Harvest Scientific Services Pty Ltd
Geotechnical Environmental & Resource Consultants
ABN 43 132 363 289

SITE-SPECIFIC URBAN SALINITY STUDY

FOR A PLANNING PROPOSAL

No.1 ABBOTSFORD ROAD, PICTON

Prepared for

Berten Pty Ltd

Job reference: 201368-Salinity
16 April 2013

All Correspondence to: PO Box 427 Narellan NSW 2567
Unit 4, 20 Somerset Avenue NARELLAN NSW 2567
www.harvestscientific.com.au
Email: narellan@harvestscientific.com.au
Tel: 02 4647 6177 • Fax: 02 4647 7332

Revisions register

Version	Date	Details
1	08/03/2013	Draft document for review. Any portion of this document may change. Awaiting some groundwater monitoring results from the laboratory.
2	08/04/2013	Final draft
3	16/04/2013	Report finalised

Executive Summary

INTRODUCTION

Harvest Scientific Services Pty Ltd (Harvest) was commissioned by Berten Pty Ltd to carry out a Site-Specific Urban Salinity Study for a 70 hectare portion of land (i.e. the 'Study Area') located within No. 1 (part Lot 1 DP 1086066) Abbotsford Road, Picton. This land is located approximately 130 metres to the west of the township of Picton.

This study has been prepared in support of a Planning Proposal to rezone the Study Area to a more intensive residential zoning, thus enabling subdivision applications for smaller lot sizes than currently exist to be lodged and assessed by Wollondilly Shire Council.

The objective of the planning proposal is to rezone the Study Area from '*Zone RU2 Rural Landscape*' to a more intensive residential zoning, such as '*Zone R5 Large Lot Residential*'.

The proposed re-zoning may, depending upon the outcome of the studies, result in the creation of new rural/residential lots, with each having a minimum lot size of 4000m^2. Some lots may be subject to higher Minimum Lot Size (MLS) standards where site constraints, natural features and other environmental constraints dictate.

SPECIALIST STUDY REQUIRMENTS AND OBJECTIVES

Specialist Study Requirements for the Planning Proposal were issued by Wollondilly Shire Council (WSC) in an un-dated document entitled 'Planning Proposal Specialist Study Abbotsford'. That document outlined the output, objectives and task/methodology requirements for each of the Specialist Studies that were to be prepared in support of the re-zoning application.

The objective of this Study was to address the Specialist Study Requirements outlined under the heading '*5.13 Site Specific Urban Salinity Assessment*'. The conditions issued relevant to this Study are as follows:

'5.13.1 Output

- *A site specific Urban Salinity Assessment (in accordance with "Site Investigations for Urban Salinity' (DLWC, 2002a) which considers the necessary land use planning phases throughout the assessment process;*
- *An examination and analysis of the Salinity Hazard existent on the site.*
- *Practical and relevant information regarding effective salinity planning responses.*

5.13.2 Objectives

- *To assess the Salinity Hazard of the site to determine whether development will be affected by salinity and whether salinity will be affected by development.*
- *To aid in the formulation of Planning Responses that address the off-site, long term and cumulative impacts of the development.*
- *To provide guideline for appropriate land uses and management practices on land affected by salinity.*

- *To assess the potential damage to building and infrastructure, as well as environmental values that may be caused by salinity on and off the development site.*
- *To assess whether the manner in which land use and development on the site may have a significant effect on the groundwater systems, waterways, drainage lines and soils.*

5.13.3 Tasks/Methodology

- *Conduct an assessment and collect information on-site in order to determine what further information is required, as well as what further tests and research must be conducted.*
- *Conduct detailed onsite analysis by methods such as digging soil test pits and installing piezometers.*
- *Assess information gathered and undertake further laboratory analysis of selected soils and water samples and interpretations of results.*
- *Select appropriate management and evaluation techniques to suit the salt and water processes and the likely future development.'*

METHODOLOGY

This Study was conducted based on the Local Government Salinity Initiative guidelines entitled '*Site Investigations for Urban Salinity*' (DLWC, 2002a).

The methodology for this Study consisted of the following:

- A review of existing desktop information, including geology, soil landscape maps and available technical reports;
- A visual site assessment for indicators of salinity processes;
- An electromagnetic induction survey;
- Installation of piezometers for groundwater investigation and sampling;
- A soil sampling program; and
- Laboratory analysis of soil and groundwater samples by a NATA accredited laboratory.

Salinity hazards identified in this Study were summarised based on the 4 categories outlined in the 'Salinity Code of Practice' (WSROC, 2004).

Appropriate management and evaluation techniques were then adopted to address the salt and water processes identified and these were considered in the context of future development.

RESULTS

The Study Area was found to contain a number of salinity hazards. These hazards were summarised based on the four hazard categories outlined in the '*Western Sydney Salinity Code of Practice*'and are summarised in the following table.

Salinity hazard (WSROC, 2004)	Identified (Yes/No)	Characteristics
Localised concentration of salinity	Yes	Laboratory analysis results for salinity are summarised in Table 3. Alluvial Soils (Figure 7) have the following features: • Topsoil's are non-saline. • Subsoil's are non-saline. Residual Soils (Figure 7) have the following features: • Topsoil's are non-saline. • Subsoil's range in salinity level from non-saline to moderately saline.
Shale Soil Landscape (including sodic soils)	Yes	Both shale soil landscapes and sodic soils were identified within the investigation area. Laboratory analysis results for scaling and corrosion assessment of soils toward steel and concrete, salinity and sodicity are summarised in Tables 3, 4 and 6. Alluvial Soils (Figure 7) have the following features: • Topsoil's are non-sodic, non-aggressive to concrete and non-corrosive to steel. Based on AS 3600 Concrete Structure and AS 2870-2011 Residential Slabs and Footings these soils are an A1 exposure class. • Subsoil's are non-sodic, non-aggressive to concrete and moderately corrosive to steel. Based on AS 3600 Concrete Structure and AS 2870-2011 Residential Slabs and Footings these soils are an A1 exposure class. Residual Soils (Figure 7) have the following features: • Topsoil's are non-sodic, non-aggressive to concrete and non-corrosive to steel. Based on AS 3600 Concrete Structure and AS 2870-2011 Residential Slabs and Footings these soils are an A1 exposure class. • Subsoil's are sodic (dispersive), non-aggressive to concrete and moderately corrosive to steel. Based on AS 3600 Concrete Structure and AS 2870-2011 Residential Slabs and Footings these soils are an A2 exposure class.
Deeply weathered soil landscapes	No	This salinity hazard was not identified within the Study Area.
Groundwater salinity	Yes	This salinity hazard was identified within the Study Area. The groundwater regime of the Study Area consists of the following features: • Intermittently shallow groundwater within the area delineated as containing Alluvial Soil (Figure 7). After rain the groundwater in this area water found to range from 0.5 to 2.0 metres below ground level. If residential construction occurs in this area without ameliorating this constraint significant potential exits for damage to built infrastructure from intermittently shallow saline groundwater tables in this area; • Highly saline groundwater was encountered at a depth of 4.3 metres (location 201368-13) in a First Order Watercourse within the area delineated as containing Residual Soils (Figure 7); and • Non-saline groundwater was encountered at a depth of

Salinity hazard (WSROC, 2004)	Identified (Yes/No)	Characteristics
		0.9 metres at location 201368-17. This location is located at the 'break-of-slope' topographic location and it is suspected that groundwater at this location resulted from sub-soil drainage resulting from recent prolonged heavy rain and was not as a result of a deeper groundwater regime surfacing at this location. If a deeper groundwater regime was surfacing at this location saline groundwater would have been anticipated. As a safeguard measure it was recommended that future Development Controls should include a further detailed groundwater assessment of the Study Area.

STUDY CONCLUSIONS

With regard to the Specialist Study Requirement's stated objectives, the following conclusions are noted:

- This Study has assessed the Salinity Hazards of the Study Area and it was found that:
    a. The Study Area contains the following Salinity Hazards:
        i. Saline and sodic sub-soils;
        ii. Shale Soil Landscapes; and
        iii. Groundwater Salinity.
    b. The impacts from the above salinity hazards on the development are capable of management by implementation of modest salinity management protocols that are included in the Salinity Management Plan section of this Study. These protocols include:
        i. the use of appropriate building materials for the corrosion and scaling conditions that occur onsite;
        ii. sub-soil drainage and minimising water inputs;
        iii. The filling/raising of land mapped as 'Alluvial Soils' on Figure 7. Land-filling is to ensure a vertical separation of shallow groundwater tables in this area from built infrastructure. Additional groundwater and flood studies will need to be undertaken to determine the extent of filling required. These studies may be undertaken at the Development Application Stage of development.

            Alternatively, this area may be utilised to host stormwater treatment devices such as sediment basins to treat stormwater run-off from the development; and
        iv. Additional levels of groundwater assessment at the Development Application Stage of development.
    c. Impacts of the development on salinity hazards are capable of management by modest salinity management protocols that are included in the Salinity Management Plan section of this Study. These protocols include:
        i. the minimisation water inputs; and

    ii. sub-soil drainage upslope of built infrastructure.

- Off-site, long term and cumulative impacts of the development are to be managed by the salinity management protocols outlined in the Salinity Management Plan section of this Study;
- Providing the recommendations outlined in this Study are implemented the land within the Study Area is considered to be capable of hosting the proposed large lot residential land-use;
- The potential for damage to buildings and infrastructure and environmental values was assessed in Section 5 of this Study. Both onsite and offsite impacts are considered to be capable of management via the protocols outlined in Salinity Management Plan section of this Study; and
- The proposed land-use and development within the Study Area are unlikely to have a significant salinity related effect on the groundwater systems, waterways, drainage lines and soils of the Study Area. This is because of the combined low density of development and a number of protocols have been recommended in the Salinity Management Plan section of this Study to manage the potential salinity impacts related to the proposed development.

No impediments to the re-zoning of the Study Area were identified in this Study.

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICIES

PLATES

ABBREVIATIONS

CEC	Cation Exchange Capacity
DA	Development Application
DCP	Development Control Plan
DCP 2011	Wollondilly Shire Council's Development Control Plan 2011
DOFA	NSW Department of Fisheries and Aquaculture
DOP&I	Department of Planning and Infrastructure
Harvest	Harvest Scientific Services Pty Ltd
LGA	Local Government Area
LEP	Local Environmental Plan
LEP 2011	Wollondilly Shire Council's Local Environmental Plan 2011
NOW	NSW Office of Water
SMP	Salinity Management Plan
WMA 2000	Water Management Act 2000
WSC	Wollondilly Shire Council

1.0 OVERVIEW

1.1 Introduction

Harvest Scientific Services Pty Ltd (Harvest) was commissioned by Berten Pty Ltd to carry out a Site-Specific Urban Salinity Study for a 70 hectare portion of land (i.e. the 'Study Area') located within No. 1 (part Lot 1 DP 1086066) Abbotsford Road, Picton. This land is located approximately 130 metres to the west of the township of Picton.

This study has been prepared in support of a Planning Proposal to rezone the Study Area to a more intensive residential zoning, thus enabling subdivision applications for smaller lot sizes than currently exist to be lodged and assessed by Wollondilly Shire Council.

The objective of the planning proposal is to rezone the Study Area from '*Zone RU2 Rural Landscape*' to a more intensive residential zoning, such as '*Zone R5 Large Lot Residential*'.

The proposed re-zoning may, depending upon the outcome of the studies, result in the creation of new rural/residential lots, with each having a minimum lot size of 4000m^2. Some lots may be subject to higher Minimum Lot Size (MLS) standards where site constraints, natural features and other environmental constraints dictate.

1.2 Specialist Study Requirements

Specialist Study Requirements for the Planning Proposal were issued by Wollondilly Shire Council (WSC) in an un-dated document entitled 'Planning Proposal Specialist Study Abbotsford'. That document outlined the output, objectives and task/methodology requirements for each of the Specialist Studies that were to be prepared in support of a re-zoning application for the Study Area.

The objective of this Study was to address the Specialist Study Requirements outlined under the heading '*5.13 Site Specific Urban Salinity Assessment*'. The conditions issued in relation to a Salinity Study are as follows:

"5.13.1 Output

- *A site specific Urban Salinity Assessment in accordance with "Site Investigations for Urban Salinity' (DLWC, 2002a).which considers the necessary land use planning phases throughout the assessment process;*
- *An examination and analysis of the Salinity Hazard existent on the site.*
- *Practical and relevant information regarding effective salinity planning responses.*

5.13.2 Objectives

- *To assess the Salinity Hazard of the site to determine whether development will be affected by salinity and whether salinity will be affected by development.*
- *To aid in the formulation of Planning Responses that address the off-site, long term and cumulative impacts of the development.*
- *To provide guideline for appropriate land uses and management practices on land affected by salinity.*

- *To assess the potential damage to building and infrastructure, as well as environmental values that may be caused by salinity on and off the development site.*
- *To assess whether the manner in which land use and development on the site may have a significant effect on the groundwater systems, waterways, drainage lines and soils.*

5.13.3 Tasks/Methodology

- *Conduct an assessment and collect information on-site in order to determine what further information is required, as well as what further tests and research must be conducted.*
- *Conduct detailed onsite analysis by methods such as digging soil test pits and installing piezometers.*
- *Assess information gathered and undertake further laboratory analysis of selected soils and water samples and interpretations of results.*
- *Select appropriate management and evaluation techniques to suit the salt and water processes and the likely future development."*

1.3 Location

The Study Area comprises of a portion of land within Lot 1 DP 1086066 and is located immediately west of the existing residential township of Picton (Figure 1). The Study Area is divided by Fairleys Road and Abbotsford Road on its eastern extremity, with the bulk of the Study Area lying to the west and south of Abbotsford Road.

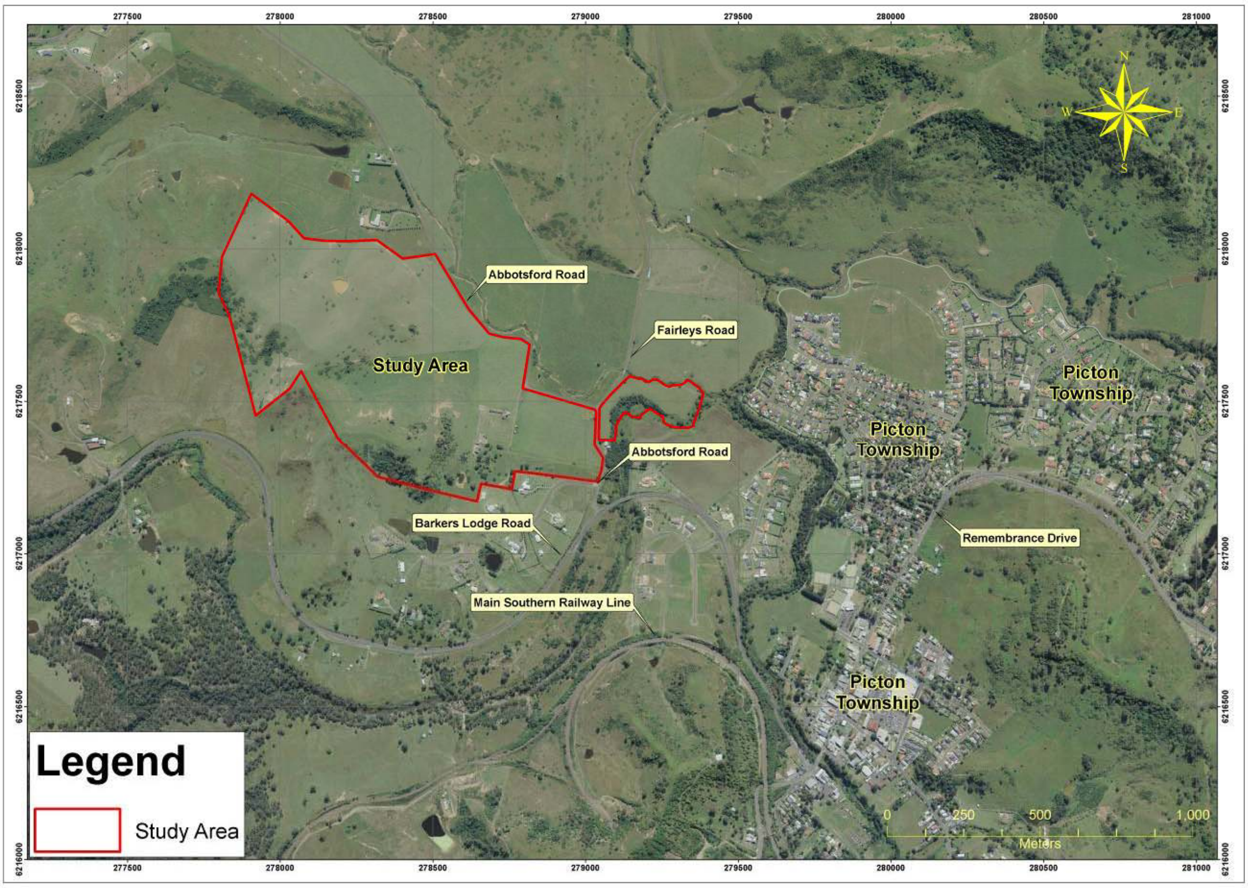


Figure 1: Study Area location. Source of aerial photo: Department of Lands circa 2008.

1.4 Study methodology

This Study was conducted based on the Local Government Salinity Initiative guidelines entitled '*Site Investigations for Urban Salinity*' (DLWC, 2002a).

The methodology for this Study consisted of the following:

- A review of existing desktop information, including geology, soil landscape maps and available technical reports;
- A visual site assessment for indicators of salinity processes;
- An electromagnetic induction survey;
- Installation of piezometers for groundwater investigation and sampling;
- A soil sampling program; and
- Laboratory analysis of soil and groundwater samples by a NATA accredited laboratory.

Salinity hazards identified in this Study were summarised based on the 4 categories outlined in the 'Salinity Code of Practice' (WSROC, 2004).

Appropriate management and evaluation techniques were then adopted to address the salt and water processes identified and these were considered in the context of future development.

2.0 LITERATURE REVIEW AND DESKTOP STUDY

2.1 Introduction

Salt is a natural part of the Australian landscape, with areas of naturally high soil or water salinity occurring throughout the country. It is increasingly recognized that land management practices are resulting in the expansion of areas affected by salinity, and as a consequence, salinity is having a greater impact on human activities and development (WSROC, 2004).

Salinity has been recognised as a nationally significant environmental problem for some time, with the Salinity Action Funding Program commencing in 1990 and the National Dryland Salinity Program being established in 1993.

Whilst salinity is widely recognised as a problem in agricultural areas, the impacts of salinity within urban areas are now being more widely acknowledged. In the urban environment, the impacts of salinity go beyond the degradation of vegetation and soils.

