicated on the environmental logs unless noted in the report.

SITE ANOMALIES

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, EIS should be notified immediately.

GRAPHIC LOG SYMBOLS FOR SOIL AND ROCKS

SOIL


FILL


TOPSOIL


CLAY (CL, CH)


SILT (ML, MH)


SAND (SP, SW)


GRAVEL (GP, GW)


SANDY CLAY (CL, CH)


SILTY CLAY (CL, CH)


CLAYEY SAND (SC)


SILTY SAND (SM)


GRAVELLY CLAY (CL, CH)


CLAYEY GRAVEL (GC)


SANDY SILT (ML)


PEAT AND ORGANIC SOILS

ROCK


CONGLOMERATE


SANDSTONE


SHALE


SILTSTONE, MUDSTONE, CLAYSTONE


LIMESTONE


PHYLLITE, SCHIST


TUFF


GRANITE, GABBRO


DOLERITE, DIORITE


BASALT, ANDESITE


QUARTZITE

DEFECTS AND INCLUSIONS


CLAY SEAM


SHEARED OR CRUSHED SEAM


BRECCIATED OR SHATTERED SEAM/ZONE


IRONSTONE GRAVEL


ORGANIC MATERIAL

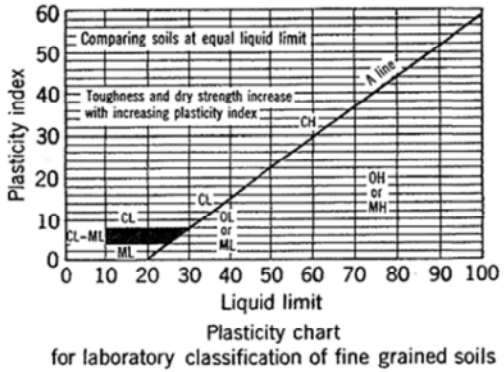
OTHER MATERIALS


CONCRETE


BITUMINOUS CONCRETE, COAL


COLLUVIUM

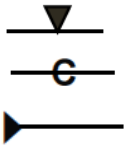
Field Identification Procedures (Excluding particles larger than 75 μm and basing fractions on estimated weights)						Group Symbols [a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Coarse-grained soils More than half of material is *larger* than 75 μm sieve size[b] (The 75 μm sieve size is about the smallest particle visible to naked eye)	Gravels More than half of coarse fraction is larger than 4 mm sieve size	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes			*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles 12 mm maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (*SM*)	Use grain size curve in identifying the fractions as given under field identification Determine percentages of gravel and sand from grain size curve Depending on percentage of fines (fraction smaller than 75 μm sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP* More than 12% *GM, GC, SM, SC* 5% to 12% *Borderline* cases requiring use of dual symbols $C_U = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for *GW* Atterberg limits below "A" line, or *PI* less than 4 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols Atterberg limits above "A" line, with *PI* greater than 7
			Predominantly one size or a range of sizes with some intermediate sizes missing			*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines		
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)			*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures		
			Plastic fines (for identification procedures, see *CL* below)			*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		
	Sands More than half of coarse fraction is smaller than 4 mm sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes			*SW*	Well graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for *SW* Atterberg limits below "A" line or *PI* less than 5 — Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols Atterberg limits below "A" line with *PI* greater than 7
			Predominantly one size or a range of sizes with some intermediate sizes missing			*SP*	Poorly graded sands, gravelly sands, little or no fines		
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)			*SM*	Silty sands, poorly graded sand-silt mixtures		
			Plastic fines (for identification procedures, see *CL* below)			*SC*	Clayey sands, poorly graded sand-clay mixtures		
Fine-grained soils More than half of material is *smaller* than 75 μm sieve size	Identification Procedures on Fraction Smaller than 380 μm Sieve Size		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)				
	Silts and clays liquid limit less than 50		None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (*ML*)	
			Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
			Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity		
	Silts and clays liquid limit greater than 50		Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
			High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays		
			Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity		
Highly Organic Soils			Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils		



Plasticity chart
for laboratory classification of fine grained soils

Note: 1 Soils possessing characteristics of two groups are designated by combinations of group symbols (eg. GW-GC, well graded gravel-sand mixture with clay fines).
2 Soils with liquid limits of the order of 35 to 50 may be visually classified as being of medium plasticity.

LOG SYMBOLS

LOG COLUMN	SYMBOL	DEFINITION
Groundwater Record		Standing water level. Time delay following completion of drilling may be shown. Extent of borehole collapse shortly after drilling. Groundwater seepage into borehole or excavation noted during drilling or excavation.
Samples	ES U50 DB DS ASB ASS SAL	Soil sample taken over depth indicated, for environmental analysis. Undisturbed 50mm diameter tube sample taken over depth indicated. Bulk disturbed sample taken over depth indicated. Small disturbed bag sample taken over depth indicated. Soil sample taken over depth indicated, for asbestos screening. Soil sample taken over depth indicated, for acid sulfate soil analysis. Soil sample taken over depth indicated, for salinity analysis.
Field Tests	N = 17 4, 7, 10	Standard Penetration Test (SPT) performed between depths indicated by lines. Individual show blows per 150mm penetration. 'R' as noted below.
	N_c = 5 7 3 R	Solid Cone Penetration Test (SCPT) performed between depths indicated by lines. Individual figures show blows per 150mm penetration for 60 degree solid cone driven by SPT hammer. 'R' refers to apparent hammer refusal within the corresponding 150mm depth increment.
	VNS = 25 PID = 100	Vane shear reading in kPa of Undrained Shear Strength. Photoionisation detector reading in ppm (Soil sample heads pace test).
Moisture (Cohesive Soils) (Cohesionless)	MC > PL MC ≈ PL MC < PL D M W	Moisture content estimated to be greater than plastic limit. Moisture content estimated to be approximately equal to plastic limit. Moisture content estimated to be less than plastic limit. DRY – Runs freely through fingers. MOIST – Does not run freely but no free water visible on soil surface. WET – Free water visible on soil surface.
Strength (Consistency) Cohesive Soils	VS S F St VSt H ( )	VERY SOFT – Unconfined compressive strength less than 25kPa SOFT – Unconfined compressive strength 25-5 0kPa FIRM – Unconfined compressive strength 50-1 00kPa STIFF – Unconfined compressive strength 100- 200kPa VERY STIFF – Unconfined compressive strength 200- 400kPa HARD – Unconfined compressive strength greater than 400kPa Bracketed symbol indicates estimated consistency based o n tactile examination or other tests.
Density Index/ Relative Density (Cohesionless Soils)	VL L MD D VD ( )	**Density Index (ID) Range (%)** / **SPT ' N' Value Range (Blows/300mm)** Very Loose <15 / 0-4 Loose 15-35 / 4-10 Medium Dense 35-65 / 10-30 Dense 65-85 / 30-50 Very Dense >85 / >50 Bracketed symbol indicates estimated density based on ease of drilling or other tests.
Hand Penetrometer Readings	300 250	Numbers indicate individual test results in kPa on representative undisturbed material unless noted otherwise
Remarks	'V' bit 'TC' bit T_{60}	Hardened steel 'V' shaped bit. Tungsten carbide wing bit. Penetration of auger string in mm under static load of rig applied by drill head hydraulics without rotation of augers.

LOG SYMBOLS CONTINUED

ROCK STRENGTH

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance in the bedding. The test procedure is described by the International Journal of Rock Mechanics, Mining and Geomechanics Abstract Volume 22, No 2, 1985.

TERM	SYMBOL	Is (50) MPa	FIELD GUIDE
Extremely Low:	EL	0.03	Easily remoulded by hand to a material with soil properties.
Very Low:	VL	0.1	May be crumbled in the hand. Sandstone is "sugary" and friable.
Low:	L	0.3	A piece of core 150 mm long x 50mm dia. may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
Medium Strength:	M	1	A piece of core 150 mm long x 50mm dia. can be broken by hand with difficulty. Readily scored with knife.
High:	H	3	A piece of core 150 mm long x 50mm dia. core cannot be broken by hand, can be slightly scratched or scored with knife; rock rings under hammer.
Very High:	VH	10	A piece of core 150 mm long x 50mm dia. may be broken with hand-held pick after more than one blow. Cannot be scratched with pen knife; rock rings under hammer.
Extremely High:	EH		A piece of core 150 mm long x 50mm dia. is very difficult to break with h and-held hammer . Rings when struck with a hammer.

ROCK STRENGTH

ABBREVIATION	DESCRIPTION	NOTES
Be	Bedding Plane Parting	Defect orientations measured relative to the normal to (i.e. relative to horizontal for vertical holes)
CS	Clay Seam	
J	Joint	
P	Planar	
Un	Undulating	
S	Smooth	
R	Rough	
IS	Iron stained	
XWS	Extremely Weathered Seam	
Cr	Crushed Seam	
60t	Thickness of defect in millimetres	

APPENDIX B

Laboratory Reports and Chain of Custody Documents

Envirolab Services Pty Ltd
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CERTIFICATE OF ANALYSIS 114272

Client:

Environmental Investigation Services
PO Box 976
North Ryde BC
NSW 1670

Attention: Todd Hore

Sample log in details:

Your Reference:	**2640E27532KH, Edmondson Park**		
No. of samples:	42 soils		
Date samples received / completed instructions received	07/08/14	/	07/08/14

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: / Issue Date:	14/08/14	/	15/08/14
Date of Preliminary Report:	Not Issued		

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

Results Approved By:

Jacinta Hurst
Laboratory Manager

Miscellaneous Inorg - soil						
Our Reference:	UNITS	114272-2	114272-4	114272-5	114272-7	114272-8
Your Reference	----------	BH1	BH1	BH1	BH2	BH2
Depth	----------	0.7-0.95	1.8-2.0	2.8-3.0	0.5-0.95	1.5-1.95
Date Sampled		06/08/2014	06/08/2014	06/08/2014	06/08/2014	06/08/2014
Type of sample		soil	soil	soil	soil	soil
Date prepared	-	13/08/2014	13/08/2014	13/08/2014	13/08/2014	13/08/2014
Date analysed	-	13/08/2014	13/08/2014	13/08/2014	13/08/2014	13/08/2014
pH 30:100 soil:water	pH Units	8.4	8.3	8.2	4.6	7.8
Sulphate, SO4 1:5 soil:water	mg/kg	120	330	180	150	95
Chloride, Cl 1:5 soil:water	mg/kg	65	350	290	100	140

Miscellaneous Inorg - soil						
Our Reference:	UNITS	114272-10	114272-12	114272-13	114272-16	114272-18
Your Reference	----------	BH2	BH3	BH3	BH3	BH4
Depth	----------	4-4.2	0-0.2	0.5-0.95	4-4.2	0.5-0.95
Date Sampled		06/08/2014	06/08/2014	06/08/2014	06/08/2014	06/08/2014
Type of sample		soil	soil	soil	soil	soil
Date prepared	-	13/08/2014	13/08/2014	13/08/2014	13/08/2014	13/08/2014
Date analysed	-	13/08/2014	13/08/2014	13/08/2014	13/08/2014	13/08/2014
pH 30:100 soil:water	pH Units	8.7	6.2	7.0	9.1	6.9
Sulphate, SO4 1:5 soil:water	mg/kg	74	22	230	66	110
Chloride, Cl 1:5 soil:water	mg/kg	79	38	240	160	88

Miscellaneous Inorg - soil						
Our Reference:	UNITS	114272-19	114272-22	114272-24	114272-26	114272-28
Your Reference	----------	BH4	BH4	BH5	BH5	BH5
Depth	----------	1.5-1.95	4-4.2	0-0.2	1.5-1.7	4-4.2
Date Sampled		06/08/2014	06/08/2014	06/08/2014	06/08/2014	06/08/2014
Type of sample		soil	soil	soil	soil	soil
Date prepared	-	13/08/2014	13/08/2014	13/08/2014	13/08/2014	13/08/2014
Date analysed	-	13/08/2014	13/08/2014	13/08/2014	13/08/2014	13/08/2014
pH 30:100 soil:water	pH Units	7.4	8.3	7.5	8.6	8.4
Sulphate, SO4 1:5 soil:water	mg/kg	300	51	120	130	220
Chloride, Cl 1:5 soil:water	mg/kg	800	32	480	1,100	850

Miscellaneous Inorg - soil						
Our Reference:	UNITS	114272-30	114272-32	114272-33	114272-36	114272-37
Your Reference	----------	BH6	BH6	BH6	BH7	BH7
Depth	----------	0.5-0.95	2.5-2.7	4-4.2	0.5-0.95	1.5-1.7
Date Sampled		06/08/2014	06/08/2014	06/08/2014	06/08/2014	06/08/2014
Type of sample		soil	soil	soil	soil	soil
Date prepared	-	13/08/2014	13/08/2014	13/08/2014	13/08/2014	13/08/2014
Date analysed	-	13/08/2014	13/08/2014	13/08/2014	13/08/2014	13/08/2014
pH 30:100 soil:water	pH Units	7.5	8.4	8.3	5.4	8.0
Sulphate, SO4 1:5 soil:water	mg/kg	160	160	<10	250	98
Chloride, Cl 1:5 soil:water	mg/kg	760	1,400	<10	930	610

Miscellaneous Inorg - soil					
Our Reference:	UNITS	114272-38	114272-40	114272-41	114272-42
Your Reference	----------	BH7	BH8	BH8	BH8
Depth	----------	2.5-2.7	0.5-0.95	1.5-1.7	2.5-2.7
Date Sampled		06/08/2014	06/08/2014	06/08/2014	06/08/2014
Type of sample		soil	soil	soil	soil
Date prepared	-	13/08/2014	13/08/2014	13/08/2014	13/08/2014
Date analysed	-	13/08/2014	13/08/2014	13/08/2014	13/08/2014
pH 30:100 soil:water	pH Units	8.2	7.0	8.3	8.4
Sulphate, SO4 1:5 soil:water	mg/kg	180	140	140	140
Chloride, Cl 1:5 soil:water	mg/kg	760	200	310	1,000

Texture and Salinity						
Our Reference:	UNITS	114272-2	114272-4	114272-5	114272-7	114272-8
Your Reference	----------	BH1	BH1	BH1	BH2	BH2
Depth	----------	0.7-0.95	1.8-2.0	2.8-3.0	0.5-0.95	1.5-1.95
Date Sampled		06/08/2014	06/08/2014	06/08/2014	06/08/2014	06/08/2014
Type of sample		soil	soil	soil	soil	soil
Electrical Conductivity 1:5 soil:water	µS/cm	310	570	500	<1	240
Texture Value		6.0	8.5	8.5	7.0	8.5
TEXTURE	-	Heavy Clay	Light Clay	Light Clay	Medium Clay	Light Clay
ECe	dS/m	2.0	5.0	4.0	0	2.0
Class	-	NON SALINE	MODERATELY SALINE	MODERATELY SALINE	NON SALINE	SLIGHTLY SALINE

Texture and Salinity						
Our Reference:	UNITS	114272-10	114272-12	114272-13	114272-16	114272-18
Your Reference	----------	BH2	BH3	BH3	BH3	BH4
Depth	----------	4-4.2	0-0.2	0.5-0.95	4-4.2	0.5-0.95
Date Sampled		06/08/2014	06/08/2014	06/08/2014	06/08/2014	06/08/2014
Type of sample		soil	soil	soil	soil	soil
Electrical Conductivity 1:5 soil:water	µS/cm	230	360	470	340	260
Texture Value		8.5	10	7.0	8.5	6.0
TEXTURE	-	Light Clay	Loam	Medium Clay	Light Clay	Heavy Clay
ECe	dS/m	2.0	4.0	3.0	3.0	2.0
Class	-	NON SALINE	SLIGHTLY SALINE	SLIGHTLY SALINE	SLIGHTLY SALINE	NON SALINE

Texture and Salinity						
Our Reference:	UNITS	114272-19	114272-22	114272-24	114272-26	114272-28
Your Reference	----------	BH4	BH4	BH5	BH5	BH5
Depth	----------	1.5-1.95	4-4.2	0-0.2	1.5-1.7	4-4.2
Date Sampled		06/08/2014	06/08/2014	06/08/2014	06/08/2014	06/08/2014
Type of sample		soil	soil	soil	soil	soil
Electrical Conductivity 1:5 soil:water	µS/cm	940	190	600	1,800	1,100
Texture Value		8.0	10	10	8.5	8.5
TEXTURE	-	Light Medium Clay	Loam	Loam	Light Clay	Light Clay
ECe	dS/m	7.0	2.0	6.0	15	9.0
Class	-	MODERATELY SALINE	NON SALINE	MODERATELY SALINE	VERY SALINE	VERY SALINE