2.2 Salinity in Urban Areas

In urban areas the processes which cause salinity are intensified by the increased volumes of water added to the natural system. Additional water comes from irrigation of gardens, lawns and parks, from leaking underground pipes and pools, and from concentrated infiltration of storm water. Urban salinity can also be related to sub-surface water flows being impeded by structures such as roads, and by poor drainage conditions on a site (WSROC, 2004).

The surface impacts of salinity in landscaped area may include damage to vegetation, including, gardens lawns and playing fields.

Urban salinity also affects built infrastructure, due to the chemical and physical impact of salt on concrete, bricks and metal. Salt moves with water into pores of bricks and concrete exposed to damp, salt laden soils. As water evaporates from the material, salt concentrates, and over-time this can be substantial enough to cause corrosion and damage the materials structure (WSROC, 2004).

Effect on building infrastructure may include crumbling, eroded or powdering mortar or bricks as demonstrated in Figure 2, the flaking of brick facing, and the cracking or corrosion of concrete. Salt may also result in the corrosion of steel reinforcing and long term structural damage.

Underground service pipes, such as those used for sewer or water supplies may also be damaged if these structures are not constructed address the soil and groundwater aggressiveness that where this infrastructure is built.

Additionally, water-logging and salts associated with urban salinity have a considerable impact on roads and pavements. The road base can be physically and chemically degraded, becoming more susceptible to cracking, pot-holing and eventual failure (WSROC, 2004).

For further detail on the processes associated with salinity and mechanisms of salinisation, the reader is referred to the Salinity Code of Practice (WSROC, 2004), an extract from this publication is included in Annexure 1.

Figure 2: Demonstration of the effects of salinity: Structural breakdown of brickwork on a Camden residence.

2.3 Salinity in Western Sydney

Salinity has long been recognised in Western Sydney, with references being made to saline groundwater and brackish creeks in historical accounts from the early 1800s (Mitchell, 2000). In addition, the number of salt tolerant species present in the region suggests that the region has naturally high levels of salt in the groundwater, and that in places, this groundwater is naturally close to the surface (WSROC, 2004).

In 1942 a paper was published by the Department of Mines (Old, 1942) describing the occurrence of saline groundwater across the region, hypothesizing that this was related to the distribution of Wianamatta Group Shales. This paper explored why groundwater bores in the region were generally unsuitable for agriculture or domestic use.

Salinity was recognised as a surface environmental problem in the region by the former Soil Conservation Service in the 1960s. However, it was not widely acknowledged as an urban issue until 1997, when the Department of Land and Water Conservation released the report entitled 'Salinity in the South Creek Catchment' (Dias and Thomas, 1997). That report found that approximately 5% (4500ha) of land in the study area was affected by salinity, and that a further 20% (19000ha) of land in the study area could potentially be affected.

Since that study the Department of Planning and Natural Resources (DIPNR, 2002) has released the findings of further studies in the form of a map entitled 'the Map of Salinity Potential in Western Sydney'. This map broadly delineated Western Sydney into areas of varying salinity risk, ranging from low to extreme. This map is based on the use of geology and Compound Topographic Index (derived from elevation data) as the main input layers and was ground-truthed on areas of known salinity (DIPNR, 2002). This map was intended for broad-scale assessment and is intended for planning purposes only. It should be noted that this map has identified large areas of Western Sydney as being prone to high and extreme salinity risk. These risk zones appear to predominately correspond to drainage lines on soils derived from shales of the Wianamatta Group.

WSROC (2004) 'Final draft Salinity Code of Practice' (as amended) identified four main types of processes associated with salinity in Western Sydney, these include:

- Shale Soil Landscapes;
- Localised concentrations of Salinity;
- Deeply Weathered Soil Landscapes; and
- Groundwater salinity.

For further details on each of the above processes, refer to WSROC (2004), an extract from this publication is appended as Appendix 1.

3.0 BIOPHYSICAL FEATURES OF THE STUDY AREA – DESKTOP REVIEW

3.1 Geology

Based on the 1:100,000 Wollongong to Port Hacking Map Sheet the Study Area is underlain by the three geological units that are classified as Bringelly Shale, Ashfield Shale and Quaternary Alluvium (Sherwin and Holmes, 1982). The distribution of these units within the Study Area and in the immediate surrounds in illustrated on Figure 3.

The ridgetops within the Study Area are generally dominated by Bringelly Shale which is composed of shales, carbonaceous claystone, lithic sandstones and laminates.

The Ashfield Shale geological unit occurs below Bringelly Shale and is the dominant geological unit occurring within the major part of the Study Area. Ashfield Shale forms part of the Winamatta Group which consists of laminite and dark grey siltstones. A thin layer of sandstone (Minchinbury Sandstone) often separates the Bringelly Shales from the Ashfield Shales.

Quaternary alluvial sediments occupy the low lying drainage areas of the Study Area and are associated with Stonequarry Creek and an un-named tributary.

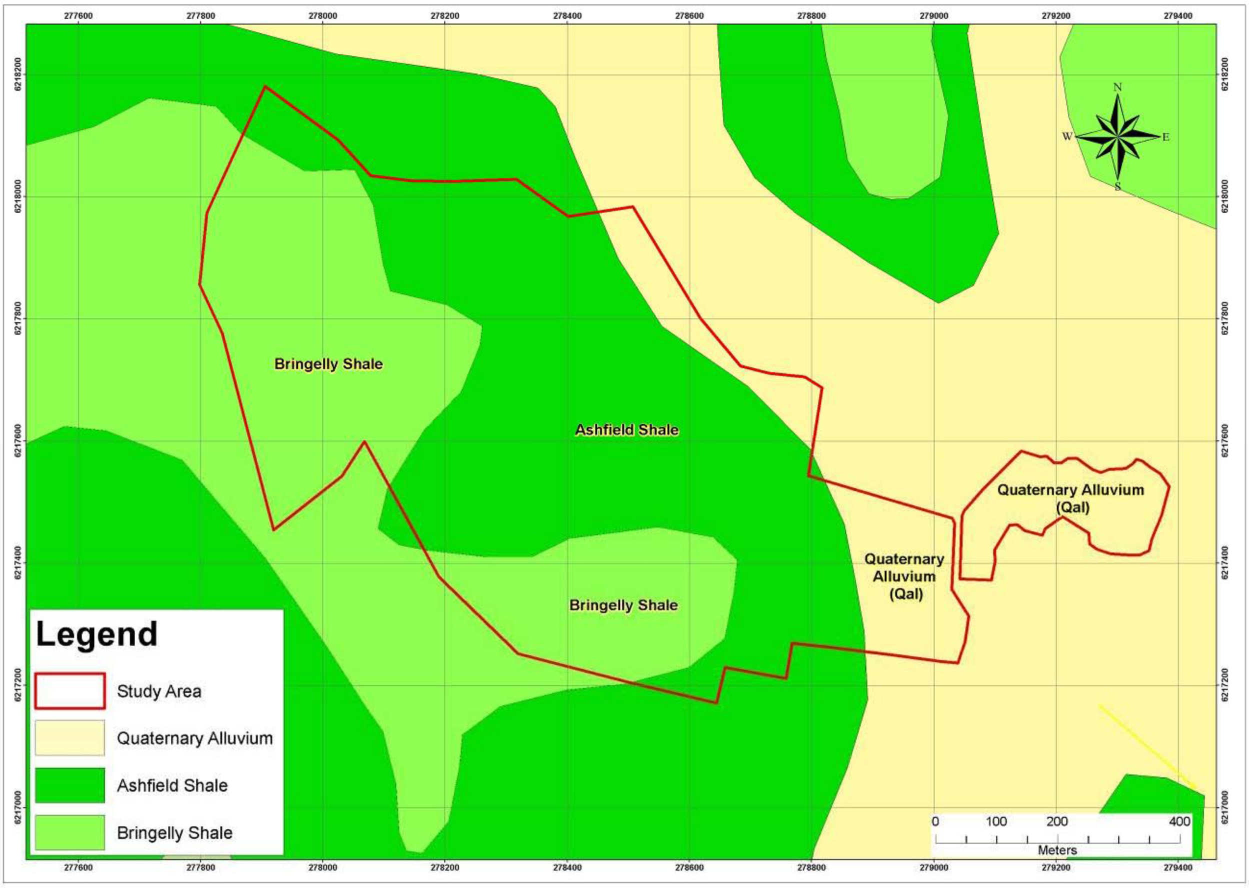


Figure 3: Geology (Sherwin and Holmes, 1982).

3.2 Regional Soil Landscape mapping

Based on regional Soil Landscape mapping, as published in the Wollongong 1:100,000 Soil Landscape Group map (Hazelton and Tille, 1990), the Picton and Monkey Creek Soil Landscape Groups are mapped as occurring within the Study Area. The spatial distribution of these soil landscape groups are illustrated in Figure 4.

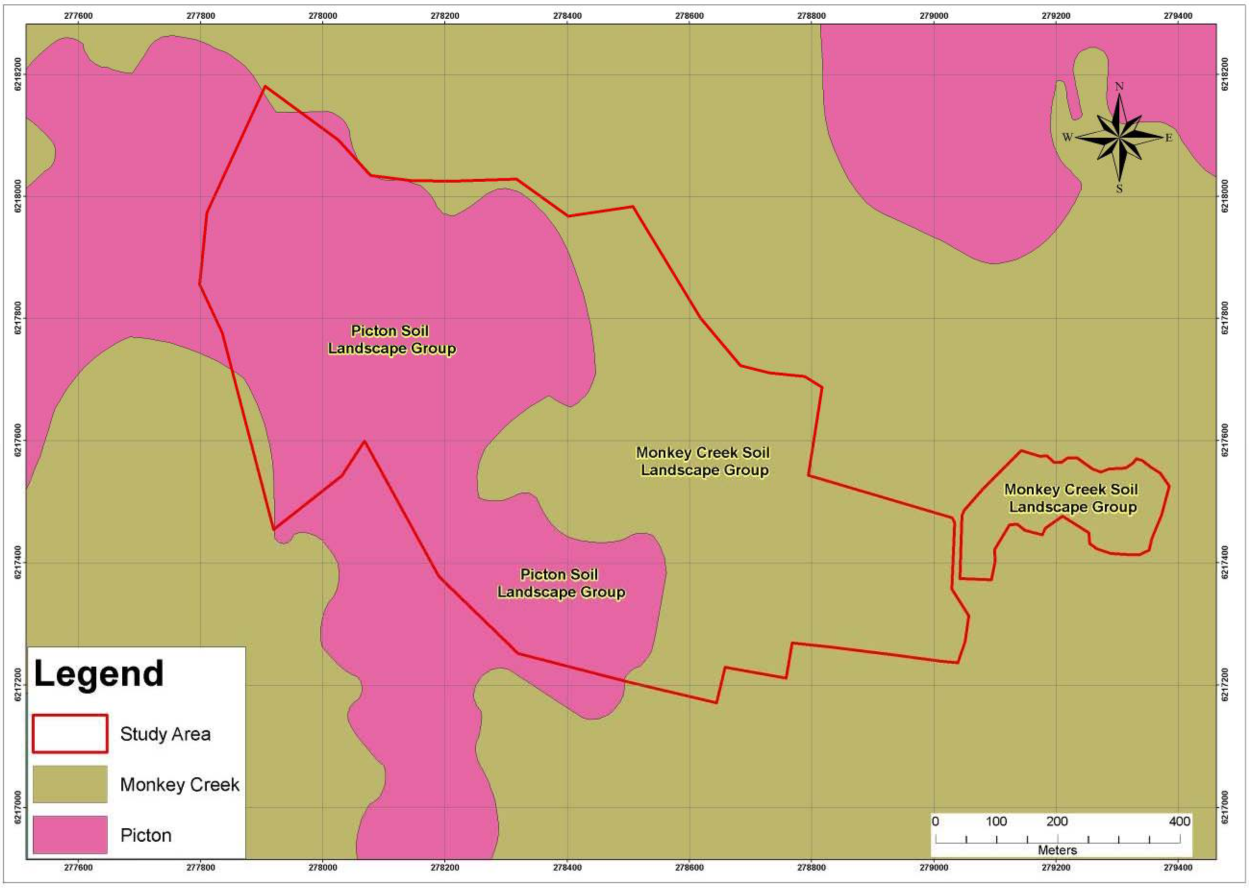


Figure 4: Soil Landscape Groups (Hazelton and Tille, 1990).

General characteristics/constraints of each soil landscape group as described by Hazelton and Tille (1990) are outlined in Table 1, but it is noted that all constraints as summarised in Table 4 do not occur at all locations within a mapped Soil Landscape Unit. Conversely, additional constraints may be identified in site-specific assessments that were not identified in the regional soil landscape map.

Table 1: Summary of Soil Landscape characteristics (adapted from Hazelton and Tille, 1990).

Soil Landscape Group	Aspect	Characteristics
Picton	Fertility	Moderate to low fertility. Top soil is moderately fertile. Subsoils are not fertile and have a low nutrient content. Soils can be deep but with poor soil structure which inhibits root penetration.
	Erodibity	Moderate to highly erodible, particularly the sub-soil. Slope failure due to through-flow and development of percolines is common.
	Erosion hazard	For non-concentrated flows, the erosion hazard is considered to be extreme. Calculated soil loss for the first 12 months of urban development ranges from 300 tonnes/ha for topsoil on steeper slopes to 170 tonnes/ha for

Soil Landscape Group	Aspect	Characteristics
		exposed sub-soil. Steep slopes are subject to mass movement when saturated. Soil erosion for concentrated flows is high to very high.
	Mass movement potential	High. Special foundation designs may be required.
	Landscape limitations	Include steep slopes, mass movement hazard, seasonal waterlogging, water erosion, surface movement and rock fall.
	Urban capability	Not recommended for urban development. Has limited rural capability unless strict management practices are adhered.
Monkey Creek	Fertility	Soils of the Monkey Creek Soil Landscape Group are considered to have a moderate to low fertility. Soils are sodic (locally) and are not suitable for penetration by dee roots, but have good moisture storage.
	Erodibity	The soils are considered to highly erodible. Soil materials have a high percentage of fine sand and subsoils are low in organic matter.
	Erosion hazard	For non-concentrated flows, the erosion hazard is considered to be very high. Calculated soil loss for the first 12 months of urban development ranges up to 55 tonnes /ha for topsoil and 70 tonnes/ha for exposed sub-soil. Soil erosion for concentrated flows is very high.
	Mass movement potential	Considered to be moderately to slightly reactive. Soils are deep and have high clay content.
	Landscape limitations	Include flood hazard, permanently high water-tables and seasonal water-logging.
	Urban capability	Not recommended for urban development due to flood hazard.

3.2.1. Map of Salinity Potential of Western Sydney

A resource available for broad-scale salinity assessment is the '*Map of Salinity Potential in Western Sydney*'. This map was produced by the Department of Infrastructure, Planning and Natural Resources (DIPNR, 2002) in response to concerns about salinity in Western Sydney. The map utilises geology and topography to rank sites in terms of salinity potential. The salinity potential within the Study Area is illustrated in Figure 5.

Based on this map, the main drainage line that extends through the central portion of the Study Area and including an area on the northern boundary of the Study is mapped as having a 'High' salinity potential. A high salinity potential refers to areas where soil, geology, topography and groundwater conditions predispose a site to salinity. These areas contain conditions that are similar to areas of know salinity and are most common in lower slopes and drainage systems where water accumulation is high (DIPNR, 2002).

The remainder of the site however, was mapped as having a 'Moderate Salinity Potential'. The 'Moderate Salinity Potential' rating is defined as areas on Wianamatta Group Shales and Tertiary Alluvial Terraces where scattered areas of scalding and indicator vegetation have been noted but no salt concentrations have been mapped. Saline areas may occur in this zone which have not yet been identified or may occur if risk factors change adversely.

It is noted however, that this map has been generated at a scale of 1:100,000 and is intended for general planning purposes only and should not be used as a substitute for a site-specific assessment.

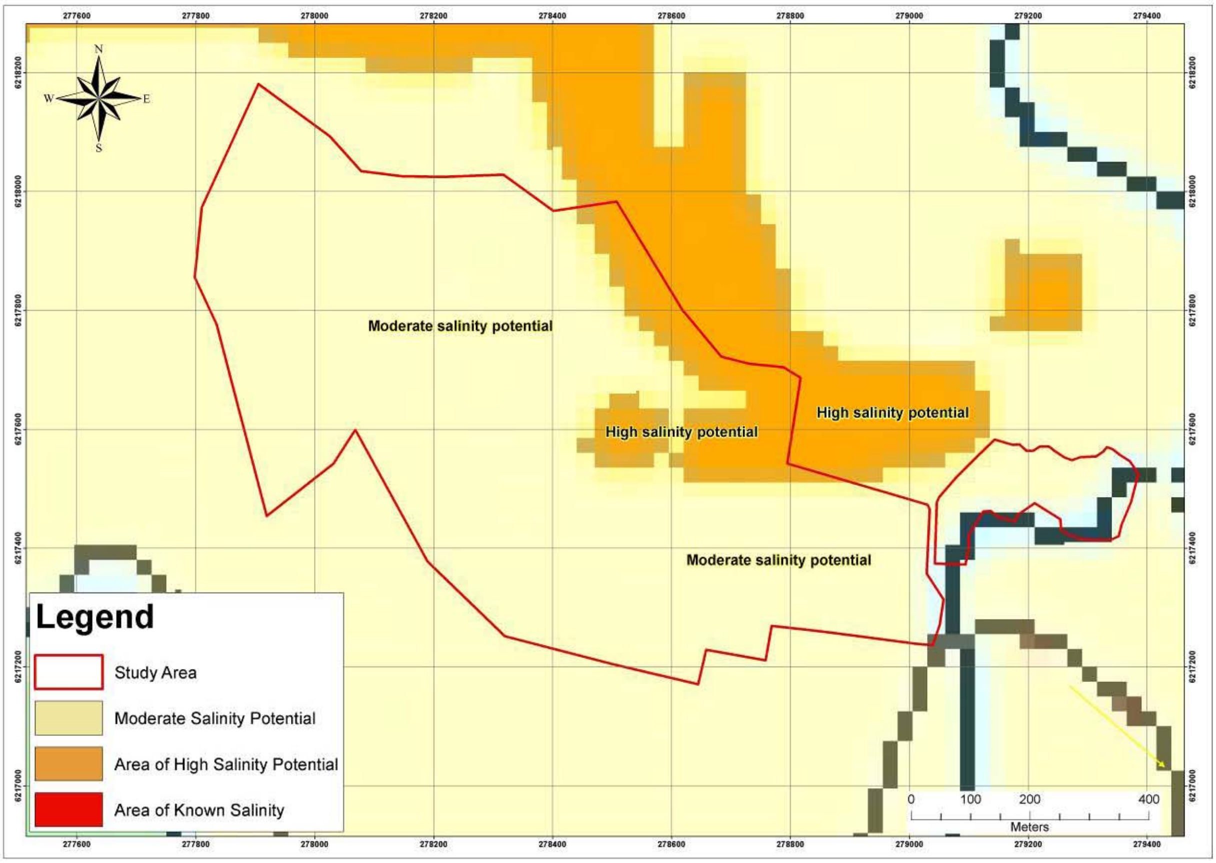


Figure 5: Map of Salinity Potential of Western Sydney (DIPNR, 2002)

3.2.2. Geotechnical constraints

The geotechnical instability of the Study Area was assessed by Harvest Scientific Services Pty Ltd (2013). The areas that were identified in that assessment as being un-suitable for residential development were classified as having either a '*High*' or *'Very High'* Geotechnical Instability Risk Category. The location of these areas is delineated on Figure 6. These areas are considered to be suitable for grazing purposes only with low stocking density.