Texture and Salinity						
Our Reference:	UNITS	114272-30	114272-32	114272-33	114272-36	114272-37
Your Reference	----------	BH6	BH6	BH6	BH7	BH7
Depth	----------	0.5-0.95	2.5-2.7	4-4.2	0.5-0.95	1.5-1.7
Date Sampled		06/08/2014	06/08/2014	06/08/2014	06/08/2014	06/08/2014
Type of sample		soil	soil	soil	soil	soil
Electrical Conductivity 1:5 soil:water	µS/cm	920	1,600	950	1,000	640
Texture Value		8.0	8.0	8.0	7.0	8.5
TEXTURE	-	Light Medium Clay	Light Medium Clay	Light Medium Clay	Medium Clay	Light Clay
ECe	dS/m	7.0	13	8.0	7.0	5.0
Class	-	MODERATELY SALINE	VERY SALINE	MODERATELY SALINE	MODERATELY SALINE	MODERATELY SALINE

Texture and Salinity					
Our Reference:	UNITS	114272-38	114272-40	114272-41	114272-42
Your Reference	----------	BH7	BH8	BH8	BH8
Depth	----------	2.5-2.7	0.5-0.95	1.5-1.7	2.5-2.7
Date Sampled		06/08/2014	06/08/2014	06/08/2014	06/08/2014
Type of sample		soil	soil	soil	soil
Electrical Conductivity 1:5 soil:water	µS/cm	860	400	750	1,200
Texture Value		8.5	8.5	8.0	8.5
TEXTURE	-	Light Clay	Light Clay	Light Medium Clay	Light Clay
ECe	dS/m	7.0	3.0	6.0	10
Class	-	MODERATELY SALINE	SLIGHTLY SALINE	MODERATELY SALINE	VERY SALINE

CEC						
Our Reference:	UNITS	114272-4	114272-5	114272-7	114272-10	114272-13
Your Reference	----------	BH1	BH1	BH2	BH2	BH3
Depth	----------	1.8-2.0	2.8-3.0	0.5-0.95	4-4.2	0.5-0.95
Date Sampled		06/08/2014	06/08/2014	06/08/2014	06/08/2014	06/08/2014
Type of sample		soil	soil	soil	soil	soil
Date Extracted	-	08/08/2014	08/08/2014	08/08/2014	08/08/2014	08/08/2014
Date analysed	-	08/08/2014	08/08/2014	08/08/2014	08/08/2014	08/08/2014
Exchangeable Ca	meq/100g	1.8	0.8	7.4	2.7	5.8
Exchangeable K	meq/100g	0.2	0.2	0.1	0.2	0.1
Exchangeable Mg	meq/100g	6.6	4.9	9.9	4.9	16
Exchangeable Na	meq/100g	0.53	1.4	0.55	2.0	2.7
Cation Exchange Capacity	meq/100g	9.1	7.4	18	9.8	25

CEC						
Our Reference:	UNITS	114272-16	114272-18	114272-19	114272-26	114272-28
Your Reference	----------	BH3	BH4	BH4	BH5	BH5
Depth	----------	4-4.2	0.5-0.95	1.5-1.95	1.5-1.7	4-4.2
Date Sampled		06/08/2014	06/08/2014	06/08/2014	06/08/2014	06/08/2014
Type of sample		soil	soil	soil	soil	soil
Date Extracted	-	08/08/2014	08/08/2014	08/08/2014	08/08/2014	08/08/2014
Date analysed	-	08/08/2014	08/08/2014	08/08/2014	08/08/2014	08/08/2014
Exchangeable Ca	meq/100g	1.3	1.1	<0.1	0.6	0.8
Exchangeable K	meq/100g	0.2	0.1	0.1	0.1	0.2
Exchangeable Mg	meq/100g	4.4	9.8	4.5	4.8	4.5
Exchangeable Na	meq/100g	2.3	1.3	2.2	2.2	1.9
Cation Exchange Capacity	meq/100g	8.2	12	6.9	7.7	7.4

CEC						
Our Reference:	UNITS	114272-30	114272-32	114272-36	114272-38	114272-41
Your Reference	----------	BH6	BH6	BH7	BH7	BH8
Depth	----------	0.5-0.95	2.5-2.7	0.5-0.95	2.5-2.7	1.5-1.7
Date Sampled		06/08/2014	06/08/2014	06/08/2014	06/08/2014	06/08/2014
Type of sample		soil	soil	soil	soil	soil
Date Extracted	-	08/08/2014	08/08/2014	08/08/2014	08/08/2014	08/08/2014
Date analysed	-	08/08/2014	08/08/2014	08/08/2014	08/08/2014	08/08/2014
Exchangeable Ca	meq/100g	0.5	1.1	1.4	0.7	0.9
Exchangeable K	meq/100g	<0.1	0.2	0.1	0.1	0.2
Exchangeable Mg	meq/100g	7.0	7.0	9.3	4.3	7.9
Exchangeable Na	meq/100g	2.1	2.8	1.9	2.3	3.7
Cation Exchange Capacity	meq/100g	9.6	11	13	7.4	13

CEC		
Our Reference:	UNITS	114272-42
Your Reference	----------	BH8
Depth	----------	2.5-2.7
Date Sampled		06/08/2014
Type of sample		soil
Date Extracted	-	08/08/2014
Date analysed	-	08/08/2014
Exchangeable Ca	meq/100g	0.7
Exchangeable K	meq/100g	0.1
Exchangeable Mg	meq/100g	4.8
Exchangeable Na	meq/100g	1.9
Cation Exchange Capacity	meq/100g	7.6

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA 22nd ED, 4500-H+. Please note that the results for water analyses are indicative only, as analysis outside of the APHA storage times.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 22nd ED, 4110 -B.
Inorg-002	Conductivity and Salinity - measured using a conductivity cell at 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons.
Metals-009	Determination of exchangeable cations and cation exchange capacity in soil based on Rayment and Lyons 2011.

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			08/08/2014	114272-2	13/08/2014 || 13/08/2014	LCS-1	08/08/2014
Date analysed	-			13/08/2014	114272-2	13/08/2014 || 13/08/2014	LCS-1	13/08/2014
pH 30:100 soil:water	pH Units		Inorg-001	[NT]	114272-2	8.4 || 8.6 || RPD: 2	LCS-1	100%
Sulphate, SO4 1:5 soil:water	mg/kg	10	Inorg-081	<10	114272-2	120 || 100 || RPD: 18	LCS-1	111%
Chloride, Cl 1:5 soil:water	mg/kg	10	Inorg-081	<10	114272-2	65 || 74 || RPD: 13	LCS-1	97%
QUALITY CONTROL Texture and Salinity	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Electrical Conductivity 1:5 soil:water	µS/cm	1	Inorg-002	<1	[NT]	[NT]	LCS-1	92%
Texture Value			Inorg-002	[NT]	[NT]	[NT]	[NR]	[NR]
Class	-			[NT]	[NT]	[NT]	[NR]	[NR]
QUALITY CONTROL CEC	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date analysed	-			13/08/2014	114272-26	08/08/2014 || 08/08/2014	LCS-1	08/08/2014
Exchangeable Ca	meq/100g	0.1	Metals-009	<0.1	114272-26	0.6 || 0.6 || RPD: 0	LCS-1	107%
Exchangeable K	meq/100g	0.1	Metals-009	<0.1	114272-26	0.1 || 0.1 || RPD: 0	LCS-1	107%
Exchangeable Mg	meq/100g	0.1	Metals-009	<0.1	114272-26	4.8 || 4.4 || RPD: 9	LCS-1	106%
Exchangeable Na	meq/100g	0.1	Metals-009	<0.1	114272-26	2.2 || 2.2 || RPD: 0	LCS-1	103%
Cation Exchange Capacity	meq/100g	1	Metals-009	<1.0	114272-26	7.7 || 7.4 || RPD: 4	[NR]	[NR]

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	114272-19	13/08/2014 || 13/08/2014	LCS-2	13/08/2014
Date analysed	-	114272-19	13/08/2014 || 13/08/2014	LCS-2	13/08/2014
pH 30:100 soil:water	pH Units	114272-19	7.4 || 7.3 || RPD: 1	LCS-2	101%
Sulphate, SO4 1:5 soil:water	mg/kg	114272-19	300 || 300 || RPD: 0	LCS-2	99%
Chloride, Cl 1:5 soil:water	mg/kg	114272-19	800 || 780 || RPD: 3	LCS-2	89%
QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	114272-40	13/08/2014 || 13/08/2014	114272-4	13/08/2014
Date analysed	-	114272-40	13/08/2014 || 13/08/2014	114272-4	13/08/2014
pH 30:100 soil:water	pH Units	114272-40	7.0 || 7.1 || RPD: 1	[NR]	[NR]
Sulphate, SO4 1:5 soil:water	mg/kg	114272-40	140 || 140 || RPD: 0	114272-4	#
Chloride, Cl 1:5 soil:water	mg/kg	114272-40	200 || 240 || RPD: 18	114272-4	#

QUALITY CONTROL Miscellaneous Inorg - soil	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	[NT]	[NT]	114272-41	13/08/2014
Date analysed	-	[NT]	[NT]	114272-41	13/08/2014
pH 30:100 soil:water	pH Units	[NT]	[NT]	[NR]	[NR]
Sulphate, SO4 1:5 soil:water	mg/kg	[NT]	[NT]	114272-41	78%
Chloride, Cl 1:5 soil:water	mg/kg	[NT]	[NT]	114272-41	#

Report Comments:

Misc Inorg #Matrix spike recovery was outside recommended acceptance criteria, however an acceptable recovery was achieved for the LCS.
This indicates a sample matrix interference.