3.2.3. Flooding

The extent of flooding within the Study Area is currently un-known and it is understood that this constraint is to be delineated by the Applicant with the aid of a separate flood study. Nonetheless, it is considered that flood constraints are potentially associated with the lower lying portions of the site particularly in the vicinity of the existing watercourses.

3.2.4. Regional catchment

The Study Area is located within the Hawkesbury-Nepean catchment, with the Nepean River being located approximately five kilometres to the southeast of the Study Area.

3.2.5. Landform

The land associated with the Study Area consists of the following landform features:

- relatively flat foot-slopes (Plate 1);
- side-slopes (Plate 2);
- steep side-slopes (Plate 3); and
- hill crests (Plate 4).

3.2.6. Land-uses within the Study Area

The Study Area used for cattle and sheep grazing activities.

3.2.7. Existing infrastructure within the Study Area

The Study Area contains the following infrastructure:

- A former dairy (Plates 5, 6, 7);
- A former feed shed (Plate 8 and 9);
- A derelict former homestead (Plates 10, 12, 13, 14, 15 and 16); and
- Cattle yards (Plate 11).

3.2.8. Natural drainage watercourses

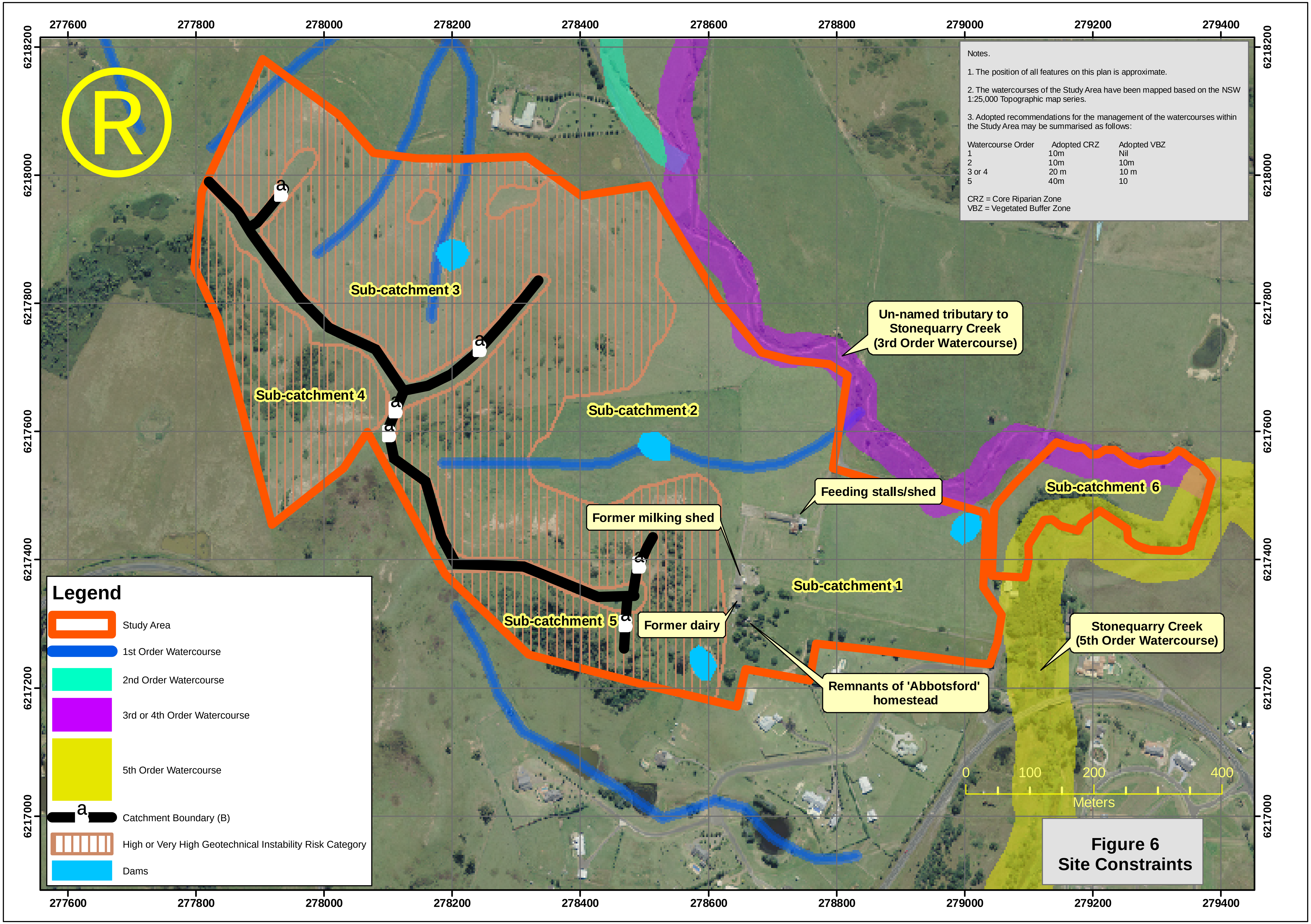
Based on a review of the 1:25,000 topographic map series and was classified according to the generally accepted Strahler stream order classification system (**Strahler, 1952**). The watercourses associated with the Study Area are summarised as follows:

- 4 un-named 1st order watercourses were identified within the bounds of the Study Area;
- A further 1st Order watercourse was identified immediately to the south of the southern boundary of the Study Area;
- An un-named 2nd order watercourse was identified to the north of the Study Area;
- An un-named 3nd order watercourse was identified to the north of the Study Area; and
- Stonequarry Creek, a 5th Order watercourse was identified to the east of Study Area.

The location of these features is depicted on Figure 6**.**

3.2.9. Anthropogenic (man-made) drainage systems

With the exception of road drain systems and a number of farm dams, no other anthropogenic (man-made) drainage systems were identified within the Study Area.


Notes.
1. The position of all features on this plan is approximate.
2. The watercourses of the Study Area have been mapped based on the NSW 1:25,000 Topographic map series.
3. Adopted recommendations for the management of the watercourses within the Study Area may be summarised as follows:
Watercourse Order | Adopted CRZ | Adopted VBZ
1 | 10m | Nil
2 | 10m | 10m
3 or 4 | 20 m | 10 m
5 | 40m | 10
CRZ = Core Riparian Zone
VBZ = Vegetated Buffer Zone
Sub-catchment 1
Sub-catchment 2
Sub-catchment 3
Sub-catchment 4
Sub-catchment 5
Sub-catchment 6
Un-named tributary to Stonequarry Creek (3rd Order Watercourse)
Feeding stalls/shed
Former milking shed
Former dairy
Remnants of 'Abbotsford' homestead
Stonequarry Creek (5th Order Watercourse)
Legend
Study Area
1st Order Watercourse
2nd Order Watercourse
3rd or 4th Order Watercourse
5th Order Watercourse
Catchment Boundary (B)
High or Very High Geotechnical Instability Risk Category
Dams
0 100 200 400
Meters
277600 277800 278000 278200 278400 278600 278800 279000 279200 279400
6218200 6218000 6217800 6217600 6217400 6217200 6217000
Figure 6
Site Constraints

4.0 ASSESSMENT OF SALINITY HAZARDS WITHIN THE STUDY AREA

4.1 Overview

Salinity Hazards within the Study Area were according to the Local Government Salinity Initiative guidelines entitled 'Site Investigations for Urban Salinity' (DLWC, 2002a). Accordingly, the following components were assessed:

- A review of background literature of relevance to urban salinity (Section 3 of this Study);
- A review of existing desktop information, including geology, soil landscape maps and available technical reports;
- A visual site assessment for indicators of salinity processes;
- An electromagnetic induction survey;
- Installation of piezometers for groundwater investigation and sampling;
- A soil sampling program; and
- Laboratory analysis of soil and groundwater samples by a NATA accredited laboratory.

Salinity hazards identified in this Study were summarised based on the 4 categories outlined in the 'Salinity Code of Practice' (WSROC, 2004).

4.2 Assessment methodology

4.2.1. Salinity Electromagnetic induction survey

4.2.1.1 Relationship between electromagnetic induction and soil salinity

Electromagnetic induction (EMI) instruments provide a rapid assessment of the soil's electrical conductivity. They can provide information that can be used for land resource assessment, salinity assessment, soil works, precision farming and property and catchment management.

The technology works on the basis that within an electromagnetic field, any conductive body carries a current. The instrument measures the apparent flow of electrical conductivity through the soil, called the soil's apparent electrical conductivity (ECa) measured in milliSiemens / metre, (mS/m). Each instrument has two coils (a transmitter and a receiver) that are at a fixed (EM38, EM31 and EM39) or a variable (EM34) separation. The instrument induces an electrical current into the soil, with the depth of penetration determined by the separation of the coils and the frequency of the current. ECa is affected by the soil's salt content and type, clay content and type, mineralogy, depth to bedrock, soil moisture, organic matter and temperature.

Soil data is required to validate the EMI survey. Soil sampling sites need to be selected to represent the range of soil conductivity zones (low, medium and high) based on the range of ECa values as collected by the EMI instrument.

Generally, as salts have a higher electrical conductivity, more elevated levels of soil salinity occur within zones of higher electromagnetic conductivity.

4.2.1.2 Study Area electromagnetic induction survey

An Electromagnetic Induction (EMI) survey was conducted on 29 November 2012.

EMI data was collected using a GEONICS EM38B (**Geonics, 2003**) in the vertical mode of operation. EMI readings were spatially referenced with a standard Garmin Global Positioning System (GPS) with a typical reported accuracy of approximately 4 to 5 metres, but greater errors may occur around trees and buildings or due to poor satellite geometry.

In the vertical mode of operation the EM38B has an approximate depth of exploration of 1.5m below the soil surface (McNeil, 1992).

4.2.2. Soil survey

Sub-surface soil features within the Study Area were investigated via an invasive soil survey. The objective of the invasive soil survey was to confirm surface features, to investigate the electromagnetic features of the Study Area and describe sub-surface soil features in sufficient detail to assess potential salinity related constraints.

A total fourteen (14) test-pits were excavated with a mechanical excavator and soil profiles were logged. Test-pit locations are depicted on Figure 7 and soil profile logs are included in Appendix 2.

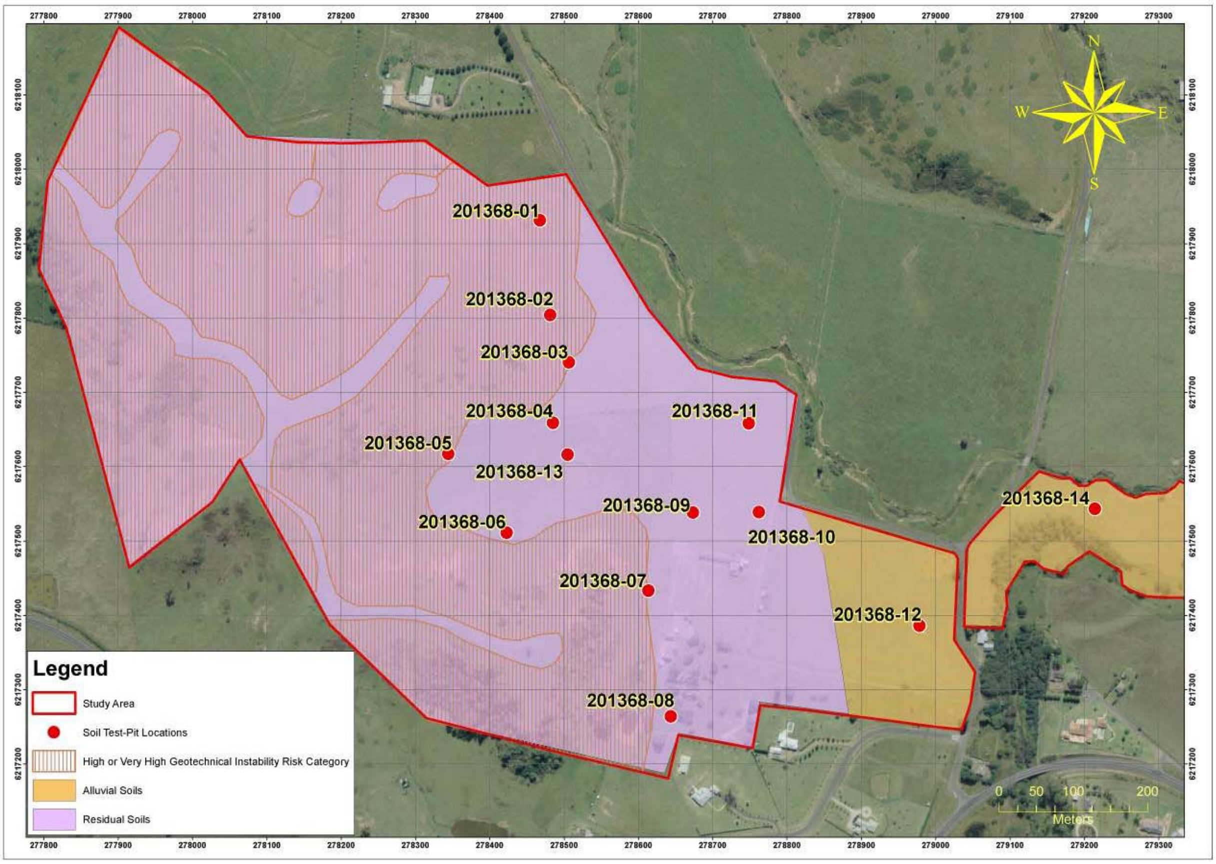


Figure 7: Soil test-pit locations

Sixteen (16) soil samples were collected and analysed in a NATA accredited laboratory for texture, pH, Cation Exchange Capacity (CEC), Exchangeable Sodium Percentage (ESP%), phosphorus retention index (PRI), $EC_{1:5}$ and pH. An additional 8 sub-soil samples were collected and analysed in the laboratory for texture, pH, Cation Exchange Capacity (CEC), Exchangeable Sodium Percentage (ESP%), $EC_{1:5}$ and pH.

Laboratory analysis was undertaken by Sydney Environmental and Soil Laboratory (SESL) located at Thornleigh, NSW. Laboratory analysis results are included in Appendix 3.

4.2.3. Groundwater survey

Five (5) piezometers were installed within the Study Area and the locations of these are depicted on Figure 8. Drillers logs are included in Appendix 2.

Groundwater samples collected and analysed in the laboratory are summarised as follows:

- Two (2) groundwater samples were collected on 28 February 2013 from locations 201368-15 and 201368-16;
- A single groundwater sample was collected from location 201368-13 during the soil sampling regime on 9 January 2013; and
- A single groundwater sample was collected on 20 March 2013 from location 201368-17.

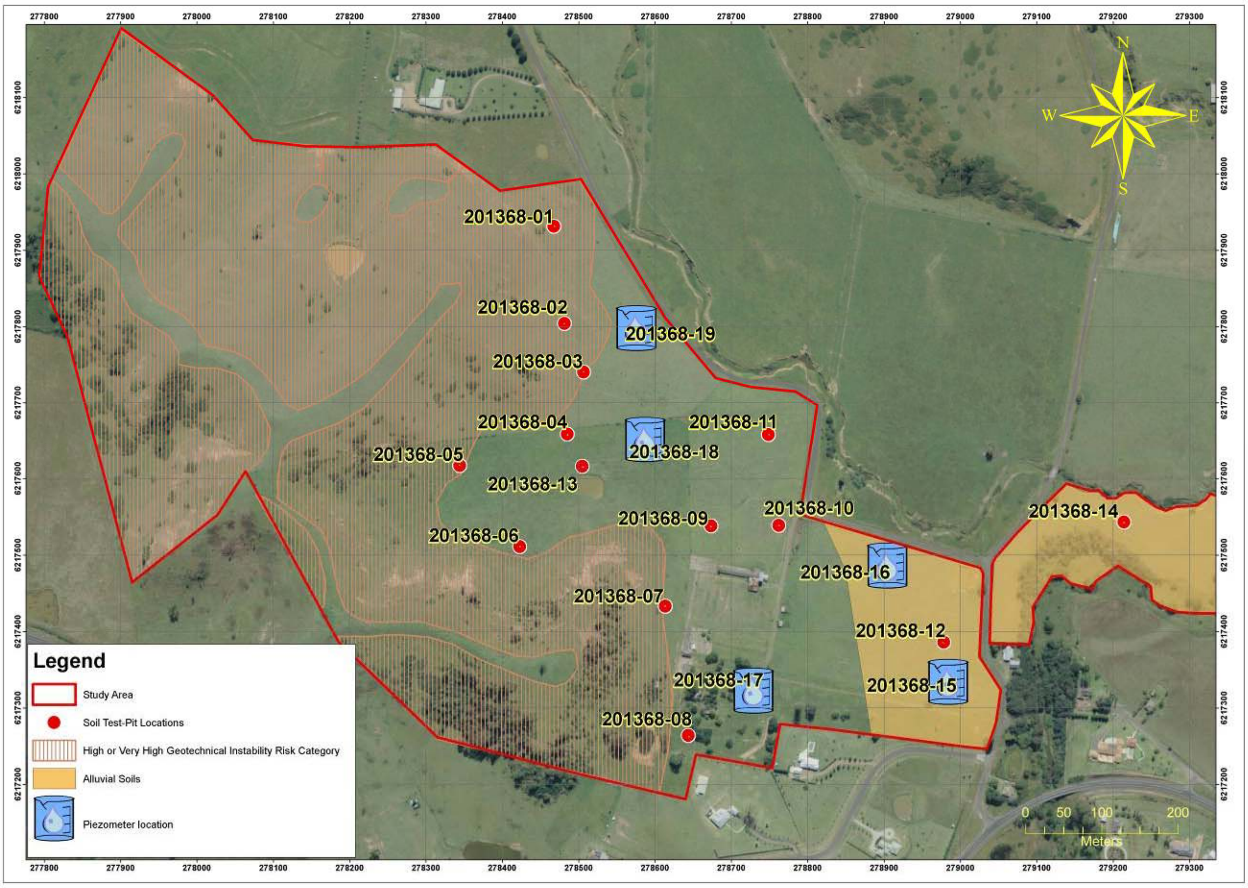


Figure 8: Groundwater piezometer locations (depicted by blue symbol)

Groundwater samples analysed in the laboratory were analysed for pH, EC, sulphate and chloride content. Laboratory analysis was undertaken by Sydney Environmental and Soil Laboratory (SESL) located at Thornleigh, NSW. SESL is a NATA accredited laboratory.

All groundwater piezometers were pumped empty on 19 March 2013 and groundwater depth was re-measured 24 hours later on 20 March 2013. This measurement was taken approximately 1 week after an extended period of heavy rain.

4.3 Results

4.3.1. Visual indicators of salinity process

The following visual indicators of salinity type processes were identified in a site walk-over:

- Physical attack of brickwork (Plates 12, 13 and 14) and mortar (Plates 15 and 16) in the now derelict former 'Abbotsford' homestead;
- Dispersive soils in landslips (Plates 3 and 17), indicating potential sub-soil sodicity constraints;
- Cloudy water in surface waters (Plate 18). The presence of cloudy water indicates that the soils in the catchment may have sodicity constraints; and
- A raised site entrance across low-lying portion of the Study Area (Plate 19). The construction of this feature in a raised manner indicates that the landform in this area may be subject to either potential flooding and/or potential water-logging constraints.

4.3.2. Electromagnetic induction survey

Results of the electromagnetic induction survey are depicted in Figure 9. The following features of this survey are noted:

- The major part of the Study Area contains low to moderate electromagnetic induction values indicating that the major part of the Study Area contain low to moderate soil salinity levels. This finding is consistent with the '*Map of Salinity Potential of Western Sydney*' (Figure 5);
- Several zones within the Study Area contain elevated electromagnetic induction values indicated that elevated soil salinity levels may be associated with these areas. These areas are outlined on Figure 7 and be summarised as follows:
    - The central portion of the Study Area contains a zone of elevated electromagnetic induction values. This zone is associated with a 1st Order Watercourse and includes land down-slope of the former dairy. Salts may have accumulated in this area as a result of natural accumulation processes associated with the topography and local groundwater regime or may be derived from accumulation of animal manures and urine associated with the current grazing land-use and/or former dairy.

      This area also partially correspondences with the area high salinity risk on the '*Map of Salinity Potential of Western Sydney'* (Figure 5);
    - Two zones of elevated conductivity occur on the ridgeline located in the west of the Study Area. Elevated levels of soil salinity may be present in this area due to exposure or naturally saline sub-soils or as result of the past placement of salt cattle licks or salt accumulation from cattle urine/manure; and
    - The northern boundary of the Study Area contains a thin zone of elevated electromagnetic induction values. This may be as a result of the topographic location and natural accumulation of salts. This area approximately corresponds with a high

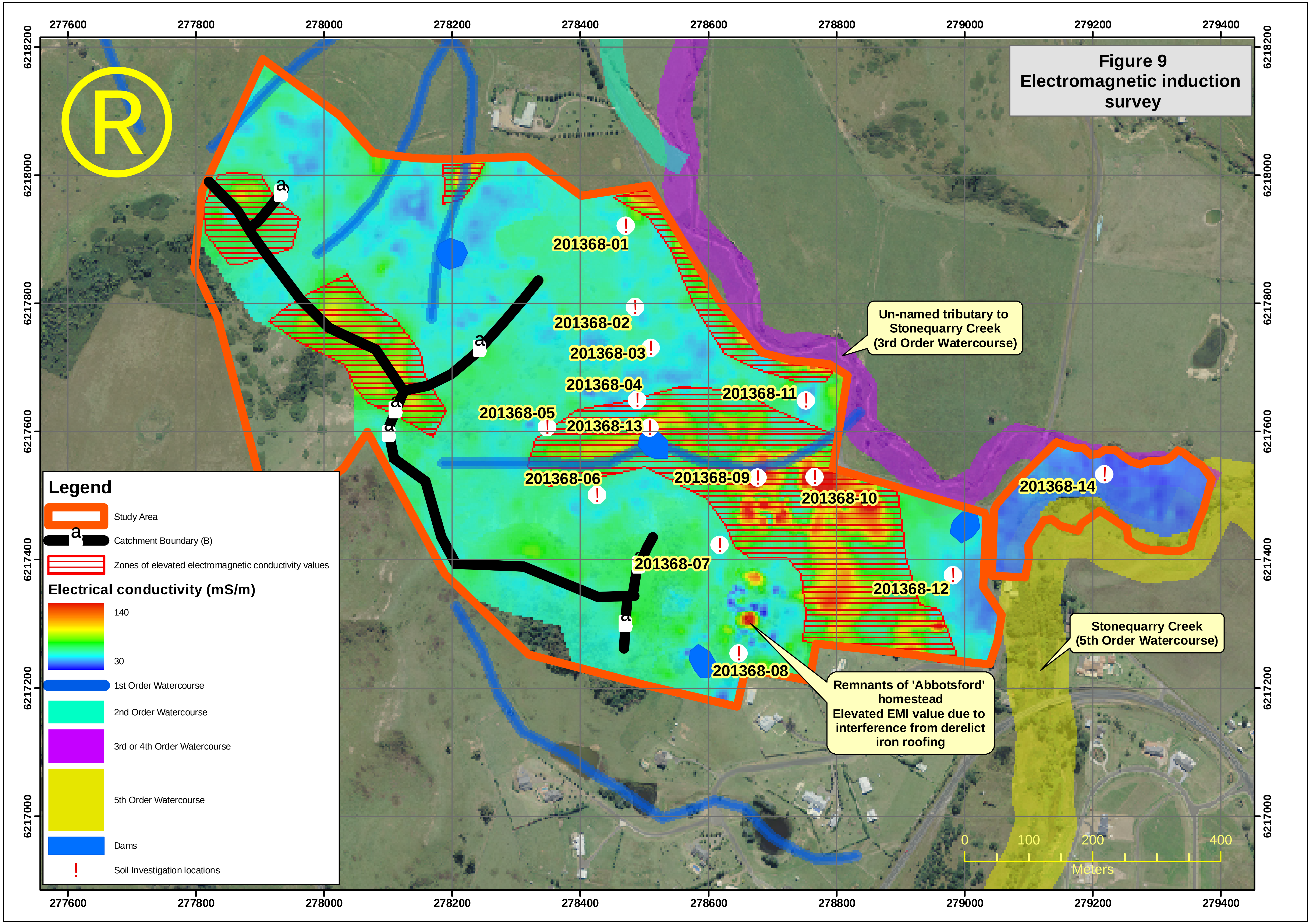


Figure 9
Electromagnetic induction survey
Legend
Study Area
Catchment Boundary (B)
Zones of elevated electromagnetic conductivity values
Electrical conductivity (mS/m)
140
30
1st Order Watercourse
2nd Order Watercourse
3rd or 4th Order Watercourse
5th Order Watercourse
Dams
Soil Investigation locations
Un-named tributary to Stonequarry Creek (3rd Order Watercourse)
Stonequarry Creek (5th Order Watercourse)
Remnants of 'Abbotsford' homestead
Elevated EMI value due to interference from derelict iron roofing
201368-01
201368-02
201368-03
201368-04
201368-05
201368-06
201368-07
201368-08
201368-09
201368-10
201368-11
201368-12
201368-13
201368-14
0
100
200
400
Meters
277600
277800
278000
278200
278400
278600
278800
279000
279200
279400
6218200
6218000
6217800
6217600
6217400
6217200
6217000

salinity risk area identified on the *Map of Salinity Potential of Western Sydney'* (Figure 5); and

- Electromagnetic induction values in the east of the Study Area associated with the zone of alluvial soils are relatively low and indicate that the soil salinity levels in this zone are low.

4.4 Soil survey results

4.4.1. Soil Profile Types

Two main soil profile types were identified within the Study Area and these were broadly divided into residual soil profiles formed from the weathering of the underlying bedrock (i.e. Residual Soils) and soils formed as a result of the deposition of alluvial sediments (i.e. Alluvial Soils). The location and approximate boundary of these two soil types are illustrated in Figure 7.

Alluvial Soils were found on the relatively flat and lower lying areas of the Study Area. These soils are derived from the deposition of quaternary sediments associated with Stonequarry Creek and the adjacent un-named tributary of Stonequarry Creek.

Residual Soils occur over the remaining portions of the Study Area and are derived from the weathering of underlying bedrock, which consists of Ashfield Shale on the side-slopes and lower slopes and Bringelly Shale on the more elevated portions and hill crests.

Topsoil depth was variable, with deeper coarser textured (i.e. higher sand content) topsoils typically associated with Alluvial Soils and shallower fine-textured soils associated with Residual soils.

Alluvial Soils also included a bleached A2 horizon at location 201368-12, indicating that significant lateral water movement may occur after rain, which may cause water-logging and nutrient management difficulties if these soils are utilised for intensive agricultural production.

Shale bedrock was not encountered within the Alluvial Soil profiles but was encountered at a depth of ranging from 1.1 metres (location 201368-01) to 4 metres (location 201368-07) within the zone containing Residual Soils.

Sub-soils across the Study Area typically contained high clay content with low inferred permeability which may result in water-logging. Onsite soils are therefore generally not suited to agricultural crops that are susceptible to water-logging.

The soil structure was poorly developed within all soils of the Study Area, with Alluvial soils being massive and Residual Soils having slightly better structure but still weak to moderate at best.

The main physical limitations may be summarised as follows:

- Alluvial Soils:
  - Water-logging;
  - Soil structural constraints; and
  - Lateral water movement and nutrient management constraints.
- Residual Soils:
  - Water-logging;
  - Soil structural constraints; and
  - Soil depth constraints.

4.4.2. Soil texture and permeability

Field assessment of soil texture and structure are summarised in Table 2. Permeability was inferred from these parameters with reference to the relevant table on page

TABLE 2: Summary of soil texture, structure and inferred permeability

Soil Type	Soil horizon	Depth (mm)	Texture/s	Structure	Inferred permeability[1] (mm/hour)
Alluvial Soils	A	0-1200	Fine Sandy Clay Loam, Clayey Sand	Massive	2.5– 120 (Slow to rapid)
	B	600-3200	Sandy Clay	Massive, Weak	<2.5 (Slow)
	B/C	Not encountered			
	C				
Residual Soils	A	0-900	Clay Loam	Weak, Moderate	2.5– 20 (Slow to mod rapid)
	B	250-4300	Light Clay, Medium Clay	Weak, Moderate	<2.5 (Slow)
	B/C	750-2700	Light Clay, Medium Clay	Weak	<2.5 (Slow)
	C	1100	Shale	N/A	N/A

Notes

1. Permeability categories are based on page 13 of the guidelines entitled 'Site Investigations for Urban Salinity' DLWC (2002a).

4.4.3. Soil salinity

Soil salinity characteristics are summarised in Table 3.

Alluvial soils were found to be non-saline.

Topsoils of the residual soils were found to be non-saline and subsoils range from non-saline to moderately saline. The most saline sub-soils were found within the zone of elevated electromagnetic conductivity values (Figure 9).

TABLE 3: Summary of laboratory analysis results for soil salinity (EC_e)

Soil Type	Soil horizon	Depth (mm)	EC_E	DLWC (2002) Salinity classification[2, 5]	AS3600-2009 Salinity classification[3, 5]	AS2870-2011 Salinity classification[5, 6]
Alluvial Soils	A	0-1200	0.3	Non-saline	A1	A1
	B	600-3200	0.2	Non-saline	A1	A1
Residual Soils	A	0-900	0.2-1.0	Non-saline	A1	A1
	B	250-4300	0.1-4.8	Moderately saline	A2	A2
	B/C	750-2700	0.3-7.0	Moderately saline	A2	A2

Notes:

1. Properties highlighted by shading are outside the range for a non-saline status.
2. Salinity classification is based on page 21 of the guidelines entitled 'Site Investigations for Urban Salinity' **DLWC (2002a)**.
3. The AS3600-2009 salinity classifications are based on Table 4.8.2 (page 57) of the AS3600-2009 Concrete Structures.

4. EC (1:5) values were converted to EC_e values based on texture conversion factors in Table 6.1 of the 'Site Investigations for Urban Salinity' guideline (**DLWC, 2002a**). Salinity classifications are based on Table 6.2 of NSW DLWC (2002) publication entitled '*Site Investigations for Urban Salinity*'.
5. Adopted values. Unless otherwise demonstrated by laboratory analysis of onsite soils and groundwater this exposure class is to be adopted for all structures below a depth of 3.0m.
6. Exposure status (A1, A2, B1, B2, C2) classifications are based on: Table 5.1 (page 56) and Table 5.2 (page 57) of the AS 2870 – 2011 Residential Slabs and footings.

4.4.4. Sodicity

Sodicity characteristics of onsite soils are summarised in Table 4.

Alluvial soils have similar topsoil and subsoil characteristics and are non-sodic.

Topsoils of the Residual Soil type are non-sodic whereas sub-soils range from non-sodic to highly sodic. The high levels of sodicity within the subsoils of the Residual Soil type presents an erosion hazard risk if the topsoils are disturbed and the sub-soils are exposed.

TABLE 4: Summary of laboratory analysis results for soil sodicity (%)

Soil Type	Soil horizon	Exchangeable Sodium Percentage (ESP) (%)	Sodicity Classification
Alluvial Soils	A	0.8	Non-sodic
	B	1.4-1.6	Non-sodic
Residual Soils	A	0.5-5.1	Non-sodic
	B	1.5-35.2	Non-sodic to highly sodic
	B/C	6.7-27.5	Sodic to highly sodic

Notes:

1. Sodicity classifications are based on classifications presented on page 14 of NSW DLWC (2002) publication entitled '*Site Investigations for Urban Salinity*'.
2. Values highlighted by shading are outside the range non-sodic.

4.5 Groundwater survey results

4.5.1. Groundwater depth and laboratory analysis

Results of groundwater monitoring are summarised in Table 5.

TABLE 5: Summary of groundwater depth and laboratory analysis results

Soil Type	Location	Depth (m) (22/01/2013)[5]	Depth (m) (28/02/2013)	Depth (m)[3] (20/03/2013)	Salinity (mS/cm)	pH	Sulphate ($mgSO_4/L$)	Chloride (mgCl/L)
Alluvial Soils	201368-15	Not intercepted	0.5	0.9	0.48 (Moderate)	6.5	18.4 (Low)	88.6 (Low)
	201368-16	Not intercepted	2.0	2.2	0.56 (Moderate)	6.6	12.9 (Low)	111.8 (Low)
Residual Soils	201368-17	Not intercepted	NM	0.9	0.27 (Low)	6.0	7.8 (low)	8.3 (Low)
	201368-18	Not intercepted	NM	3.2	NM	NM	NM	NM
	201368-19	Not intercepted	NM	3.1	NM	NM	NM	NM
	201368-13	Not intercepted	~4.3	~4.3	2.73 (very high)	8.0	340	4020

Notes:

1. Salinity classifications are based on classifications presented on page 5-8 of National Water Quality Management Strategy (1992) publication entitled '*Australian Water Quality Guidelines for Fresh and Marine Waters*''.
2. Values highlighted by shading are outside the range low-salinity.
3. All piezometers were pumped empty on 19/03/2013 and groundwater depth was measured 24 hours later on 20/03/2013.
4. NM = Not measured.
5. Piezometers were installed on 21/01/2013

4.5.2. Groundwater within Alluvial Soils

Groundwater within Alluvial soils was found to be rated as Medium Salinity and is only suitable for irrigation purposes on soils that are well drained.

Whilst all piezometers were at the time of installation initially dry, after an extended period of heavy rain, shallow groundwater was detected and ranged in depth from within 0.5 metres of the soil surface on 28/02/2013 at location 201368-15 to 2.2 metres at location 201368-16 approximately one week after the extended period of heavy rain ended.

4.5.3. Groundwater within Alluvial Soils

Groundwater within the residual soils was found to range from Low Salinity at location 201368-17 to High Salinity at location 201368-13. The low salinity level at location 201368 was likely as a result of surficial seepage from recent rain saturating the soil profile rather than an interaction with a deeper groundwater regime as a more elevated salinity level would have been anticipated. The higher salinity levels at location 201368-17 are considered to be more typical of the deeper groundwater regime of the Study Area.

High Salinity groundwater is not suitable for irrigation purposes.

Whilst all piezometers were at the time of installation initially dry, after an extended period of heavy rain, shallow groundwater was detected and ranged in depth from within 0.9 metres of the soil surface at location 201368-17 to 3.2 metres at location 201368-18.

4.6 Scaling and corrosion of soils and groundwater toward steel and concrete

Based on laboratory analysis results (Appendix 3 and 4), the scaling and corrosion categories of onsite soils and groundwater toward steel and concrete are presented in Table 6.

Table 6: Summary of laboratory analysis results for scaling and corrosion assessment of soils and groundwater toward steel and concrete.

Soil Type	Soil horizon (depth in mm)	Soil attribute - measured range					Exposure Class[1,2,7]	
		pH[1,2] (water 1:5)	Chloride[1] (1:5) (ppm)	Sulphate[1,2] (1:5) (expressed as SO_4) (ppm)	Resistivity[1] Ohm.cm	EC_e [2,5] (dS/m)	Concrete	Steel
Alluvial soils	A (<600)	6.5-6.7	30-50	10-20	10620-11390	0.3	NA (A1)	NC
	B (600-3000)	6.6-6.7	10-40	5-20	17770-36590	0.2	NA (A1)	NC
Residual soils	A (<250)	6.1-7.4	30-230	20-70	2640-6520	0.2-1.0	NA (A1)	NC
	B (250-750)	6-8.8	100-1100	20-170	340-6800	0.1-4.8	NA(A2)	Mo
	B/C (750-3000)	5.4-8.5	20-1330	10-550	300-5070	0.3-7.0	NA(A2)	Mo
	Ground water	8.0	4020	340		2.73 (mS/cm direct measurement not EC_e)	-	NC
All	>3.0m	Adopted values. Unless otherwise demonstrated by laboratory analysis of onsite soils and groundwater this exposure class is to be adopted for all structures below a depth of 3.9m.					S (B2)	S

1. Exposure status (NA = Non-Aggressive, NC = Non-Corrosive, Mi = Mild, Mo = Moderate, S = Severe, VS = Very Severe) classifications are based on Table 6.4.2C (page 40) and Table 6.5.2C (page 43) of the AS2159:2009 Piling Design and Installation standard.
2. Exposure status (A1, A2, B1, B2, C2) classifications are based on: Table 4.8.1 (page 56) and Table 4.8.2 (page 57) of the AS 3600-2009 Concrete Structures standard and Table 5.1 (page 56) and Table 5.2 (page 57) of the AS 2870 – 2011 Residential Slabs and footings.
3. Properties highlighted by shading are outside the range for a non-aggressive or non-corrosive status.
4. Soil and horizon depth was variable. The reported depth refers to the depth that a soil horizon was first intercepted at any location. Soil attributes are grouped based upon horizon categories and may represent soil collected from deeper than the stated depths. For actual horizon depth boundaries at each sampling location refer to **Appendix 1**. .
5. EC (1:5) values were converted to EC_e values based on texture conversion factors in Table 6.1 of the 'Site Investigations for Urban Salinity' guideline (**DLWC, 2002a**).
6. Adopted values. Unless otherwise demonstrated by laboratory analysis of onsite soils and groundwater this exposure class is to be adopted for all structures below a depth of 3.9m.