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NA: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

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.

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: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC 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.

Envirolab Services Pty Ltd
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12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
enquiries@envirolabservices.com.au
www.envirolabservices.com.au

SAMPLE RECEIPT ADVICE

Client:

Environmental Investigation Services
PO Box 976
North Ryde BC NSW 1670

ph: 02 9888 5000
Fax: 02 9888 5001

Attention: Todd Hore

Sample log in details:

Your reference:	**2640E27532KH, Edmondson Park**
Envirolab Reference:	**114272**
Date received:	07/08/14
Date results expected to be reported:	**14/08/14**

Samples received in appropriate condition for analysis:	YES
No. of samples provided	42 soils
Turnaround time requested:	Standard
Temperature on receipt (°C)	15.9
Cooling Method:	Ice Pack
Sampling Date Provided:	YES

Comments:

If there is sufficient sample after testing, samples will be held for the following time frames from date of receipt of samples:
Water samples - 1 month
Soil and other solid samples - 2 months
Samples collected in canisters - 1 week. Canisters will then be cleaned.
All other samples are not retained after analysis
If you require samples to be retained for longer periods then retention fees will apply as per our pricelist.

Contact details:

Please direct any queries to Aileen Hie or Jacinta Hurst
ph: 02 9910 6200 fax: 02 9910 6201
email: ahie@envirolabservices.com.au or jhurst@envirolabservices.com.au

SAMPLE AND CHAIN OF CUSTODY FORM

TO:		FROM:
ENVIROLAB SSERVICES PTY LTD 12 ASHFIELD STREET CHATSWOOD NSW 2067 P: (02) 99106200 F: (02) 99106201 Attention: Aileen	EIS Job Number: E27532KH Date Results Required: STANDARD Page: 1 OF 2	ENVIRONMENTAL INVESTIGATION SERVICES REAR OF 115 WICKS ROAD MACQUARIE PARK, NSW 2113 P: 02-9888 5000 F: 02-9888 5001 Attention: Todd Hore

Location:	Edmondson Park	Sample Preserved in Esky on Ice
Sampler:	GF	Tests Required

Date Sampled	Lab Ref:	Sample Number	Depth (m)	Sample Container	Sample Description	pH	EC	ECe (texture)	Sulphate	Chloride	Resistivity	CEC					
6/08/2014	1	BH1	0.3-0.5	P	Soil												
6/08/2014	2	BH1	0.7-0.95	P	Soil	X	X	X	X	X							
6/08/2014	3	BH1	1.3-1.5	P	Soil												
6/08/2014	4	BH1	1.8-2.0	P	Soil	X	X	X	X	X		X					
6/08/2014	5	BH1	2.8-3.0	P	Soil	X	X	X	X	X		X					
6/08/2014	6	BH2	0-0.2	P	Soil												
6/08/2014	7	BH2	0.5-0.95	P	Soil	X	X	X	X	X		X					
6/08/2014	8	BH2	1.5-1.95	P	Soil	X	X	X	X	X							
6/08/2014	9	BH2	2.8-3.15	P	Soil												
6/08/2014	10	BH2	4-4.2	P	Soil	X	X	X	X	X		X					
6/08/2014	11	BH2	5.5-5.7	P	Soil												
6/08/2014	12	BH3	0-0.2	P	Soil	X	X	X	X	X							
6/08/2014	13	BH3	0.5-0.95	P	Soil	X	X	X	X	X		X					
6/08/2014	14	BH3	1.6-1.9	P	Soil												
6/08/2014	15	BH3	2.5-2.7	P	Soil												
6/08/2014	16	BH3	4-4.2	P	Soil	X	X	X	X	X		X					
6/08/2014	17	BH4	0-0.2	P	Soil												
6/08/2014	18	BH4	0.5-0.95	P	Soil	X	X	X	X	X		X					
6/08/2014	19	BH4	1.5-1.95	P	Soil	X	X	X	X	X		X					
6/08/2014	20	BH4	2.2-2.4	P	Soil												
6/08/2014	21	BH4	2.7-3.0	P	Soil												
6/08/2014	22	BH4	4-4.2	P	Soil	X	X	X	X	X							
6/08/2014	23	BH4	5.5-5.7	P	Soil												
6/08/2014	24	BH5	0-0.2	P	Soil	X	X	X	X	X							
6/08/2014	25	BH5	0.5-0.95	P	Soil												

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

Job No: 114272
Date Received: 7/8/14
Time Received: 9.00
Received by: LSB
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken

Remarks (comments/detection limits required):

Sample Containers:
G - 250mg Glass Jar
A - Ziplock Asbestos Bag
P - Plastic Bag

Relinquished By:	Date:	Time:	Received By:	Date:
	7/8/14	10am	LSB - ELS	7/8/14 9.00

SAMPLE AND CHAIN OF CUSTODY FORM

TO:		FROM:
ENVIROLAB SSERVICES PTY LTD	EIS Job Number: E27532KH	ENVIRONMENTAL INVESTIGATION SERVICES
12 ASHFIELD STREET		REAR OF 115 WICKS ROAD
CHATSWOOD NSW 2067	Date Results Required: STANDARD	MACQUARIE PARK, NSW 2113
P: (02) 99106200		P: 02-9888 5000 F: 02-9888 5001
F: (02) 99106201		Attention: Todd Hore
Attention: Aileen	Page: 2 OF 2	

Location:	Edmondson Park	Sample Preserved in Esky on Ice
Sampler:	GF	Tests Required

Date Sampled	Lab Ref:	Sample Number	Depth (m)	Sample Container	Sample Description	pH	EC	ECe (texture)	Sulphate	Chloride	Resistivity	CEC					
6/08/2014	26	BH5	1.5-1.7	P	Soil	X	X	X	X	X		X					
6/08/2014	27	BH5	2.5-2.7	P	Soil												
6/08/2014	28	BH5	4-4.2	P	Soil	X	X	X	X	X		X					
6/08/2014	29	BH6	0-0.2	P	Soil												
6/08/2014	30	BH6	0.5-0.95	P	Soil	X	X	X	X	X		X					
6/08/2014	31	BH6	1.5-1.7	P	Soil												
6/08/2014	32	BH6	2.5-2.7	P	Soil	X	X	X	X	X		X					
6/08/2014	33	BH6	4-4.2	P	Soil	X	X	X	X	X							
6/08/2014	34	BH6	5.5-5.7	P	Soil												
6/08/2014	35	BH7	0-0.2	P	Soil												
6/08/2014	36	BH7	0.5-0.95	P	Soil	X	X	X	X	X		X					
6/08/2014	37	BH7	1.5-1.7	P	Soil	X	X	X	X	X							
6/08/2014	38	BH7	2.5-2.7	P	Soil	X	X	X	X	X		X					
6/08/2014	39	BH8	0-0.2	P	Soil												
6/08/2014	40	BH8	0.5-0.95	P	Soil	X	X	X	X	X							
6/08/2014	41	BH8	1.5-1.7	P	Soil	X	X	X	X	X		X					
6/08/2014	42	BH8	2.5-2.7	P	Soil	X	X	X	X	X		X					
~~6/08/2014~~		~~BH1~~	~~0.2-0.5~~	P	~~Material~~												

Remarks (comments/detection limits required):	Sample Containers: G - 250mg Glass Jar A - Ziplock Asbestos Bag P - Plastic Bag

Relinquished By:	Date:	Time:	Received By:	Date:
	7/8/14	10am		

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

CERTIFICATE OF ANALYSIS 114557

Client:

Environmental Investigation Services
PO Box 976
North Ryde BC
NSW 1670

Attention: Todd Hore

Sample log in details:

Your Reference:	**E27532KH, Edmondson Park**		
No. of samples:	3 waters		
Date samples received / completed instructions received	13/08/14	/	13/08/14

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: / Issue Date:	20/08/14	/	19/08/14
Date of Preliminary Report:	Not Issued		

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025. **Tests not covered by NATA are denoted with *.**

Results Approved By:

Jacinta Hurst
Laboratory Manager

Miscellaneous Inorganics				
Our Reference:	UNITS	114557-1	114557-2	114557-3
Your Reference	----------	MW2	MW4	MW6
Date Sampled	----------	13/08/2014	13/08/2014	13/08/2014
Type of sample		Water	Water	Water
Date prepared	-	13/08/2014	13/08/2014	13/08/2014
Date analysed	-	13/08/2014	13/08/2014	13/08/2014
pH	pH Units	7.4	7.4	7.5
Electrical Conductivity	µS/cm	4,300	4,300	22,000
Chloride, Cl	mg/L	870	660	8,000
Sulphate, SO4	mg/L	240	180	400

Method ID	Methodology Summary
Inorg-001	pH - Measured using pH meter and electrode in accordance with APHA 22nd ED, 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 25oC in accordance with APHA 22nd ED 2510 and Rayment & Lyons.
Inorg-081	Anions - a range of Anions are determined by Ion Chromatography, in accordance with APHA 22nd ED, 4110 -B.