4.7 Construction design parameters for concrete and steel structures

Based on laboratory analysis results recommended design parameters for non-residential surface concrete structures (such as footpaths, culverts etc), sub-surface structures (piles and piers) and residential slabs and foots are presented in Tables 6, 7 and 8 respectively.

4.7.1. Surface concrete structures

Design parameters for surface structures (Table 7) are based on Tables 4.8.1 and 4.10.3.2 of AS 3600-2009 Concrete Structures. This standard sets out the minimum requirements for the design and construction of concrete building structures and members that contain reinforcing steel and tendons, or both. It also sets out the minimum requirements for plain concrete pedestals and footings.

Table 7: Design parameters for surface structures designed in accordance with AS 3600-2009 Concrete Structures.

		Concrete design parameters[2]		
Infrastructure area	**Exposure class[1]**	**Source**	**Strength (MPa)**	**Minimum cover (mm)**
Alluvial soils less than 3.0 metres in depth	A1	Table 4.8.2 of AS 3600-2009	20	20
Residual soils less than 3.0 metres in depth	A2	Table 4.8.2 of AS 3600-2009	25	30
All soils greater than 3.0 metres in depth	B2	Table 4.8.2 of AS 3600-2009	40	55

Notes:

1. Exposure classes are based on comparison of soil properties presented in Tables 3 and 5 to the classifications outlined in Tables 4.8.1 (page 56) and 4.8.2 (page 57) of AS 3600-2009 Concrete Structures.
2. Design recommendations are based on Table 4.8.2 (page 57) and Table 4.10.3.2 (page 58) of AS 3600-2009 Concrete Structures.

4.7.2. Sub-surface structures (piles and piers)

Design parameters for sub-surface structures (Table 8) are based on Table 6.4.3 of AS 2159-2009 Piling Design and Installation. This standard sets out the minimum requirements for the design and construction of piled footings for civil engineering and building structures on land or immediate inshore locations.

Table 8: Design parameters for sub-surface structures (including piles and piers) designed in accordance with the AS 2159-2009 Piling Design and Installation.

	Exposure class		Concrete design parameters[3]		Steel design parameters[2]
Infrastructure depth	**Concrete[1]**	**Steel[2]**	**Strength (MPa)**	**Minimum cover (mm)**	**Corrosion allowances for unprotected steel (mm/year)**
Alluvial Soils less than 3.0 metres in depth	NA	NC	20	45	<0.01
Residual Soils less than 3.0 metres in depth	NA	Mo	20	45	0.02-0.04
All soils greater than 3.0 metres in depth	S	S	50	70	0.04-0.1

1. Concrete exposure classes are based on comparison of soil properties presented in Table 2 to the classifications outlined Table 6.4.3 of AS 2159-2009 Piling design and installation. NA = non-aggressive, Mi = Mild, Mo = Moderate, S = Severe, VS = Very Severe.
2. Steel exposure classes are based on comparison of soil properties presented in Table 2 to the classifications outlined Table 6.5.2(C) of AS 2159-2009 Piling design and installation. NC = non-corrosive, Mi = Mild, Mo = Moderate, S = Severe, VS = Very Severe. Design parameters for steel are based upon Table 6.5.3 (page 44) of AS2159-2009.
3. Assuming a 50 year design life.

4.7.3. Residential slabs and footings

Design parameters for residential slabs and footings (Table 9) are based on Tables 5.3 and 5.4 of AS AS2870-2011 Residential Slabs and Footings. This standard sets out the minimum performance criteria and specific designs for footing systems for foundation conditions commonly found in Australia and to provide guidance on the design of footing systems by engineering principles.

Table 9: Design parameters for residential slabs and footings designed in accordance with the AS AS2870-2011 Residential Slabs and Footings.

		Concrete design parameters[2]		
Infrastructure area	**Exposure class[1]**	**Source**	**Strength (MPa)**	**Minimum reinforcing cover (mm)**
Alluvial Soils less than 3.0 metres in depth	A1	Tables 5.3 and 5.4 (page 57) and Clause 5.3.2 of AS 2870-2011	20	40 for unprotected ground 30 with a damp-proofing membrane in contract with ground) 20 to an internal surface
Residual Soils less than 3.0 metres in depth	A2	Tables 5.3 and 5.4 (page 57) and Clause 5.3.2 of AS 2870-2011	25	45
All soils greater than 3.0 metres in depth	B2	Table 5.4 (page 57) of AS 2870-2011	40	65

Notes:

1. Exposure classes are based on comparison of soil properties presented in Tables 3 and 5; and
2. Design recommendations are based Table 5.4 (page 57) and Clause 5.3.2 of AS 2870-2011.

4.8 Summary of salinity hazards identified within the Study Area

The Study Area was found to contain a number of salinity hazards. These hazards are summarised in Table 10 and are categorized based on the hazard categories outlined in the '*Western Sydney Salinity Code of Practice*' (pages 16-19 0f WSROC, 2004).

For further information on the processes associated with these hazards refer to Appendix 1 of this Study.

Table 10: Summary of salinity hazards identified within the Study Area

Salinity hazard (WSROC, 2004)	Identified (Yes/No)	Characteristics
Localised concentration of salinity	Yes	Laboratory analysis results for salinity are summarised in Table 3. Alluvial Soils (Figure 7) have the following features: • Topsoil's are non-saline. • Subsoil's are non-saline. Residual Soils (Figure 7) have the following features: • Topsoil's are non-saline. • Subsoil's range in salinity level from non-saline to moderately saline.
Shale Soil Landscape (including sodic soils)	Yes	Both shale soil landscapes and sodic soils were identified within the investigation area. Laboratory analysis results for scaling and corrosion assessment of soils toward steel and concrete, salinity and sodicity are summarised in Tables 3, 4 and 6. Alluvial Soils (Figure 7) have the following features: • Topsoil's are non-sodic, non-aggressive to concrete and non-corrosive to steel. Based on AS 3600 Concrete Structure and AS 2870-2011 Residential Slabs and Footings these soils are an A1 exposure class. • Subsoil's are non-sodic, non-aggressive to concrete and moderately corrosive to steel. Based on AS 3600 Concrete Structure and AS 2870-2011 Residential Slabs and Footings these soils are an A1 exposure class. Residual Soils (Figure 7) have the following features: • Topsoil's are non-sodic, non-aggressive to concrete and non-corrosive to steel. Based on AS 3600 Concrete Structure and AS 2870-2011 Residential Slabs and Footings these soils are an A1 exposure class. • Subsoil's are sodic (dispersive), non-aggressive to concrete and moderately corrosive to steel. Based on AS 3600 Concrete Structure and AS 2870-2011 Residential Slabs and Footings these soils are an A2 exposure class.
Deeply weathered soil landscapes	No	This salinity hazard was not identified within the Study Area.
Groundwater salinity	Yes	This salinity hazard was identified within the Study Area. The groundwater regime of the Study Area consists of the following features: • Intermittently shallow groundwater within the area delineated as containing Alluvial Soil (Figure 7). After rain the groundwater in this area water found to range from 0.5 to 2.0 metres below ground level. If residential construction occurs in this area without ameliorating this

Salinity hazard (WSROC, 2004)	Identified (Yes/No)	Characteristics
		constraint significant potential exits for damage to built infrastructure from intermittently shallow saline groundwater tables in this area; • Highly saline groundwater was encountered at a depth of 4.3 metres (location 201368-13) in a First Order Watercourse within the area delineated as containing Residual Soils (Figure 7); and • Non-saline groundwater was encountered at a depth of 0.9 metres at location 201368-17. This location is located at the 'break-of-slope' topographic location and it is suspected that groundwater at this location resulted from sub-soil drainage resulting from recent prolonged heavy rain and was not as a result of a deeper groundwater regime surfacing at this location. If a deeper groundwater regime was surfacing at this location saline groundwater would have been anticipated. As a safeguard measure it is recommended that future Development Controls should include a further detailed groundwater assessment of the Study Area.

5.0 SALINITY MANAGEMENT PLAN (SMP)

5.1 Salinity risk assessment and risk management

This SMP section takes into consideration the salinity hazards and salinity risks on this site and outlines salinity mitigation strategies to address the risks identified in this assessment. Management strategies have been divided on the based of the following:

- Construction design considerations for buildings, roads and drainage systems; and
- Landscaping.

The likelihood of salinity hazards and risks eventuating may be categorized into three levels as follows:

Low: The risk is minimal and adverse impacts are unlikely to occur unless under exceptional circumstances;

Moderate: The risk of adverse salinity impacts is moderate and some management procedures should be in place to reduce such risk;

High: The risk of adverse salinity impacts is high and proper management and treatment will be required to mitigate risk.

5.2 Salinity management recommendations

Recommendations for the management of onsite salinity hazards identified in this Study are outlined in Table 11 and in brief include measures and management strategies to manage salinity risks associated with soil conditions, drainage and construction aspects.

Table 11: Salinity Management Recommendations

Possible hazard or environmental risk	Potential impact/s	Risk class	Control measures and management
Physical attack of concrete and steel by aggressive soil and groundwater conditions. Including buildings, driveways, fencing, footings, and electrical earthing devices etc.	Possible impacts include; possible electrocution risk; partial or complete destruction of built infrastructure; and death of vegetation.	Moderate to High	All buildings and associated infrastructure must: • be designed by a structural engineer for the soil salinity, scaling and corrosion conditions defined in this report (**Tables 3, 5 and 6**) and unless otherwise designed by a structural engineer, must have the concrete strengths, minimum cover (mm) to reinforcing and scaling allowances outlined in **Tables 7, 8 and 9**. • use building materials that are salt tolerant. All masonry units in contact with the ground/onsite soils (including retaining walls) must be 'Exposure Class' in accordance with AS/NZS4456.10. • have subsoil drainage installed on the upslope side of all buildings, slabs, footings and driveways. Subsoil drainage is to include appropriate geotextile fabric for dispersive soil conditions. • have drainage waters from upslope service trenches to residences diverted or intercepted via an appropriate sub-soil drainage system. • have appropriate surface water drainage installed. Surface drainage should be designed to prevent surface ponding. • use appropriate bedding sand for the installation of all services; and • ensure adequate compaction of trench back-fill during installation of services to reduce trench permeability and settling. All imported soil materials are to be tested for compliance with the design parameters outlined in **Table 9** of this report.

Possible hazard or environmental risk	Potential impact/s	Risk class	Control measures and management
			Due to the low permeability of onsite soils water sensitive urban design principles that promote the infiltration of rainwater into onsite soils are not appropriate for this site.
Intermittently shallow groundwater in the location delineated on Figure 7 as containing 'Alluvial Soils'.	Residential infrastructure constructed in this area is at high risk of physical salinity damage and saturation due to intermittently shallow groundwater tables in this area.	High	This area should be filled/raised if it is to be utilised for a residential land-use. Land-filling is to ensure a vertical separation of shallow groundwater tables in this area from built infrastructure. Additional groundwater and flood studies will be required to determine the extent of filling required. These works may be undertaken at the Development Application Stage of development. Alternatively, this area may be utilised to host stormwater treatment devices such as sediment basins to treat stormwater run-off from the development.
Intermittently shallow groundwater in the location delineated on Figure 7 as containing 'Residual Soils'.	Residential infrastructure constructed in this area is at high risk of physical salinity damage and saturation due to intermittently shallow groundwater tables in this area.	High	This area should be subjected to a detailed groundwater assessment at the Development Application Stage of development and when infrastructure locations are known. The detailed groundwater assessment must: • Include the installation of additional piezometers and include monitoring over an extended period of time; and • Consider the location of proposed infrastructure in the context of the local groundwater regime and include protocols to manage the risks identified.
Salt accumulation on retaining wall structures.	Possible impacts include partial or complete destruction of retaining wall structure.	High	The following salinity management controls should be implemented for the management of salinity risks associated with retaining wall structures: • Subsoil drainage should be installed behind all retaining walls with drainage waters diverted to the stormwater collection system. Drainage waters from retaining walls should not discharge to the soil surface or gravel pits; and • Only salt resistant building materials should be used in retaining was structures.
Soil erosion and scouring of sodic sub-soils from excavation works (cut operations).	Possible pollution of stormwater/s with excessive sediments. Possible tunneling and severe erosion.	High	The following salinity management controls should be implemented for the management of salinity risks associated soil erosion risks: • Install adequate erosion controls prior to construction activities, including silt fence and diversionary bunds. • Top-dress (with at least 200mm of non-sodic top-soils) and re-vegetate as soon as practical after soil disturbance of sodic soils.
Risk of tunnel erosion (creation of underground cavities) in sodic subsoils from concentrated water flows post construction.	Possible creation of underground cavities leading to possible road and pavement failure, possible ground failure and excessive sediment loads in the local stormwater drainage system.	High	The following salinity management controls should be implemented for the management of salinity risks associated with potential tunnel erosion: • Use of geotextile fabric rated for 'Dispersive Soils' on all subsoil drains; • Installation of geotextile fabric rated for 'Dispersive Soils' on the exposed soil surface of all retaining walls; • Use appropriate bedding sand for the installation of all services; • Back fill from the installation of services should consist of

Possible hazard or environmental risk	Potential impact/s	Risk class	Control measures and management
			sub-soils replaced at the base of trenches and only top-soils at the surface. • Ensure all pipes are joined appropriately/to the correct standard. This is particularly important for stormwater pipes; and • Ensure adequate compaction of trench back-fill during installation of services to reduce trench permeability and settling.
Risk of poor vegetative growth/plant mortality.	Visual amenity loss and excessive soil erosion.	Low to Moderate	If sub-soil is exposed, treat exposed subsoil with the following ameliorants: • Gypsum at a rate of 500 g per m^2. And then cap the treated sub-soil with at least 200mm of good quality non-sodic topsoil. Appropriate subsoil drainage must be installed upslope of all infrastructure and must incorporate the following: • geotextile fabric that is suitable for dispersive soil conditions; • drainage waters from sub-soil drains must not be permitted to pond on the soil surface and where practical be collected via a reticulated stormwater collection system. Other controls include: • Where practical, avoid planting trees and vegetation that are sensitive to salts; • Minimise water inputs to gardens and parks. Plant species with low water requirements in gardens and mulch garden beds; • Avoid over-irrigation and over-fertilising of parks and landscaped areas; and • Do not irrigate with saline waters.

6.0 SPECIALIST STUDY REQUIREMENTS AND LOCATION WHERE REQUIREMENT IS ADDRESSED

Tables 12A, 12B and 12C provides a summary of the Study and identifies how each of the Specialist Study Requirements have been met.

Table 12A: Satisfaction of Specialist Study Requirements - Output

Output	How and Where Guidelines addressed
A site specific Urban Salinity Assessment (in accordance with "Site Investigations for Urban Salinity' (DLWC, 2002a) which considers the necessary land use planning phases throughout the assessment process;	This document
An examination and analysis of the Salinity Hazard existent on the site.	This document
Practical and relevant information regarding effective salinity planning responses.	Section 5

Table 12B: Satisfaction of Specialist Study Requirements - Objectives

Objectives	**How and Where Guidelines addressed**
To assess the Salinity Hazard of the site to determine whether development will be affected by salinity and whether salinity will be affected by development.	Section 4
To aid in the formulation of Planning Responses that address the off-site, long term and cumulative impacts of the development.	Section 5
To provide guideline for appropriate land uses and management practices on land affected by salinity.	Section 5
To assess the potential damage to building and infrastructure, as well as environmental values that may be caused by salinity on and off the development site.	Section 5
To assess whether the manner in which land use and development on the site may have a significant effect on the groundwater systems, waterways, drainage lines and soils.	Section 5

Table 12C: Satisfaction of Specialist Study Requirements – Tasks/methodology

Tasks/Methodology	**How and Where Guidelines addressed**
Conduct an assessment and collect information on-site in order to determine what further information is required, as well as what further tests and research must be conducted.	Sections 4 and 5
Conduct detailed onsite analysis by methods such as digging soil test pits and installing piezometers.	Section 4
Assess information gathered and undertake further laboratory analysis of selected soils and water samples and interpretations of results.	Section 4
Select appropriate management and evaluation techniques to suit the salt and water processes and the likely future development.	Section 5

7.0 LIMITATIONS OF THIS STUDY

This report has been prepared subject to a number of limitations, these include:

- Site assessments identify actual sub-surface conditions only at those points where samples are taken and when they are taken. Data obtained from the sampling and subsequent laboratory analysis are interpreted by professional consultants and opinions are drawn about the overall sub-surface conditions, the nature and extent of the salinity, the likely impact on any proposed development and appropriate remediation measures. Actual conditions may differ from those inferred, because no professional no matter how qualified and no sub-surface 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;

- An environmental site assessment is based on conditions existing at the time of the investigation and project decisions should not be based on environmental site assessment data that may be affected by time;

- Salinity is complex problem and that can operate at both local and regional scales (WSROC, 2004). At the local scale (the limit of this report), the final impact of salinity in the urban environment will be influenced by many interacting factors, including factors such as the current salinity status of a site (DLWC, 2002a), the type of salts present (DLWC, 2002a), site drainage (DLWC, 2002a), the amount of wetting and drying occurring (DLWC, 2002a), and the type of building materials used for construction and construction technique (DLWC, 2002a). As a consequence, with regard to construction, whilst this report highlights some general salinity risks and makes some recommendations, ultimately the level of precautionary measures to be implemented on this site will be determined by the property owner, the local regulatory requirements and acceptance of some salinity risk. For all sites (including non-saline sites) the importance of good site drainage (reducing the number of wetting and drying cycles), choice of construction materials and construction technique cannot be overemphasized; and

- Salinity is a process which lags between cause and effect, both in time and distance, which makes it difficult to model (WSROC, 2004), and hence manage. At present, there are only limited resources available to aid the site-specific understanding of these processes and prediction of outcomes with regard to salinity with respect to time. Consequently, this assessment, in particular the current salinity status of this property, should be viewed as a 'snap shot' of this site, and that the actual salinity status of this site may change with time. The choice of building materials and general onsite salinity mitigation practices should reflect this uncertainty. Further, due to the nature of salinity (as outlined above), this report provides no guarantee that salinity will not develop, even where all possible precautions have been used.

- In preparing this report, Harvest Scientific Services Pty Ltd has relied upon certain verbal information and documentation provided by the client and/or third parties. Harvest Scientific did not attempt to independently verify the accuracy or completeness of that information. To the extent that the conclusions and recommendations in this report are based in whole or in part on such information, they are contingent on its validity. Harvest Scientific Services assume no responsibility for any consequences arising from any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to Harvest Scientific Services.

- The findings contained in this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site in question. Under no circumstances, however, can it be considered that these findings represent the actual state of the site/sites at all points.
- The application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document. In particular, implications of climate change and/or global warming of any magnitude and extreme rainfall events have not been considered but should they occur, may have a significant impact on the site. The client agrees that such events are possible but nevertheless accepts the risk that they pose.

8.0 STUDY CONCLUSIONS

With regard to the Specialist Study Requirement's stated objectives, the following conclusions are noted:

- This Study has assessed the Salinity Hazards of the Study Area and it was found that:
  a. The Study Area contains the following Salinity Hazards:
     i. Saline and sodic sub-soils;
     ii. Shale Soil Landscapes; and
     iii. Groundwater Salinity.
  b. The impacts from the above salinity hazards on the development are capable of management by implementation of modest salinity management protocols that are included in the Salinity Management Plan section of this Study. These protocols include:
     i. the use of appropriate building materials for the corrosion and scaling conditions that occur onsite;
     ii. sub-soil drainage and minimising water inputs;
     iii. The filling/raising of land mapped as 'Alluvial Soils' on Figure 7. Land-filling is to ensure a vertical separation of shallow groundwater tables in this area from built infrastructure. Additional groundwater and flood studies will need to be undertaken to determine the extent of filling required. These studies may be undertaken at the Development Application Stage of development.

        Alternatively, this area may be utilised to host stormwater treatment devices such as sediment basins to treat stormwater run-off from the development; and
     iv. Additional levels of groundwater assessment at the Development Application Stage of development.
  c. Impacts of the development on salinity hazards are capable of management by modest salinity management protocols that are included in the Salinity Management Plan section of this Study. These protocols include:
     i. the minimisation water inputs; and
     ii. sub-soil drainage upslope of built infrastructure.

- Off-site, long term and cumulative impacts of the development are to be managed by the salinity management protocols outlined in the Salinity Management Plan section of this Study;
- Providing the recommendations outlined in this Study are implemented the land within the Study Area is considered to be capable of hosting the proposed large lot residential land-use;
- The potential for damage to buildings and infrastructure and environmental values was assessed in Section 5 of this Study. Both onsite and offsite impacts are considered to be capable of management via the protocols outlined in Salinity Management Plan section of this Study; and
- The proposed land-use and development within the Study Area are unlikely to have a significant salinity related effect on the groundwater systems, waterways, drainage lines and soils of the Study Area. This is because of the combined low density of development and a number of protocols have been recommended in the Salinity Management Plan section of this Study to manage the potential salinity impacts related to the proposed development.

No impediments to the re-zoning of the Study Area were identified in this Study.

Prepared by:

Jim Cupitt *BSc Agr (Hons) MAusIMM CP(Env)*
Principal Environmental Scientist

Mart Rampe *BSc (Applied Geology)*
Principal

9.0 REFERENCES

Bannerman, S.M. & Hazelton, P.A. (1990) Soil Landscapes of the Penrith 1:100 000 Sheet. Soil Conservation Service of NSW, Sydney

Charman, P.E.V. & Murphy, B.W. (2000) Soils: their Properties and Management (Second Edition). Oxford University Press, Melbourne.

Department of Land and Water Conservation. 2002a. Site Investigations for Urban Salinity (Local Government Salinity Initiative). Department of Land and Water Conservation, Sydney.

Department of Land and Water Conservation. 2002b. Broad Scale Resources for Urban Salinity Assessment (Local Government Salinity Initiative).

Department of Infrastructure, Planning and Natural Resources, 2002. Salinity Potential in Western Sydney. Department of Infrastructure, Planning and Natural Resources.

Department of Land and Water Conservation. 2003. Roads and Salinity (Local Government Salinity Initiative).

Department of Land and Water Conservation. 2003. Building in a Saline Environment.

Department of Land and Water Conservation. 2005. Salinity Indicator Plants (Local Government Salinity Initiative). Department of Infrastructure, Planning and Natural Resources.

Department of Natural Resources, 1997. Salinity Management Handbook. Queensland Department of Natural Resources.

Dias and Thomas., 1997. Salinity in the South Creek Catchment. Department of Land and Water Conservation, Goulbourn.

Geonics Limited, 2003. EM38B Ground Conductivity Meter – Dual Output Version Operating Manual. Geonics Limited.

Harvest Scientific Services 2011. Water Management and Erosion and Sediment Control Plan for Spring Farm Sand and Soil Extraction (continuation of existing operations) Lot 32 DP 635271 Spring Farm

Hazelton, P.A. & Tille, P.J. (1990) Soil Landscapes of the Wollongong to Port Hacking 1:100,000 Sheet. Soil Conservation Service of NSW, Sydney.

Isbell, R.F., 1996. The Australian Soil Classification. CSIRO Australia, Collingwood, Australia.

Jones, D.C. & Clark, N.R., (Eds), (1991) Geology of the Penrith 1:100000 Sheet 9030. New South Wales Geological Survey, Sydney

Mitchell, 2000. Salinity Hazard Mapping and Concept Modelling on the Cumberland Plain, Final Report. Groundtruth Consulting, unpublished.

NSW Government, 2011. Wollondilly Local Environment Plan (LEP) 2011. www.legislation.nsw.gov.au

Old, 1942. The Wianamatta Shale Waters of the Sydney District: their Salinity and a suggested geological explanation. NSW Department of Mines.

Sherwin, L. & Holmes, G.G. (1982) Geology of the Wollongong and Port Hacking 1:100,000 sheets 9029,9129. New South Wales Geological Survey, Sydney.

Strahler, A. N. 1952. Hypsometric (Area Altitude) Analysis of Erosional Topology. *Geological Society of America Bulletin*.

WSROC, 2004. Final Draft – Salinity Code of Practice.

PLATES

PLATE 1 Relatively flat grazing land

PLATE 2 Side-slope grazing land

PLATE 3 Exposed dispersive sodic sub-soil on steep slope

PLATE 4 Hill crest grazing land

PLATE 5 Infrastructure associated with a former dairy

PLATE 6 Infrastructure associated with a former dairy

PLATE 7 Infrastructure associated with a former dairy

PLATE 8 Infrastructure associated with a feed shed

PLATE 9 Infrastructure associated with a former feed shed

PLATE 10 Derelict residence

PLATE 11 Cattle yards

PLATE 12 Effects of salinity processes on susceptible brickwork in former Abbotsford homestead

PLATE 13 Effects of salinity processes on susceptible brickwork in former Abbotsford homestead

PLATE 14 Effects of salinity processes on susceptible brickwork in former Abbotsford homestead

PLATE 15 Effects of salinity processes on susceptible mortar in former Abbotsford homestead

PLATE 16 Effects of salinity processes on susceptible mortar in former Abbotsford homestead

PLATE 17 Exposed dispersive sodic sub-soil associated with former land-slip

PLATE 18 'Cloudy' dam water indicating the potential presence of sodic soils within dam catchment

PLATE 19 View of raised access driveway to former dairy

APPENDIX 1 Extract from WSROC (2004)

5. BACKGROUND TO URBAN SALINITY

5.1 Introduction

Salt is a natural part of the Australian landscape and areas of naturally high soil or water salinity exist throughout the country. However, it has been increasingly recognised that land management practises are resulting in expansion of the areas of land affected by salinity. Correspondingly, salinity is having a greater impact on human activities and development.

Salinity has been recognised as a nationally significant environmental problem for some time. The Salinity Action Funding Program commenced in 1990 and the National Dry land Salinity Program was established in 1993. More recently a number of national and state reports and forums have highlighted the significant hazard of salinity across Australia. In response to this and public concerns, the National Action Plan for Salinity and Water Quality was announced by the Commonwealth Government in 2000 and the NSW State Salinity Strategy was launched in August 2000.

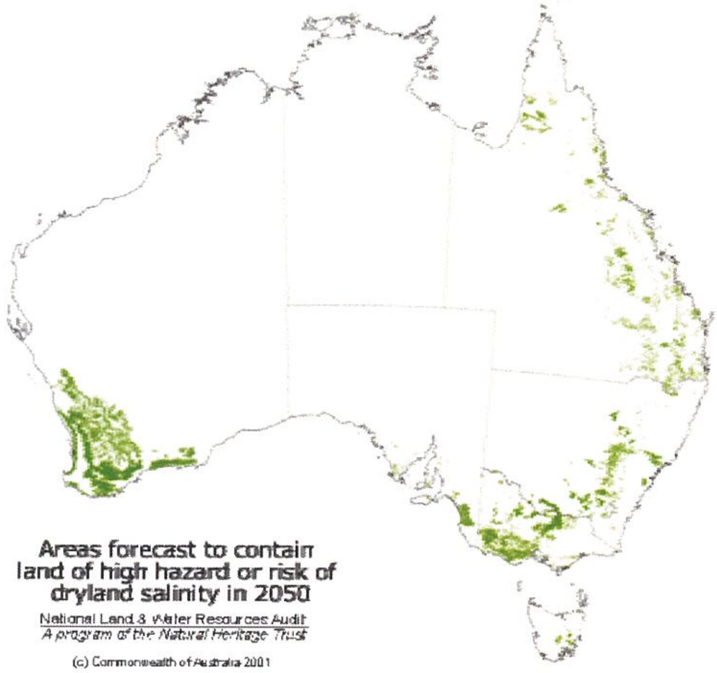


Figure 1: Salinity Hazard for Australia, 2050

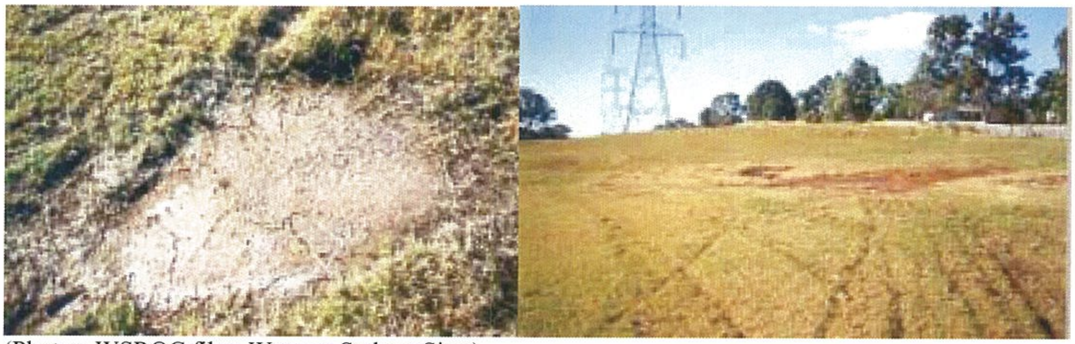
While salinity is widely recognised as a problem in agricultural areas, the impacts of salinity are also being felt in urban areas. Urban salinity is now recognised as a growing problem with potentially high costs to the communities affected. The impacts go beyond the degradation of vegetation and soils and if unmanaged urban salinity can result in significant problems for a variety of urban infrastructure including buildings, roads, underground services, parks and gardens.

5.2 Urban salinity

Salinity occurs when salts naturally found in soil or groundwater mobilise, allowing capillary rise and evaporation to concentrate the salt at the ground's surface. Such movements are caused by changes in the natural water cycle. In these areas, activities, infrastructure and resources on and above the soil surface may be affected.

In urban areas the processes which cause salinity are intensified by the increased volumes of water added to the natural system in urban areas. Additional water comes from the irrigation of gardens, lawns and parks, from leaking underground pipes and pools and from the concentrated infiltration of stormwater. Urban salinity can also be related to sub-surface water flows being impeded by structures such as roads and by poor drainage conditions on a site.

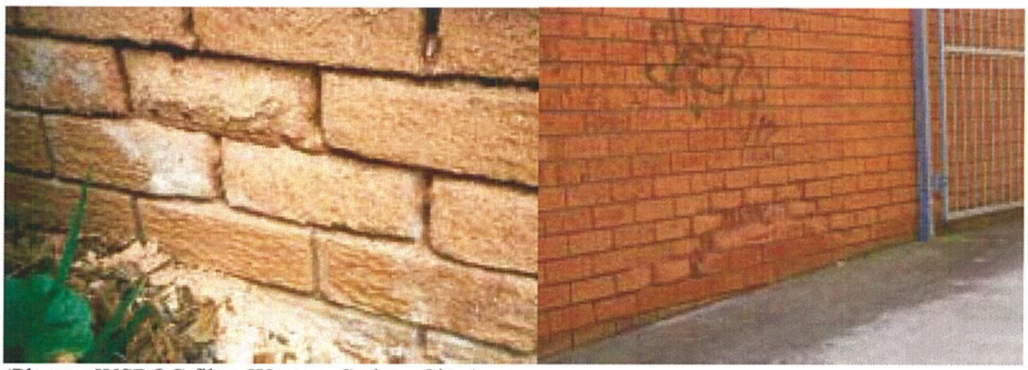
The surface impacts of urban salinity may include damage to vegetation similar to that observed in rural areas and may affect lawns, playing fields and private and public gardens. Potentially salinity in urban areas could also place additional stress on remnant natural areas such as bushland, wetlands, rivers and creeks.



(Photos: WSROC files, Western Sydney Sites)

Figure 2: Salt affected land in Western Sydney

Urban salinity affects built infrastructure, due to the chemical and physical impact of salt on concrete, bricks and metal. The Salt moves with water into the pores of bricks and concrete when they are exposed to damp, salt-laden soils. As the water is evaporated from the material, the salt concentrates and over time this can be substantial enough to cause corrosion and damage the material's structure. This is seen as crumbling, eroded or powdering mortar or bricks, the flaking of brick facing and the cracking or corrosion of concrete. The salt within the material can also have a corrosive effect on steel reinforcing. The long-term consequences can be structural damage.



(Photos: WSROC files, Western Sydney Sites)

Figure 3: Salt affected buildings in Western Sydney

Underground service pipes, such as those used for sewer or water supplies may also be damaged. Increased leakage from the pipes and corroded joints can drive the salinisation processes further.

Additionally, the waterlogging and salts associated with urban salinity have a considerable impact on roads and pavements. The road base can be physically and chemically degraded, becoming more susceptible to cracking, pot-holing and eventual failure.

(Photos: WSROC files, Western Sydney Sites)

Figure 4: Salt affected roads in Western Sydney

Such impacts on public infrastructure contribute to the high community costs from salinity. In the Murray Darling Basin it is estimated that approximately 60% of non-agricultural costs due to salinity are from road damage (Murray-Darling Basin Salinity Audit 1999).

Much of the cost of urban salinity will be borne by local authorities in the form of increased infrastructure repair and replacement, decreased useability of assets and environment, increased environmental obligations and a potentially reduced rate base. While cost figures cannot be directly transferred from one area to another, the following table from Wagga Wagga City Council gives a general indication of the potential magnitude of costs in urban areas. The figures are the annual recurring costs for approximately 1/9th of the Local Government Area, if nothing is done.

Roads	$ 226, 000
Footpaths	$ 4, 400
Parks	$ 103, 400
Houses	$ 72, 500
Industrial	$ 6,000

Source: Annual recurring costs of Salinity in Wagga Wagga, Christiansen 1995

Figure 5: Cost of Urban Salinity

5.3 Managing urban salinity

Salinity is a complex problem that can operate at both a local and regional scale. With the changes to surface flow and groundwater systems related to urban development, mapping the occurrence and impacts of urban salinity is difficult. Additionally, salinity is a process with lags between cause and effect, both in time and distance, which make it difficult to model.

Salinity problems can change substantially over time. It is difficult to predict exactly where salinity will occur and how it will respond to the changing environmental conditions. It is important that management strategies reflect the level of uncertainty.

Approaches to urban salinity management need to be pro-active and precautionary, with efforts focused on avoiding potential salinity problems when development occurs, rather than trying to treat salinity problems once they are identified. This means that some activities will need to be managed on the basis that they may contribute to a salinity problem, without having certainty of how they do contribute. This approach is in keeping with the principles of ESD, as included in the Local Government Act amendment of 1999.

At its most fundamental, urban salinity management is about sustainability, both of the development being proposed, and of the locality and region where the development is situated. The costs and damage associated with urban salinity not only affect the individual property owners, but are also transferred on to the community as a whole through damage to roads, infrastructure and recreation facilities and even potentially through declining land values. Urban salinity and the damage it causes can be seen as a potential future cost that needs to be incorporated into the cost of the urban development process.

Nationally, a number of areas have been managing urban salinity for years and programs exist which may provide guidance for the best practice management of urban salinity in Western Sydney. Western Australia has recognised the impact of dry land salinity on rural towns and established a Rural Towns Program in 1997. Wagga Wagga City Council acknowledged that they had a problem with urban salinity in 1994 and as a result they have developed and implemented a series of Salinity Action Plans. Dubbo City Council has also recognised that there is an urban salinity problem in their city and has developed a Salinity Management Strategy. Additionally many towns in the irrigation districts of NSW and Victoria have been managing urban impacts from irrigation salinity.

At the Federal and State level, initiatives to address urban salinity are more recent. The Commonwealth National Action Plan does recognise urban salinity impacts, but does not treat it as a separate issue. The NSW State Salinity Strategy specifically recognises urban salinity and has established an Urban Salinity Team to develop management options. This includes a Local Government Initiative to assist Councils in managing urban salinity. There is also a move to review the Australian Building Code in order to provide a national standard for building in salt-affected environments.

This Code of Practice attempts to link National, State and local initiatives within a regional management framework to provide a coordinated response to urban salinity in Western Sydney.

5.4 Salinity as a Cross Boundary issue

A cross boundary issue is one that has the potential to manifest its effects in a different area to that where the factors contributing to the problem occur. Due to the relationship between salinity and the water cycle, salinity is an issue with the potential to cross boundaries. This can be at the local scale, eg, between building sites and at the regional scale, such as between local government areas.

An example of a local scale impact is the construction of a road which may change groundwater flow conditions by causing an impediment to flow. This can result in groundwater discharging or collecting on adjacent property, potentially creating salinity problems for that property.

At a regional scale there are the cumulative impacts of a new development that significantly increases the amount of water in the system (due to changed drainage, increased infiltration and increased water use). Such a development may contribute to an accumulation of groundwater lower in the catchment, increasing the salinity problem in this area.

Cross boundary problems may have implications for liability and for on-going management strategies. The potential for cross boundary impacts needs to be carefully considered as part of the assessment of urban salinity and effectively addressed in any Salinity Management responses or plans for a site.

Through regional cooperation and coordination, such as involvement in the Western Sydney Salinity Working Party and the use of the Salinity Code of Practice, councils in Western Sydney can better understand and manage such cross boundary issues.