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			13/08/2014	[NT]	[NT]	LCS-1	13/08/2014
Date analysed	-			13/08/2014	[NT]	[NT]	LCS-1	13/08/2014
pH	pH Units		Inorg-001	[NT]	[NT]	[NT]	LCS-1	101%
Electrical Conductivity	µS/cm	1	Inorg-002	<1	[NT]	[NT]	LCS-1	99%
Chloride, Cl	mg/L	1	Inorg-081	<1	[NT]	[NT]	LCS-1	83%
Sulphate, SO4	mg/L	1	Inorg-081	<1	[NT]	[NT]	LCS-1	93%

Report Comments:

Asbestos ID was analysed by Approved Identifier:	Not applicable for this job
Asbestos ID was authorised by Approved Signatory:	Not applicable for this job

INS: Insufficient sample for this test	PQL: Practical Quantitation Limit	NT: Not tested
NA: Test not required	RPD: Relative Percent Difference	NA: Test not required
<: Less than	>: Greater than	LCS: Laboratory Control Sample

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.

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: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC 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.

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12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
enquiries@envirolabservices.com.au
www.envirolabservices.com.au

SAMPLE RECEIPT ADVICE

Client:

Environmental Investigation Services
PO Box 976
North Ryde BC NSW 1670

ph: 02 9888 5000
Fax: 02 9888 5001

Attention: Todd Hore

Sample log in details:

Your reference:	**E27532KH, Edmondson Park**
Envirolab Reference:	**114557**
Date received:	13/08/14
Date results expected to be reported:	**20/08/14**

Samples received in appropriate condition for analysis:	YES
No. of samples provided	3 waters
Turnaround time requested:	Standard
Temperature on receipt (°C)	5.5
Cooling Method:	Ice Pack
Sampling Date Provided:	YES

Comments:

If there is sufficient sample after testing, samples will be held for the following time frames from date of receipt of samples:
Water samples - 1 month
Soil and other solid samples - 2 months
Samples collected in canisters - 1 week. Canisters will then be cleaned.
All other samples are not retained after analysis
If you require samples to be retained for longer periods then retention fees will apply as per our pricelist.

Contact details:

Please direct any queries to Aileen Hie or Jacinta Hurst
ph: 02 9910 6200 fax: 02 9910 6201
email: ahie@envirolabservices.com.au or jhurst@envirolabservices.com.au

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	EIS Job Number: E27532KH Date Results Required: STANDARD Page: 1 OF 1	ENVIRONMENTAL INVESTIGATION SERVICES REAR OF 115 WICKS ROAD MACQUARIE PARK, NSW 2113 P: 02-9888 5000 F: 02-9888 5001 Attention: TODD HORE

Location:	EDMONDSON PARK					Sample Preserved in Esky on Ice												
Sampler:	GF					Tests Required												
Date Sampled	Lab Ref:	Sample Number	Sample Containers	PID	Sample Description	Chloride	Sulphate		pH / EC									
13/08/2014	1	MW2	PVC		WATER	X	X		X									
13/08/2014	2	MW4	PVC		WATER	X	X		X									
13/08/2014	3	MW6	PVC		WATER	X	X		X									

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

Job No: 114557
Date Received: 13/8/14
Time Received: 15:30
Received by: PT
Temp: Cool/Ambient
Cooling: Ice/Icepack
Security: Intact/Broken/None

Remarks (comments/detection limits required):

All analysis PQLs to ANZECC (2000) Detection Limits Please

Sample Containers:
G1 - 500mL Amber Glass Bottle G2 - 1L Amber Glass Bottle
V - BTEX Vial H - HNO3 Wash PVC
PVC - HDPE Plastic Bottles

Relinquished By:	Date:	Time:	Received By:	Date:
	13/8/14	14:00	PT	

APPENDIX C

Abbreviations and Sampling Protocols

ABBREVIATIONS

AHD	Australian Height Datum (metres)
ANZECC	Australian and New Zealand Environment Conservation Council
BH	Borehole
Ca	Calcium
$CaCO_3$	Calcium Carbonate (Agricultural lime)
$Ca(OH)_2$	Calcium Hydroxide (Hydrated Lime)
CEC	Cation Exchange Capacity: The total quantity of exchangeable cations that the soil can absorb. Includes Ca, Mg, Na, K, H and Al.
DECCW	Department of Environment, Climate Change and Water, now OEH & EPA
DIPNR	Department of Infrastructure, Planning and Natural Resources (NSW), now OEH & EPA
DLWC	Department of Land and Water Conservation (NSW), now OEH & EPA
DNR	Department of Natural Resources, now OEH
DUAP	Department of Urban Affairs and Planning (NSW) – renamed DIPNR, then Department of Planning (DOP)
EAT	Emerson Aggregate Test (Class number). Scale of 1 to 8.
EC	Electrical Conductivity – measure of salinity levels in µS/cm
Eh	REDOX Potential
EPA NSW	Environment Protection Authority, New South Wales, now EPA
K	Potassium
Mg	Magnesium
Na	Sodium
NATA	National Association of Testing Authorities, Australia
NDSP	National Dryland Salinity Program
OEH	NSW Office of Environment and Heritage
P	Phosphorus
pH	A measure of acidity. The chemical activity of hydrogen ions in soil.
SWL	Standing Water Level
TN 37	Technical Note: Cement and Concrete Association
WSROC	Western Sydney Regional Organisation of Councils

SOIL AND GROUNDWATER SAMPLING PROTOCOLS FOR SALINITY ASSESSMENTS

These protocols specify the basic procedures to be used when sampling soils or groundwater for salinity assessments undertaken by EIS. The purpose of these protocols is to provide standard methods for: sampling, sample preservation, sample storage and sample handling. Deviations from these procedures must be recorded.

Soil Sampling

1. Prepare a test pit/borehole log.
2. 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 drill rig/excavator can operate in a safe manner.
3. Remove any surface debris from the immediate area of the sampling location.
4. Collect soil samples and place in plastic bags and seal with twist ties.
5. Label the bag with the EIS job number, sample location (eg. BH1), sampling depth interval and date. If more than one sample container is used, this should also be indicated.
6. Record the lithology of the sample and sample depth on the borehole/test pit log in accordance with AS1726-1993[19].
7. 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 AS 4482.1:2005, AS 4482.2:1999 and AS/NZS 5667.1:1998.
8. 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.
9. Backfill the boreholes/test pits with the excavation cuttings or clean sand prior to leaving the site.

Groundwater Sampling

Groundwater samples are more sensitive to salinity conditions 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:

1. 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.
2. Groundwater monitoring wells should then be left to recharge for at least five 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.
3. 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.
4. Purging and sampling of piezometers/monitoring wells is done on the same site visit when using low flow techniques. Layout and organize all equipment associated with

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

groundwater sampling in a location where they will not interfere with the sampling procedure. Equipment generally required includes:

- Bucket with volume increments.
- Sample containers.
- 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 sampling equipment or disposable bailers.
- Groundwater sampling forms.

5. Disposable gloves should be used whenever samples are taken to protect the sampler and to assist in avoidance of contamination.
6. Groundwater samples are obtained from the monitoring wells using low flow sampling equipment and/or disposable bailers.
7. 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%.
8. All measurements are recorded on specific data sheets.
9. Once steady state conditions are considered to have been achieved, groundwater samples are obtained and placed in appropriate sampling containers.
10. All samples are preserved in accordance with water sampling requirements and placed in an insulated container with ice. Groundwater samples are preserved by immediate storage in an insulated sample container with ice in accordance with AS/NZS 5667.1:1998.
11. 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.