5.5 Cumulative Impacts and Salinity

Cumulative impacts are an important part of natural resource management and, increasingly, best practice management seeks to find ways to address them. Cumulative impacts refer to the way in which a problem may be caused gradually, due to the accumulation of effects from several contributing factors, or events. These factors, or events, may be separated by space, such as cross boundary issues, or by time, and may be a series of different and seemingly unrelated occurrences. In some cases the individual events or factors may be relatively small and seemingly insignificant. It is the way in which the effects combine over time and space and interact with each other and the environment that produces a cumulative impact.

Cumulative impacts can be difficult to anticipate through the standard assessment processes due to:

- the potential for multiple contributing factors,
- their removal in time and space from the effect and each other, and
- the complexity of the interactions involved.

Special consideration should be given to developments where salinity has the potential to involve cumulative impacts. The most obvious is the often-used example of the role of vegetation in the rising groundwater model. The cumulative effects of vegetation loss in a catchment contribute to a changed water cycle, which can result in a salinity problem. The removal of each individual tree is not sufficient to create the problem, it is the cumulative effect of the removal of many trees over time and across the whole catchment, plus the effect of regularly cropping or grazing. This example is simplistic, but shows clearly the role of cumulative impacts in relation to salinity.

A more relevant urban example is found in the role of increased water input contributing to salinity. Factors such as increased urban water use, irrigation of gardens and playing fields, infiltration of stormwater and leakage from sewer and water pipes all result in substantially increased water input in the water cycle. However, on any one site the total increase in water may seem minor. It is the cumulative impact of the increased water inputs on all sites over time that results in the problem.

It is therefore important that when the potential salinity impacts of a development are considered, the potential cumulative impacts are also assessed. It will be necessary to develop salinity management responses or plans that not only address the immediate impacts, but also address the potential for cumulative impacts. A site which is in an area of moderate salinity potential may seem to have little potential to create a salinity problem on the site, but will still need to address the possible contribution to off-site and regional salinity problems. An example may be by limiting water use on the site, therefore limiting its contribution to changes in the local and regional water balance.

5.6 Salinity in Western Sydney

Salinity has long been recognised in Western Sydney, with references being made to saline groundwater and brackish creeks in historical accounts from the early 1800s (Mitchell 2000). The ecosystems of the region, particularly the Cumberland Plain Woodlands and Riverflat forests contain a number of salt tolerant species. This suggests that the region has naturally high levels of salt in the groundwater and that in places this groundwater is naturally close to the surface. A list of salinity indicator species is included in Appendix (11.3).

The possible sources of salt in Western Sydney are from the region's geology and climate. The main geological formations of Western Sydney are the Wianamatta Shales, which formed in coastal and marine environments and have a naturally high fossil (connate) salt content (McLean and Jankowski 1999). As well as Western Sydney being close to the coast, approximately 10 to 20 kilograms per year of salt are added to each hectare of land, primarily by rainfall (Mitchell 2000). Most of this salt is flushed through and transported away from the area. However, some is added to the soil and groundwater where it accumulates.

In 1942 a paper was produced by the Department of Agriculture (Old 1942) describing the occurrence of saline groundwater across the region and hypothesising that this was related to the distribution of Wianamatta Group shales. This paper explored why groundwater bores in the region were generally unsuitable for agriculture or domestic use.

Salinity was recognised as a surface environmental problem in the region by the former Soil Conservation Service in the 1960s. However, it was not widely acknowledged as an urban issue until 1997, when the Department of Infrastructure, Planning & Natural Resources released the report *"Salinity in the South Creek Catchment"* (Dias and Thomas 1997). This report found that approximately 5% (4500ha) of land in the study area was affected by salinity and that a further 20% (19000ha) of land in the study area could potentially be affected. In association with this DIPNR appointed a Salinity Awareness Officer and a research program was developed with particular focus on urban salinity.

The Western Sydney Salinity Working Party, hosted by WSROC, was established in 1999. This group has representatives from each of the 14 Councils in Greater Western Sydney, as well as from relevant agencies and the development industry. The Working Party is raising the awareness of urban salinity problems in Western Sydney and is a forum where the stakeholders involved can discuss management options and develop opportunities for regional cooperation. WSROC, in partnership with DIPNR, received funds from the Commonwealth's Natural Heritage Trust, to develop this Code of Practice for Salinity Management in Western Sydney and the working party has assisted in the development of this document. Beyond this project the Western Sydney Salinity Working Party will continue to have a role as a regional forum for the discussion of salinity management issues, the balancing of conflicts and the identification of opportunities for cooperation and information exchange.

In 2000 the Western Sydney Environment Taskforce identified salinity as one of the top five key environmental issues for the region, following a survey of 200 stakeholders. The Taskforce therefore created a Salinity Working Group, chaired by DIPNR, to formulate a strategic regional response to managing the issue. This group has facilitated regional salinity potential and monitoring projects and has an on-going role to ensure a comprehensive and coordinated approach in the region.

A Draft Salinity Hazard Map was released in December 2000 and a larger Map of Salinity Potential in Western Sydney in 2003. The map covers most of Western Sydney and depicts potential salinity zones as well as some areas with known salinity problems. It provides a management tool to better conceptualise salinity problems and a basis from which to develop management strategies. The map and the models behind it show that salinity may occur right across the region and the map confirms that salinity is associated with the Wianamatta Group shales and their derived soil materials. It also indicates that there is likely to be more than one mechanism driving the problem and emphasises the importance of poor drainage and waterlogging in determining the severity of salinity problems. (For more information on the Salinity Potential map and its limitations see s7.3.). Currently this mapping is being extended and reviewed in light of some of the early data available from the piezometric monitoring program being conducted by DIPNR. It should be available to the councils in the region by mid-2003.

5.7 Salinity Processes in Western Sydney

Over the last decade there has been a widespread reliance on a single model to explain salinity process, based on Northern Victorian studies. This model uses the concept that the removal of vegetation from hills and slopes results in an increased flow of water to saline groundwater ('recharge'). This groundwater then begins to rise, emerging at lower lying areas in the landscape ('discharge').

The acceptance of this model has been behind most of our assumptions about how to best manage salinity. In particular, this model promotes the belief that planting deep rooted vegetation in key 'recharge' areas will address the low-land problems. However, questions are now being raised as to this model's applicability to all sites and the suitability of management strategies based on this model for all salinity problems.

There are several models that may explain salinity processes and as our conceptualisation of salinity problems determines the types of strategies we develop to manage the problem, it is essential that we develop models that reflect the actual processes and experiences in each situation. It is also important that we recognise the limitations of such models and that we remain prepared to amend them as new knowledge is developed.

In producing the Salinity Potential Map, the Department of Infrastructure, Planning & Natural Resources developed a number of alternative models of processes by which salinity may be occurring in Western Sydney. These are based on the work of Mitchell (2000) and are discussed in a technical report "Salinity Process in Western Sydney" available from DIPNR later this year.

In these models separate 'recharge' and discharge' areas are not defined. All of the landscape could be considered to be recharge areas and the particular processes operating on that site at a particular time could determine the locations of discharge areas.

Identifying the processes causing salinity is necessary when assessing a site to allow the most appropriate and effective management responses to be identified.

In summary, there are a number of processes and indicators associated with salinity in Western Sydney and these may occur on a site individually, or in combination with each other. Some of the key salinity processes are described as follows;

Localised concentration of salinity
On a number of sites in Western Sydney salinity problems have been observed that are caused by localised concentration of salts due to the relatively high evaporation rates. The salt source is probably cyclic salts delivered in the rainfall (approx. 12-15 kg/ha/yr) and the problem is usually associated with waterlogged soil and poor drainage. For example, in areas where surface and sub-surface flow is blocked by an impervious surface such as foundations, walls, paving or concrete. Where frequently wet/damp soil is in contact with bricks or concrete these materials act as a 'wick' to the water and salt and as the water evaporates, the salts concentrate within them. This salt can cause damage in susceptible material over relatively short periods of time.

This process can also cause salinity problems in areas of porous soils adjacent to more permanent water bodies eg. Stormwater basins or artificial lakes. It should be noted that this process is not associated with particularly high salinity levels and the increased water use associated with urban developments can exacerbate the problem. Management of this process on sites needs to focus on reducing water use and improving drainage. Buildings and structures need to be designed to minimise the interference with natural water flow on the site and to minimise rising damp and evaporation through bricks, pavers and concrete. Particular attention should be given to the proper installation of damp courses.

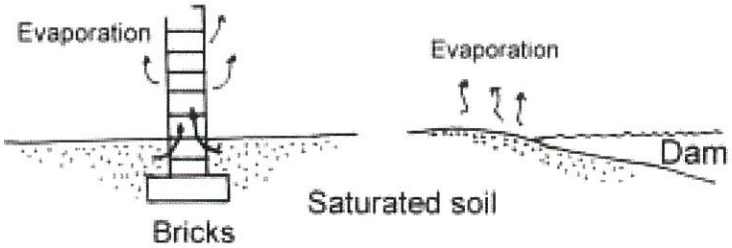


Figure 6: Localised Salinity Model, Mitchell 2000

Shale Soil Landscapes

A number of soil landscapes in Western Sydney have poorly drained duplex (texture contrast) soils. The topsoil (A horizon) is usually a loam and subsoil (B Horizon) is typically clay. As water moves more easily through loams than clays, in many of these soils, shallow soil water flows laterally across the upper B-horizon. Salt therefore usually accumulates in the clayey B-Horizon section of the soil.

The surface expression of this salinity occurs in areas where the soil water accumulates and seeps to the surface and where evaporation causes the salts to concentrate. This is common on lower slopes, or on natural and constructed flats in mid-slope across much of Western Sydney.

Salinity can also cause sodic soils and is a problem in a number of the soil landscapes of Western Sydney. These soils are defined by the dominance of sodium in the exchangeable ions of the sub-soil or B Horizon. These soils also tend to be highly dispersive, erodible and poorly drained. Sites containing sodic soils require careful management in order to minimise disturbance and avoid salinity and erosion problems.

Additionally, when sub soils are exposed by the depth of the cut, or when buildings or infrastructure are placed in a way that exposes them to the B- horizon or causes water accumulation, salinity can become a problem. Where the saline soil is exposed re-vegetation can be very difficult and on-going erosion can result in the further exposure of saline material. Information on the soil salinity at various depths and the depth of the B-horizon is needed to determine the depth of cut and the necessary exposure classification of structures. On affected sites the impeding of sub-surface water flows and disturbance of the B-horizon needs to be minimised. It should be noted that on some of these sites the situation is complicated by deep groundwater interactions.

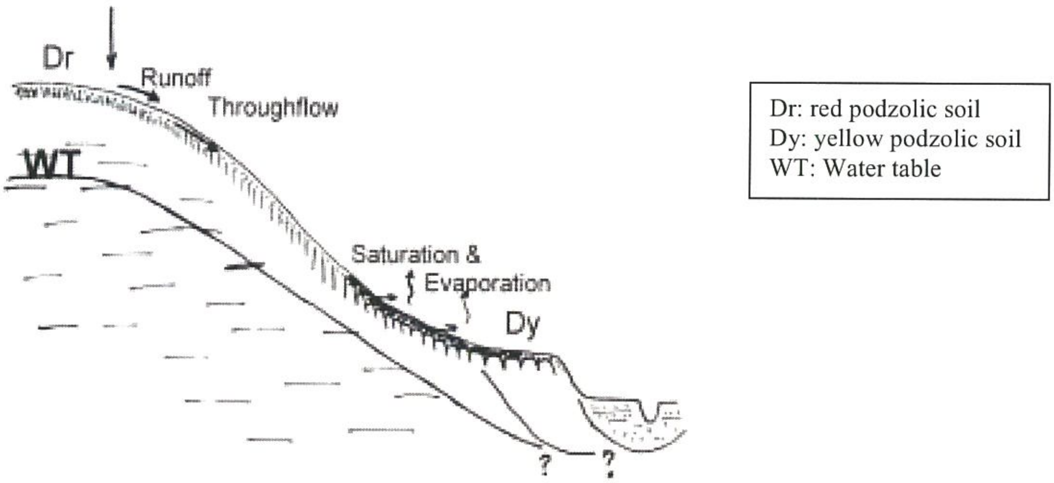


Figure 7: Shale Soil Landscape Model, Mitchell 2000

Deep Groundwater Salinity

This form of salinity is more like that depicted in the traditional salinity model. Salinity problems occur when brackish or saline groundwater rises to a level where capillary action in the soil allows the water and dissolved salts to reach the surface, where they concentrate over time. Groundwater rises are caused by increased water infiltration and may relate to above average natural rainfall, vegetation loss, irrigation, increased water use in urban areas, or construction of seepage pits or surface water bodies.

When groundwater rises to a level where capillary action brings it in contact with buildings or infrastructure, or where developments intercept the groundwater, damage due to salinity can occur. It should be noted that the depth for capillary movement varies depending on the soil type and may be as great as several metres. Additionally, the rate of groundwater rises associated with urban development can be substantial and often unpredictable. Management strategies need to reduce water infiltration, maintain natural water balance and maintain healthy vegetation in order to address this salinity process. In some cases groundwater drainage may be an option, but careful attention must be given to water quality and disposal.

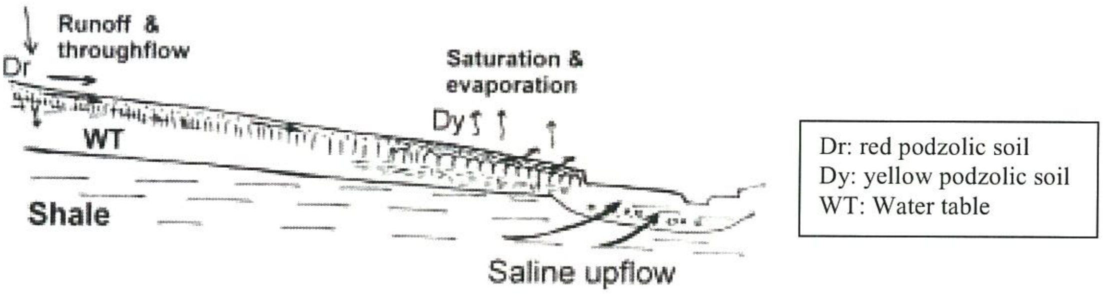


Figure 8: Deep Groundwater Model, Mitchell 2000

Deeply Weathered Soil Landscape

There are a number of sites in Western Sydney which have high salt loads and where the evaporated salts have been found to have high sulphate levels. It is believed that salinity in these areas is related to un-mapped deeply weathered soil landscapes, made up of fluvial gravel, sand and clay. Salinity problems associated with these sites are often mid-slope and hilltops may be affected due to perched saline watertables.

Sulphates are very aggressive in their impact on concrete and brickwork. The identification of areas affected by this type of salinity is very important and the use of building material resistant to sulphates is recommended.

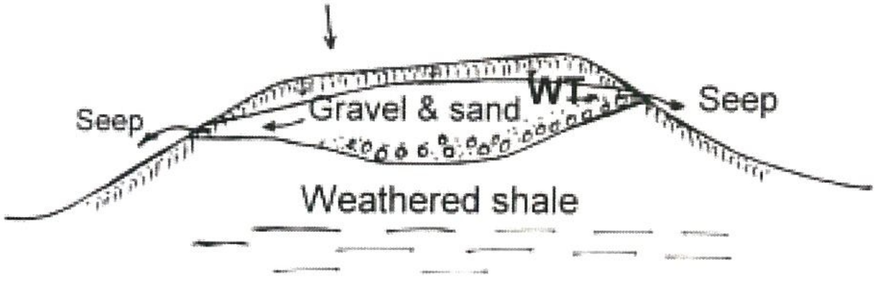


Figure 9: Deeply Weathered Soil Landscape Model, Mitchell 2000

6. SALINITY AND DEVELOPMENT

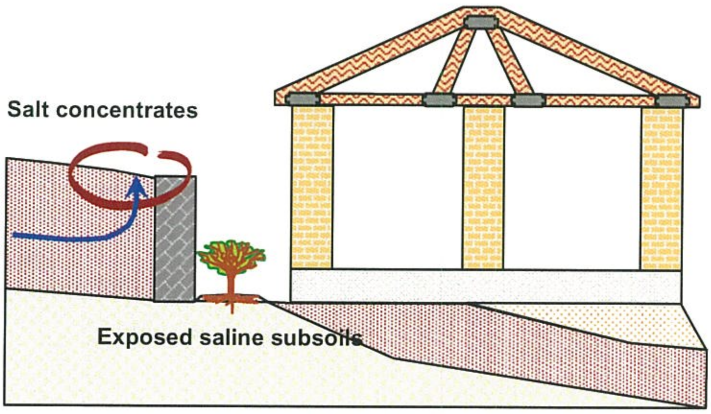
6.1 The impact of urban development

While the impact of salinity on urban development is increasingly being considered in areas with a salinity potential, the potential impacts of development on salinity must also be given equal consideration.

In Western Sydney urban development may contribute to salinity problems in the following ways:

- **By exposing sodic or saline sub-soils**. When areas are developed the processes of cut and fill, particularly for slab on ground construction, disturbs the upper layers of soils. If the lower soil profile has saline or sodic properties, this can result in the occurrence of salinity problems and erosion. This may also lower the surface closer to the water table.
- **By increasing the level of regional groundwater and encouraging the development of perched water tables**. Urban development tends to increase the amount of water entering the natural system, eg, the irrigation of parks and gardens, leaking stormwater and sewer pipes and changes in stormwater flows and concentrations. As well, compaction and fill changes permeability and soil drainage and can contribute to the creation of perched water tables.
- **By changing soil groundwater flow and creating areas of impeded drainage or forced discharge.** This can result in sub-soil salinity being expressed on the surface at these points, eg, where roads, house slabs, retaining walls or trenches impede or intercept the soil water flow, cause compaction, or create hydraulic pressure that raises groundwater.
- **By developing or disturbing areas sensitive to salinity.** Some areas exist in a delicate balance that, once disturbed, are difficult to restore and rapidly deteriorate, eg, removing established salt resistant vegetation in riparian corridors could increase erosion and down stream disturbances.

Figure 10: Development and salinity (Figure: DIPNR 2002)



6.2 The relationship between salinity and different developments

The following table gives some of the main development types or activities in urban areas and outlines the potential salinity impacts and general management options that might be considered in each case.

APPENDIX 2 Soil profile logs

SOIL PROFILE LOG 201368-01

Project	Re-zoning	**Method of Investigation**	Mechanical excavation
Job Number	201368	**Aspect**	
Location	No. 1 Abbotsford Road, Abbotsford	**Slope**	
Land Use	Grazing	**Topography**	
Geology	Ashfield Shale	**Soil Landscape Unit**	
ASC Classification		**External Drainage**	

Horizon	Depth (mm)	Boundary	Munsell Colour	Colour Class	Texture	Coarse Fraction	Structure	Fabric	$CaCO_3$	pH	H_2O_2 test	Comments
A	0 - 600	Gradual	5YR 3/3	Dark Reddish Borwn	CL	Nil	Moderate	R	N/A	N/A	+ Diffuse Mn or OM	Topsoil, pedo-logically organised. No mixing.
B	600 - 1100	Gradual Gradual	5YR 5/6	Yellowish Red	MC	Nil	Moderate	R	N/A	N/A	+ Nodular Mn	Mottled Red / Grey
C	1100 - 3500	Gradual Gradual	Fractured shale layer.						N/A	N/A	+ Diffuse Mn	Moist but no free flowing groundwater.
C	3500 - 3800	Gradual	Pedo-logically disorganised mix of fractured shale and mottled yellow/grey light to medium clay.						N/A	N/A	+ Diffuse Mn	Suspected former slip horizon. Moist.