APPENDIX D

Salinity Compliance Checklist

TABLE H-1
SALINITY COMPLIANCE RECORD
WESTERN SITE (HOUSING)

Item	P[1]	Salinity Management Recommendations	Compliance	Notes
		Earthwork Recommendations		
1	H	Concrete Grade - N25 & N32 for footings & slabs		
2	H	Check soil imported onsite for salinity & contamination		
3	M	Batter slopes stabilized		
4	M	Vegetation Cover on batters		
5	L	Erosion control for stockpiles		
6	H	Gypsum and/or lime applications		
7	H	Erosion and Sediment Control Plan		
		Gardens & Landscaped Areas		
8	M	Large trees retained on site		
9	H	Nutrient rich topsoil		
10	H	No landscape areas above the DPC next to buildings		
11	H	Native plants with minimal watering		
12	H	Not use potable water for landscaping		
13	H	Subsoil drains in landscaped areas		
14	M	Water wise gardens, drip irrigation etc.		
		Roads, Footpaths & Hardstand Areas		
15	H	Graded surfaces		
16	H	Subsoil drains along roads		
17	H	Subsoil drains under hardstand areas		
18	H	Concrete grade for slabs - N25 & N32		
19	H	Concrete grade for footpaths - N25 & N32		
20	M	Roadside landscaping		
		Surface Water, Storm water & Drainage		
21	H	Subsoil drains along foundations & retaining walls		
22	M	Guttering & down pipes connected properly		
23	H	Subsoil drains along cuts & change in grade		
		Detention Basins		
24	H	Install synthetic liner/impermeable liner		
25	M	Check soil in the vicinity of basins		
26	M	Batters along slopes vegetated		
27	M	Wetland construction accordance with Blue Book		
		Built Structures & Durability of Piles & Foundations		
28	H	Damp proof course & moisture barriers		
29	H	Exposure grade bricks		
30	H	Concrete Piles/Foundations to be designed to withstand non-aggressive soil & mildly aggressive groundwater		
31	H	Steel Piles/Foundations to be designed to withstand moderately aggressive soil & non-aggressive groundwater		
		Groundwater Management		
32	M	Reduce use of potable water		
33	M	Reduce irrigation requirements		
34	M	Avoid infiltration pits		
35	H	Prevent leaking from basins		
		Ongoing Maintenance		
36	H	Complete Compliance Record		
37	H	Maintenance of drainage during seasonal fluctuations		
38	H	Check for salinity indicators like salt scalding, vegetation dieback, cracks in roads, scalding of bricks, etc.		

Explanation

1 - Priority Class has been adopted by EIS based on the proposed development details provided and results of the salinity assessment.
This can change during physical works based on the duration, climatic & groundwater conditions and changes to proposed development.
Reference should be made to the EIS Salinity Management Plan for further details.

L	Low Priority
M	Medium Priority
H	High Priority

Compliance Inspection Date:
Inspection Undertaken By:
Of (Company Details):

TABLE H-2
SALINITY COMPLIANCE RECORD
EASTERN SITE (APARTMENTS)

Item	P[1]	Salinity Management Recommendations	Compliance	Notes
		Earthwork Recommendations		
1	H	Concrete Grade - N25 & N32 for footings & slabs		
2	H	Check soil imported onsite for salinity & contamination		
3	M	Batter slopes stabilized		
4	M	Vegetation Cover on batters		
5	L	Erosion control for stockpiles		
6	H	Gypsum and/or lime applications		
7	H	Erosion and Sediment Control Plan		
		Gardens & Landscaped Areas		
8	M	Large trees retained on site		
9	H	Nutrient rich topsoil		
10	H	No landscape areas above the DPC next to buildings		
11	H	Native plants with minimal watering		
12	H	Not use potable water for landscaping		
13	H	Subsoil drains in landscaped areas		
14	M	Water wise gardens, drip irrigation etc.		
		Roads, Footpaths & Hardstand Areas		
15	H	Graded surfaces		
16	H	Subsoil drains along roads		
17	H	Subsoil drains under hardstand areas		
18	H	Concrete grade for slabs - N25 & N32		
19	H	Concrete grade for footpaths - N25 & N32		
20	M	Roadside landscaping		
		Surface Water, Storm water & Drainage		
21	H	Subsoil drains along foundations & retaining walls		
22	M	Guttering & down pipes connected properly		
23	H	Subsoil drains along cuts & change in grade		
		Detention Basins		
24	H	Install synthetic liner/impermeable liner		
25	M	Check soil in the vicinity of basins		
26	M	Batters along slopes vegetated		
27	M	Wetland construction accordance with Blue Book		
		Built Structures & Durability of Piles & Foundations		
28	H	Damp proof course & moisture barriers		
29	H	Exposure grade bricks		
30	H	Concrete Piles/Foundations to be designed to withstand non-aggressive soil & non-aggressive groundwater		
31	H	Steel Piles/Foundations to be designed to withstand mildly aggressive soil & non-aggressive groundwater		
		Groundwater Management		
32	M	Reduce use of potable water		
33	M	Reduce irrigation requirements		
34	M	Avoid infiltration pits		
35	H	Prevent leaking from basins		
		Ongoing Maintenance		
36	H	Complete Compliance Record		
37	H	Maintenance of drainage during seasonal fluctuations		
38	H	Check for salinity indicators like salt scalding, vegetation dieback, cracks in roads, scalding of bricks, etc.		

Explanation

1 - Priority Class has been adopted by EIS based on the proposed development details provided and results of the salinity assessment.
This can change during physical works based on the duration, climatic & groundwater conditions and changes to proposed development.
Reference should be made to the EIS Salinity Management Plan for further details.

L	Low Priority
M	Medium Priority
H	High Priority

Compliance Inspection Date:
Inspection Undertaken By:
Of (Company Details):

APPENDIX E

Groundwater Sampling and Equipment Calibration Records

Groundwater Monitoring Well Development Report

Client:	KMT Constructions	**Job No.:**	E27532KH
Project:	Proposed Residential Development	**Well No.:**	2
Location:	5 Rynan Ave, Edmondson Park	**Depth (m):**	

WELL FINISH DETAILS

	Gatic Cover		Standpipe	X	PVC Pipe

WELL DEVELOPMENT DETAILS

Method:	Twister Pump	**SWL – Before: (m)**	2.17
Date:	6/8/14	**Time – Before:**	
Undertaken By:	GF	**SWL – After: (m)**	
Total Vol. Removed:	11	**Time – After:**	
PID Reading (ppm):			

Comments:

DEVELOPMENT MEASUREMENTS

Volume Removed (L)	Temp (°C)	DO (mg/L)	EC (µS/m)	pH	Eh (mV)
5	19.6	6.8	3395	8.02	176.0
10	17.5	7.6	3336	7.78	166.2

Comments:

Tested By:	
Date Tested:	
Checked By:	
Date:	

Remarks:

- All measurements are corrected to ground level
- All stated Volumes are in Litres
- SWL is an abbreviation for standing water level
- Steady state conditions - difference in the pH less than 0.2 units and difference in conductivity less than 10%
- Minimum 3 monitoring well volumes are purged

Groundwater Monitoring Well Development Report

Client:	KMT Constructions	**Job No.:**	E27532KH
Project:	Proposed Residential Development	**Well No.:**	6
Location:	5 Rynan Ave, Edmondson Park	**Depth (m):**	

WELL FINISH DETAILS

	Gatic Cover		Standpipe	X	PVC Pipe

WELL DEVELOPMENT DETAILS

Method:	Twister Pump	**SWL – Before: (m)**	2.52
Date:	6/8/14	**Time – Before:**	
Undertaken By:	GF	**SWL – After: (m)**	
Total Vol. Removed:	11	**Time – After:**	
PID Reading (ppm):	—		

Comments:

DEVELOPMENT MEASUREMENTS

Volume Removed (L)	Temp (°C)	DO (mg/L)	EC (µS/m)	pH	Eh (mV)
3	19.3	9.6	16972	5.32	175.6
6	17.9	7.2	20277	5.80	161.0
9	16.6	7.4	20306	6.14	153.0
11	17.1	7.5	18738	6.34	158.2

Comments:

Tested By:	
Date Tested:	
Checked By:	
Date:	

Remarks:

- All measurements are corrected to ground level
- All stated Volumes are in Litres
- SWL is an abbreviation for standing water level
- Steady state conditions - difference in the pH less than 0.2 units and difference in conductivity less than 10%
- Minimum 3 monitoring well volumes are purged

Groundwater Sampling Report

EIS

Client:	KMT CONSTRUCTIONS	**Job No.:**	E27532KH
Project:	PROPOSED RESIDENTIAL DEVELOPMENT	**Well No.:**	MW2
Location:	5 RYNAN AVENUE, EDMONDSON PARK, NSW	**Depth (m):**	

WELL FINISH

	Gatic Cover		**Standpipe**	X	**PVC Pipe**

WELL PURGE DETAILS:

Method:	PERISTALTIC PUMP	**SWL – Before:**	2.14 - 0.35 = 1.79m
Date:	13/8/14	**Time – Before:**	
Undertaken By:	GF	**Total Vol Removed:**	3.5 L
Pump Program No:		**PID (ppm):**	

PURGING / SAMPLING MEASUREMENTS

Time (min)	CMP	Vol (L)	SWL (m) TOSP	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Eh (mV)
11:16			~~1.79~~ 2.14					
11:21		Flowcell	2.27	18.1	3.2	4726	8.04	115.6
11:28				18.0	3.5	4292	7.65	112.2
11:34				17.9	3.8	3975	7.59	109.1
11:37			2.49	17.9	3.9	3937	7.57	108.3
11:38				18.0	4.1	3922	7.52	107.9
11:35				18.0	4.0	3910	7.57	107.6
11:40			2.52	18.0	4.0	3882	7.56	107.2
11:41			"	17.9	4.1	3869	7.56	107.0
11:42		3.5	2.52	17.9	4.0	3864	7.56	106.9

Containers Used/Comments 1 x 500ml PVC

Tested By: GF
Date Tested: 13/8/14
Checked By:
Date:

Remarks:

- All measurements are corrected to ground level
- SWL is an abbreviation for standing water level
- Steady state conditions - difference in the pH less than 0.2 units and difference in conductivity less than 10%

Groundwater Sampling Report

Client:	KMT CONSTRUCTIONS	**Job No.:**	E27532KH
Project:	PROPOSED RESIDENTIAL DEVELOPMENT	**Well No.:**	MW 4
Location:	5 RYNAN AVENUE, EDMONDSON PARK, NSW	**Depth (m):**	

WELL FINISH

	Gatic Cover		**Standpipe**	X	**PVC Pipe**

WELL PURGE DETAILS:

Method:	PERISTALTIC PUMP	**SWL – Before:**	3.17 - 0.40 = 2.77
Date:	13/8/14	**Time – Before:**	10am.
Undertaken By:	GF	**Total Vol Removed:**	
Pump Program No:		**PID (ppm):**	

PURGING / SAMPLING MEASUREMENTS

Time (min)	CMP	Vol (L)	SWL (m) TOSP	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Eh (mV)
10:25			3.17					
10:29		Flow cell.	3.33	18.2	3.3	4222	6.07	157.6
10:36			3.55	18.6	3.2	4235	7.34	141.2
10:41			3.69	18.7	3.0	4213	7.45	137.2
10:46			3.85	18.8	3.2	4101	7.47	134.0
10 47				18.7	3.5	4086	7.48	133.3
10.48				18.7	3.4	4064	7.49	133.0
10.49				18 7	3.5	4043	7.49	132.5
10:50				18.7	3.5	4020	7.49	132.0
10:51				18.7	3.6	3997	7 49	131.5
	→	Start sampling						

Containers Used/Comments 1 x 500ml PVC.

Tested By: GF	**Remarks:**
Date Tested: 13/8/14.	- All measurements are corrected to ground level
Checked By:	- SWL is an abbreviation for standing water level
Date:	- Steady state conditions - difference in the pH less than 0.2 units and difference in conductivity less than 10%

Groundwater Sampling Report

Client:	KMT CONSTRUCTIONS	**Job No.:**	E27532KH
Project:	PROPOSED RESIDENTIAL DEVELOPMENT	**Well No.:**	MW6
Location:	5 RYNAN AVENUE, EDMONDSON PARK, NSW	**Depth (m):**	

WELL FINISH

	Gatic Cover		**Standpipe**	X	**PVC Pipe**

WELL PURGE DETAILS:

Method:	PERISTALTIC PUMP	**SWL – Before:**	2.25 - 0.57 = 1.68
Date:	13/8/14	**Time – Before:**	
Undertaken By:	GF	**Total Vol Removed:**	4.
Pump Program No:		**PID (ppm):**	

PURGING / SAMPLING MEASUREMENTS

Time (min)	CMP	Vol (L)	SWL (m) TOSP	Temp (°C)	DO (mg/L)	EC (µS/cm)	pH	Eh (mV)
12:15			2.25					
12:20		Flowcell	2.33	16.8	5.7	20485	7.69	141.9
12:27			2.35	16.4	5.3	20672	7.54	135.7
12:32			2.36	16.5	5.0	20684	7.53	134.3
12:37				16.5	4.8	20684	7.53	133
12:39				16.4	4.7	20697	7.54	133.1
12:39				16.4	4.6	20689	7.55	132.8
12:40				16.4	4.5	20682	7.55	132.5
12:41				16.4	4.4	20679	7.54	132.3
12:42		4.	2.37	16.5	4.3	20664	7.54	132.1

Containers Used/Comments 1x 500ml PVC

Tested By: GF	**Remarks:**
Date Tested: 13/8/14	- All measurements are corrected to ground level
Checked By:	- SWL is an abbreviation for standing water level
Date:	- Steady state conditions - difference in the pH less than 0.2 units and difference in conductivity less than 10%

6/08/2014 14:27	472.5	470.1	10.8	209.5	4.45	20.3	E27532KH	MW6	EIS YSI2
6/08/2014 14:28	19191	20361	7.7	158.7	5.9	17	E27532KH	MW6	EIS YSI2
6/08/2014 14:28	17861	18885	7.5	157	6.3	17.2	E27532KH	MW6	EIS YSI2
6/08/2014 14:51	495.9	474.6	9.5	234.2	7.97	22.4	E27532KH	MW2	EIS YSI2
6/08/2014 14:52	3340	3469	7	171.5	7.91	18.1	E27532KH	MW2	EIS YSI2
6/08/2014 14:52	3360	3485	7.7	163.8	7.73	18.1	E27532KH	MW2	EIS YSI2
13/08/2014 10:28	4075	4222	3.3	158.7	5.9	18.2	E27532KH	MW4	EIS YSI2
13/08/2014 10:29	4091	4234	3.2	154.2	6.52	18.2	E27532KH	MW4	EIS YSI2
13/08/2014 10:30	4083	4230	3.2	151.3	6.8	18.2	E27532KH	MW4	EIS YSI2
13/08/2014 10:31	4085	4229	3.3	148.8	7	18.2	E27532KH	MW4	EIS YSI2
13/08/2014 10:32	4088	4231	3.4	147.1	7.11	18.2	E27532KH	MW4	EIS YSI2
13/08/2014 10:33	4096	4230	3.4	145.1	7.2	18.3	E27532KH	MW4	EIS YSI2
13/08/2014 10:34	4099	4226	3.3	143.5	7.27	18.4	E27532KH	MW4	EIS YSI2
13/08/2014 10:35	4110	4234	3.3	142.1	7.32	18.5	E27532KH	MW4	EIS YSI2
13/08/2014 10:36	4130	4246	3.1	140.9	7.35	18.6	E27532KH	MW4	EIS YSI2
13/08/2014 10:37	4128	4242	3.1	139.8	7.38	18.6	E27532KH	MW4	EIS YSI2
13/08/2014 10:38	4121	4231	3	139	7.4	18.6	E27532KH	MW4	EIS YSI2
13/08/2014 10:39	4125	4231	3	138.1	7.42	18.7	E27532KH	MW4	EIS YSI2
13/08/2014 10:40	4112	4213	3	137.4	7.43	18.8	E27532KH	MW4	EIS YSI2
13/08/2014 10:41	4095	4199	3	136.7	7.45	18.7	E27532KH	MW4	EIS YSI2
13/08/2014 10:42	4074	4174	3	136	7.45	18.7	E27532KH	MW4	EIS YSI2
13/08/2014 10:43	4051	4158	3.2	135.3	7.46	18.7	E27532KH	MW4	EIS YSI2
13/08/2014 10:44	4025	4128	3.2	134.8	7.47	18.7	E27532KH	MW4	EIS YSI2
13/08/2014 10:45	4012	4110	3.2	134.3	7.47	18.8	E27532KH	MW4	EIS YSI2
13/08/2014 10:46	3997	4097	3.3	133.7	7.48	18.7	E27532KH	MW4	EIS YSI2
13/08/2014 10:47	3977	4083	3.4	133.2	7.49	18.6	E27532KH	MW4	EIS YSI2
13/08/2014 10:48	3950	4053	3.5	132.6	7.5	18.7	E27532KH	MW4	EIS YSI2
13/08/2014 10:49	3925	4024	3.5	132.1	7.5	18.7	E27532KH	MW4	EIS YSI2
13/08/2014 10:50	3902	4000	3.6	131.6	7.5	18.7	E27532KH	MW4	EIS YSI2
13/08/2014 11:21	4552	4729	3.3	115.6	8.08	18	E27532KH	MW2	EIS YSI2
13/08/2014 11:22	4501	4675	3.1	115.6	7.91	18	E27532KH	MW2	EIS YSI2
13/08/2014 11:23	4434	4603	3.1	114.9	7.82	18.1	E27532KH	MW2	EIS YSI2
13/08/2014 11:24	4369	4534	3.2	114.5	7.76	18.1	E27532KH	MW2	EIS YSI2
13/08/2014 11:25	4299	4461	3.3	113.9	7.72	18.1	E27532KH	MW2	EIS YSI2
13/08/2014 11:26	4230	4392	3.3	113.2	7.69	18.1	E27532KH	MW2	EIS YSI2
13/08/2014 11:27	4168	4329	3.4	112.7	7.66	18	E27532KH	MW2	EIS YSI2
13/08/2014 11:28	4123	4284	3.5	112.1	7.64	18	E27532KH	MW2	EIS YSI2
13/08/2014 11:29	4072	4232	3.5	111.7	7.63	18	E27532KH	MW2	EIS YSI2
13/08/2014 11:30	3998	4158	3.6	111	7.62	18	E27532KH	MW2	EIS YSI2
13/08/2014 11:31	3936	4101	3.7	110.4	7.61	17.9	E27532KH	MW2	EIS YSI2
13/08/2014 11:32	3871	4035	3.8	109.6	7.6	17.9	E27532KH	MW2	EIS YSI2
13/08/2014 11:33	3827	3991	3.8	109.2	7.59	17.9	E27532KH	MW2	EIS YSI2
13/08/2014 11:34	3792	3954	3.8	108.8	7.59	17.9	E27532KH	MW2	EIS YSI2
13/08/2014 11:35	3772	3933	3.9	108.5	7.58	17.9	E27532KH	MW2	EIS YSI2
13/08/2014 11:36	3767	3926	3.9	108.3	7.57	17.9	E27532KH	MW2	EIS YSI2
13/08/2014 11:37	3779	3936	4	108.2	7.57	17.9	E27532KH	MW2	EIS YSI2
13/08/2014 11:38	3768	3922	4	107.9	7.57	17.9	E27532KH	MW2	EIS YSI2
13/08/2014 11:39	3752	3903	4	107.5	7.56	18	E27532KH	MW2	EIS YSI2
13/08/2014 11:40	3727	3879	4	107.2	7.56	17.9	E27532KH	MW2	EIS YSI2
13/08/2014 11:41	3712	3867	4	107	7.55	17.9	E27532KH	MW2	EIS YSI2
13/08/2014 11:42	3710	3865	4	106.9	7.55	17.9	E27532KH	MW2	EIS YSI2
13/08/2014 12:19	19248	20479	5.7	142.4	7.72	16.9	E27532KH	MW6	EIS YSI2
13/08/2014 12:20	19303	20591	5.5	140.3	7.62	16.7	E27532KH	MW6	EIS YSI2
13/08/2014 12:21	19320	20643	5.4	139	7.58	16.6	E27532KH	MW6	EIS YSI2
13/08/2014 12:22	19288	20668	5.4	138.1	7.56	16.5	E27532KH	MW6	EIS YSI2
13/08/2014 12:23	19260	20677	5.4	137.4	7.55	16.4	E27532KH	MW6	EIS YSI2
13/08/2014 12:24	19242	20680	5.4	136.8	7.54	16.4	E27532KH	MW6	EIS YSI2
13/08/2014 12:25	19235	20671	5.4	136.3	7.54	16.4	E27532KH	MW6	EIS YSI2
13/08/2014 12:26	19252	20672	5.4	135.8	7.54	16.4	E27532KH	MW6	EIS YSI2
13/08/2014 12:27	19259	20674	5.3	135.5	7.54	16.4	E27532KH	MW6	EIS YSI2
13/08/2014 12:28	19274	20673	5.3	135.2	7.53	16.5	E27532KH	MW6	EIS YSI2
13/08/2014 12:29	19299	20666	5.3	134.9	7.53	16.5	E27532KH	MW6	EIS YSI2
13/08/2014 12:30	19322	20694	5.2	134.7	7.53	16.5	E27532KH	MW6	EIS YSI2
13/08/2014 12:31	19320	20688	5.1	134.4	7.54	16.5	E27532KH	MW6	EIS YSI2
13/08/2014 12:32	19316	20685	5	134.1	7.54	16.5	E27532KH	MW6	EIS YSI2
13/08/2014 12:33	19308	20684	4.9	133.9	7.54	16.5	E27532KH	MW6	EIS YSI2
13/08/2014 12:34	19298	20701	4.9	133.7	7.54	16.5	E27532KH	MW6	EIS YSI2
13/08/2014 12:35	19293	20684	4.8	133.5	7.54	16.5	E27532KH	MW6	EIS YSI2
13/08/2014 12:36	19287	20684	4.8	133.3	7.54	16.5	E27532KH	MW6	EIS YSI2
13/08/2014 12:37	19283	20696	4.7	133.2	7.54	16.4	E27532KH	MW6	EIS YSI2
13/08/2014 12:38	19267	20690	4.5	132.9	7.54	16.4	E27532KH	MW6	EIS YSI2
13/08/2014 12:39	19267	20685	4.5	132.7	7.54	16.4	E27532KH	MW6	EIS YSI2
13/08/2014 12:40	19271	20681	4.4	132.4	7.55	16.4	E27532KH	MW6	EIS YSI2
13/08/2014 12:41	19269	20665	4.3	132.1	7.54	16.5	E27532KH	MW6	EIS YSI2

***** Calibrate: ORP

Date 13/08/14 DD/MM/YY
Time 10:20:44 24-hour
User ID: GF

Cal Solution Value: 245.910004 ORP mV
Sensor Value: 242.300003 ORP mV
Temperature 14.300000 %C2%B0C
Offset 25.189989
Calibrate Status Calibrated

***** Calibrate: pH

Date 13/08/14 DD/MM/YY
Time 10:19:55 24-hour
User ID: GF

Buffer Value 7.047007 pH
Sensor Value: -7.500000 pH mV
Temperature 14.450006 %C2%B0C

Buffer Value 4.000647 pH
Sensor Value: 141.899994 pH mV
Temperature 13.649988 %C2%B0C

Slope 50.980756 mV/pH
Slope 86.232672 % of Ideal pH Value
Calibrate Status Calibrated

***** Calibrate: Conductivity

Date 13/08/14 DD/MM/YY
Time 10:17:04 24-hour
User ID: GF

Method Conductance
Cal Value: 1014.000000 C-uS/cm
Sensor Value: 1014.000000 C-uS/cm
Temperature Ref. 20.000000 %C2%B0C
Temperature Comp. 1.910000 %/C
TDS Constant 0.650000

Temperature 13.700000 %C2%B0C
Cal Cell Constant: 4.458435
Calibrate Status Calibrated

***** Calibrate: DO

Date 13/08/14 DD/MM/YY
Time 10:16:04 24-hour
User ID: GF

Method DO Air Calibrate
Cal Value: 100.000000 %
Sensor Value: 4.270808 uA
Sensor Type Polarographic
Membrane Type 1.25 PE Yellow
Salinity Mode 4.270808 Auto
Temperature 20.200001 %C2%B0C
Barometer 772.599976 mmHg
Calibrate Status Calibrated

***** Calibrate: ORP

Date 06/08/14 DD/MM/YY
Time 14:17:37 24-hour
User ID: GF

Cal Solution Value: 236.419998 ORP mV
Sensor Value: 233.100006 ORP mV
Temperature 21.700001 %C2%B0C
Offset 21.579988
Calibrate Status Calibrated

***** Calibrate: pH

Date 06/08/14 DD/MM/YY
Time 14:17:11 24-hour
User ID: GF

Buffer Value 7.015223 pH
Sensor Value: -8.000000 pH mV
Temperature 21.749994 %C2%B0C

Buffer Value 4.001625 pH
Sensor Value: 144.399994 pH mV
Temperature 19.450006 %C2%B0C

Slope 51.527959 mV/pH
Slope 87.158253 % of Ideal pH Value
Calibrate Status Calibrated

***** Calibrate: DO

Date 06/08/14 DD/MM/YY
Time 14:13:01 24-hour
User ID: GF

Method DO Air Calibrate
Cal Value: 100.000000 %
Sensor Value: 6.394653 uA
Sensor Type Polarographic
Membrane Type 1.25 PE Yellow
Salinity Mode 6.394653 Auto
Temperature 28.400000 %C2%B0C
Barometer 767.000000 mmHg
Calibrate Status Calibrated