ASC: Australian Soil Classification

Notes:

1. Profile in area of former land-slip.
2. Profile terminated at a depth of 3.8 metres in a mix of light to medium clay and fractured shale.

Abbreviations:

CL = Clay Loam
MC = Medium Clay
HC = Heavy Clay
N/A = Not assessed
R = Rough
S = Smooth
WS = Weathered shale
OM = Organic Matter
Mn = Ferromagniferous Manganese

Author	JC
Date Logged	09/01/2013

SOIL PROFILE LOG 201368-02

Project	Re-zoning	**Method of Investigation**	Mechanical excavation
Job Number	201368	**Aspect**	
Location	No. 1 Abbotsford Road, Abbotsford	**Slope**	
Land Use	Grazing	**Topography**	
Geology	Ashfield Shale	**Soil Landscape Unit**	
ASC Classification		**External Drainage**	

Horizon	Depth (mm)	Boundary	Munsell Colour	Colour Class	Texture	Coarse Fraction	Structure	Fabric	$CaCO_3$	pH	H_2O_2 test	Comments
A	0 - 800	Gradual Gradual	5YR 3/3	Dark Reddish Borwn	CL	Nil	Moderate	R	N/A	N/A	+ Diffuse Mn or OM	Topsoil, pedo-logically organised. No mixing.
B	800 - 1700	Gradual Gradual	5YR 5/6	Yellowish Red	MC	Nil	Moderate	R	N/A	N/A	+ Nodular Mn	Mottled Red / Grey. Pedo-logically organised. No mixing.
B/C	1700 - 2700	Gradual	7.5YR 5/4	Brown	MC	20-40% shale	Weak	R	N/A	N/A	+ Nodular Mn	Pedologically dis-organised. Possible slip zone.
C	>2700	Shale.									+ Nodular Mn	Moist.

ASC: Australian Soil Classification

Notes:

1. Profile in area of former land-slip.
2. Profile terminated at a depth of 2.7 metres in shale.

Abbreviations:

CL = Clay Loam
MC = Medium Clay
HC = Heavy Clay
N/A = Not assessed
R = Rough
S = Smooth
WS = Weathered shale
OM = Organic Matter
Mn = Ferromagniferous Manganese

Author	JC
Date Logged	09/01/2013

SOIL PROFILE LOG 201368-03

Project	Re-zoning	**Method of Investigation**	Mechanical excavation
Job Number	201368	**Aspect**	
Location	No. 1 Abbotsford Road, Abbotsford	**Slope**	
Land Use	Grazing	**Topography**	
Geology	Ashfield Shale	**Soil Landscape Unit**	
ASC Classification		**External Drainage**	

Horizon	Depth (mm)	Boundary	Munsell Colour	Colour Class	Texture	Coarse Fraction	Structure	Fabric	$CaCO_3$	pH	H_2O_2 test	Comments
A	0 - 450	Gradual Gradual	5YR 5/3	Reddish Brown	CL	Nil	Moderate	R	N/A	N/A	+ Diffuse Mn or OM	Topsoil, pedo-logically organised. No mixing.
B	450 - 900	Gradual Gradual	2.5YR 5/3	Red	MC	Nil	Moderate	R	N/A	N/A	-	Pedo-logically organised. No mixing.
B/C	900 - 1700	Gradual Gradual	2.5YR 5/1	Reddish Grey	MC	5 - 20% shale	Weak	R	N/A	N/A	+ Diffuse Mn	
C	>1700	Gradual	Shale									

ASC: Australian Soil Classification

Notes:

1. Residual soil profile.
2. Profile terminated at a depth of 1.7 metres in shale.

Abbreviations:

CL = Clay Loam
MC = Medium Clay
HC = Heavy Clay
N/A = Not assessed
R = Rough
S = Smooth
WS = Weathered shale
OM = Organic Matter
Mn = Ferromagniferous Manganese

Author	JC
Date Logged	09/01/2013

SOIL PROFILE LOG 201368-04

Project	Re-zoning	**Method of Investigation**	Mechanical excavation
Job Number	201368	**Aspect**	
Location	No. 1 Abbotsford Road, Abbotsford	**Slope**	
Land Use	Grazing	**Topography**	
Geology	Ashfield Shale	**Soil Landscape Unit**	
ASC Classification		**External Drainage**	

Horizon	Depth (mm)	Boundary	Munsell Colour	Colour Class	Texture	Coarse Fraction	Structure	Fabric	$CaCO_3$	pH	H_2O_2 test	Comments
A	0 - 500	Gradual Gradual	2.5YR 4/4	Reddish Brown	CL	Nil	Moderate	R	N/A	N/A	+ Diffuse Mn or OM	Topsoil, pedo-logically organised. No mixing.
B	500 - 2500	Gradual Gradual	2.5YR 4/6	Red	MC	Nil	Moderate	R	N/A	N/A	+ Nodular Mn	Pedo-logically organised. No mixing.
B/C	2500 - 4000	Gradual Gradual	5Y 8/1	White	MC	5 - 10% shale	Weak	R	N/A	N/A	-	Yellow mottles.
C	>4000	Gradual	Highly weathered shale									

ASC: Australian Soil Classification

Notes:

1. Residual soil profile.
2. Profile terminated at a depth of 4.0 metres in highly weathered shale.

Abbreviations:

CL = Clay Loam
MC = Medium Clay
HC = Heavy Clay
N/A = Not assessed
R = Rough
S = Smooth
WS = Weathered shale
OM = Organic Matter
Mn = Ferromagniferous Manganese

Author	JC
Date Logged	09/01/2013

SOIL PROFILE LOG 201368-05

Project	Re-zoning	**Method of Investigation**	Mechanical excavation
Job Number	201368	**Aspect**	
Location	No. 1 Abbotsford Road, Abbotsford	**Slope**	
Land Use	Grazing	**Topography**	
Geology	Ashfield Shale	**Soil Landscape Unit**	
ASC Classification		**External Drainage**	

Horizon	Depth (mm)	Boundary	Munsell Colour	Colour Class	Texture	Coarse Fraction	Structure	Fabric	$CaCO_3$	pH	H_2O_2 test	Comments
A	0 - 350	Gradual Gradual	5YR 5/3	Reddish Brown	CL	Nil	Moderate	R	N/A	N/A	+ Diffuse Mn or OM	Topsoil, pedo-logically organised. No mixing.
B	350 - 650	Gradual Sharp	2.5YR 5/3	Red	MC	5% shale	Moderate	R	N/A	N/A	-	Pedo-logically organised. No mixing.
Possible slip horizon	650-750	Shale layer overlaying B horizon										Possible Slip zone
B	750 - 1900	Sharp Gradual	2.5YR 5/3	Red	MC	Nil	Moderate	R	N/A	N/A	-	Pedo-logically organised. No mixing. Grey mottles
B/C	>1900	Gradual	Weathered shale									

ASC: Australian Soil Classification

Notes:

1. 750mm deep land-slip overlying a residual soil profile.
2. Profile terminated at a depth of 1.9 metres in weathered shale.

Abbreviations:

CL = Clay Loam
MC = Medium Clay
HC = Heavy Clay
N/A = Not assessed
R = Rough
S = Smooth
WS = Weathered shale
OM = Organic Matter
Mn = Ferromagniferous Manganese

Author	JC
Date Logged	09/01/2013

SOIL PROFILE LOG 201368-06

Project	Re-zoning	**Method of Investigation**	Mechanical excavation
Job Number	201368	**Aspect**	
Location	No. 1 Abbotsford Road, Abbotsford	**Slope**	
Land Use	Grazing	**Topography**	
Geology	Ashfield Shale	**Soil Landscape Unit**	
ASC Classification		**External Drainage**	

Horizon	Depth (mm)	Boundary	Munsell Colour	Colour Class	Texture	Coarse Fraction	Structure	Fabric	$CaCO_3$	pH	H_2O_2 test	Comments
A	0 - 500	Gradual Gradual	2.5YR 3/1	Very dark grey	CL	1-2 % shale	Moderate	R	N/A	N/A	+ Diffuse Mn or OM	Topsoil, pedo-logically organised. No mixing.
B	500 - 1100	Gradual Gradual	2.5YR 6/6	Olive yellow	LC	Nil	Massive	R	N/A	N/A	-	Pedo-logically organised. No mixing. Porous
B/C	1100 - 2900	Gradual Gradual	2.5YR 6/6	Olive yellow	LC	5 - 10% shale	Weak	R	N/A	N/A	-	Pedo-logically organised. No mixing. Porous
C	>2900	Gradual	Highly weathered shale									

ASC: Australian Soil Classification

Notes:

1. Residual soil profile.
2. Profile terminated at a depth of 2.9 metres in highly weathered shale.

Abbreviations:

CL = Clay Loam
MC = Medium Clay
HC = Heavy Clay
N/A = Not assessed
R = Rough
S = Smooth
WS = Weathered shale
OM = Organic Matter
Mn = Ferromagniferous Manganese

Author	JC
Date Logged	09/01/2013

SOIL PROFILE LOG 201368-07

Project	Re-zoning	**Method of Investigation**	Mechanical excavation
Job Number	201368	**Aspect**	
Location	No. 1 Abbotsford Road, Abbotsford	**Slope**	
Land Use	Grazing	**Topography**	
Geology	Ashfield Shale	**Soil Landscape Unit**	
ASC Classification		**External Drainage**	

Horizon	Depth (mm)	Boundary	Munsell Colour	Colour Class	Texture	Coarse Fraction	Structure	Fabric	$CaCO_3$	pH	H_2O_2 test	Comments
A	0 - 900	Gradual Gradual	5YR 4/3	Reddish brown	CL	Nil.	Moderate	R	N/A	N/A	+ Diffuse Mn or OM	Topsoil, pedo-logically organised.
$B2_1$	900 - 3500	Gradual Gradual	5YR 5/3	Reddish Brown	LC	1-2% shale	Massive	R	N/A	N/A	+ Nodular Mn	Pedo-logically organised. Porous. Very hard
$B2_2$	3500 - 4000	Gradual Gradual	2.5YR 5/6	Red	MC	Nil	Weak	R	N/A	N/A	+ Diffuse Mn	Pedo-logically organised. Grey mottles. Moist.
$B2_2$	>4000	Gradual	Highly weathered shale									

ASC: Australian Soil Classification

Notes:

1. Residual soil profile.
2. Profile terminated at a depth of 4.0 metres in B2 medium clay horizon.

Abbreviations:

CL = Clay Loam
MC = Medium Clay
HC = Heavy Clay
N/A = Not assessed
R = Rough
S = Smooth
WS = Weathered shale
OM = Organic Matter
Mn = Ferromagniferous Manganese

Author	JC
Date Logged	09/01/2013

SOIL PROFILE LOG 201368-08

Project	Re-zoning	**Method of Investigation**	Mechanical excavation
Job Number	201368	**Aspect**	
Location	No. 1 Abbotsford Road, Abbotsford	**Slope**	
Land Use	Grazing	**Topography**	
Geology	Ashfield Shale	**Soil Landscape Unit**	
ASC Classification		**External Drainage**	

Horizon	Depth (mm)	Boundary	Munsell Colour	Colour Class	Texture	Coarse Fraction	Structure	Fabric	$CaCO_3$	pH	H_2O_2 test	Comments
A	0 - 500	Gradual Gradual	5YR 4/3	Reddish brown	CL	Nil.	Moderate	R	N/A	N/A	+ Diffuse Mn or OM	Topsoil, pedo-logically organised.
$B2_1$	50 - 1200	Gradual Gradual	5YR 5/3	Reddish Brown	MC	1-2% shale	Massive	R	N/A	N/A	-	Pedo-logically organised. Porous. Very hard
$B2_2$	> 1200	Gradual	2.5YR 6/2	Pale red	MC	1-2% shale	Massive	R	N/A	N/A	-	Pedo-logically organised. Porous. Very hard Mottled grey/red.

ASC: Australian Soil Classification

Notes:

1. Residual soil profile.
2. Profile terminated at a depth of 1.2 metres in $B2_2$ medium clay horizon.

Abbreviations:

CL = Clay Loam
MC = Medium Clay
HC = Heavy Clay
N/A = Not assessed
R = Rough
S = Smooth
WS = Weathered shale
OM = Organic Matter
Mn = Ferromagniferous Manganese

Author	JC
Date Logged	09/01/2013

SOIL PROFILE LOG 201368-09

Project	Re-zoning	**Method of Investigation**	Mechanical excavation
Job Number	201368	**Aspect**	
Location	No. 1 Abbotsford Road, Abbotsford	**Slope**	
Land Use	Grazing	**Topography**	
Geology	Ashfield Shale	**Soil Landscape Unit**	
ASC Classification		**External Drainage**	

Horizon	Depth (mm)	Boundary	Munsell Colour	Colour Class	Texture	Coarse Fraction	Structure	Fabric	$CaCO_3$	pH	H_2O_2 test	Comments
A1	0 - 500	Gradual Gradual	7.5YR 5/1	Grey	CL	Nil.	Massive	-	N/A	N/A	+ Diffuse Mn or OM	Topsoil, pedo-logically organised.
$B2_1$	500 - 1200	Gradual Gradual	2.5Y 6/4	Light yellowish brown	LC	Nil.	Weak	R	N/A	N/A	+ Nodular Mn	Pedo-logically organised. Porous. Periodically saturates.
$B2_2$	1200- 3800	Gradual	Gley 1 7/N	Light grey	MC	Nil.	Weak	R	N/A	N/A	-	Pedo-logically organised. Porous. Mottled grey/red.
$B2_3$	3800- 4200	Gradual	2.5YR 6/2	Pale red	MC	Nil.	Massive	R	N/A	N/A	+ Nodular Mn	Pedo-logically organised. Porous. Mottled grey/red.

ASC: Australian Soil Classification

Notes:

1. Residual soil profile.
2. Profile terminated at a depth of 4.2 metres in $B2_3$ medium clay horizon.

Abbreviations:

CL = Clay Loam
MC = Medium Clay
HC = Heavy Clay
N/A = Not assessed
R = Rough
S = Smooth
WS = Weathered shale
OM = Organic Matter
Mn = Ferromagniferous Manganese

Author	JC
Date Logged	09/01/2013

SOIL PROFILE LOG 201368-10

Project	Re-zoning	**Method of Investigation**	Mechanical excavation
Job Number	201368	**Aspect**	
Location	No. 1 Abbotsford Road, Abbotsford	**Slope**	
Land Use	Grazing	**Topography**	
Geology	Ashfield Shale	**Soil Landscape Unit**	
ASC Classification		**External Drainage**	

Horizon	**Depth (mm)**	**Boundary**	**Munsell Colour**	**Colour Class**	**Texture**	**Coarse Fraction**	**Structure**	**Fabric**	**$CaCO_3$**	**pH**	**H_2O_2 test**	**Comments**
A1	0 - 250	Gradual Gradual	7.5YR 5/1	Grey	CL	Nil.	Massive	-	N/A	N/A	+ Diffuse Mn or OM	Topsoil, pedo-logically organised.
$B2_1$	250 - 1000	Gradual Gradual	10YR 6/6	Brownish yellow	MC	Nil.	Weak	R	N/A	N/A	-	Pedo-logically organised. Porous.
$B2_2$	1000 - 1200	Gradual	10YR 7/1	Light grey	MC	Nil.	Weak	R	N/A	N/A	-	Pedo-logically organised. Mottled grey/yellow.

ASC: Australian Soil Classification

Notes:

1. Residual soil profile.
2. Profile terminated at a depth of 1.2 metres in $B2_2$ medium clay horizon.

Abbreviations:

CL = Clay Loam
MC = Medium Clay
HC = Heavy Clay
N/A = Not assessed
R = Rough
S = Smooth
WS = Weathered shale
OM = Organic Matter
Mn = Ferromagniferous Manganese

Author	JC
Date Logged	09/01/2013

SOIL PROFILE LOG 201368-11

Project	Re-zoning	**Method of Investigation**	Mechanical excavation
Job Number	201368	**Aspect**	
Location	No. 1 Abbotsford Road, Abbotsford	**Slope**	
Land Use	Grazing	**Topography**	
Geology	Ashfield Shale	**Soil Landscape Unit**	
ASC Classification		**External Drainage**	

Horizon	Depth (mm)	Boundary	Munsell Colour	Colour Class	Texture	Coarse Fraction	Structure	Fabric	$CaCO_3$	pH	H_2O_2 test	Comments
A1	0 - 400	Gradual Gradual	5 YR 5/1	Grey	CL	Nil.	Massive	-	N/A	N/A	+ Diffuse Mn or OM	Topsoil, pedo-logically organised.
$B2_1$	400 - 1700	Gradual Gradual	5YR 5/6	Yellowish red	MC	Nil.	Weak	R	N/A	N/A	+ Diffuse and nodular Mn	Pedo-logically organised. Porous. Mottled red/grey

ASC: Australian Soil Classification

Notes:

1. Residual soil profile.
2. Profile terminated at a depth of 1.7 metres in $B2_1$ medium clay horizon.

Abbreviations:

CL = Clay Loam
MC = Medium Clay
HC = Heavy Clay
N/A = Not assessed
R = Rough
S = Smooth
WS = Weathered shale
OM = Organic Matter
Mn = Ferromagniferous Manganese

Author	JC
Date Logged	09/01/2013

SOIL PROFILE LOG 201368-12

Project	Re-zoning	**Method of Investigation**	Mechanical excavation
Job Number	201368	**Aspect**	
Location	No. 1 Abbotsford Road, Abbotsford	**Slope**	
Land Use	Grazing	**Topography**	
Geology	Alluvium overlying Ashfield Shale	**Soil Landscape Unit**	
ASC Classification		**External Drainage**	

Horizon	Depth (mm)	Boundary	Munsell Colour	Colour Class	Texture	Coarse Fraction	Structure	Fabric	$CaCO_3$	pH	H_2O_2 test	Comments
A1	0 - 600	Gradual Gradual	5YR 4/1	Dark grey	Clayey Sand	Nil.	Massive	-	N/A	N/A	-	Alluvium Hard-setting and porous.
A2	600 - 1200	Gradual Gradual	2.5Y 7/1	Light Grey	Clayey Sand	Nil	Massive	-				Bleached Alluvium Hard-setting Porous
$B2_1$	1200- 3200	Gradual	5YR 5/6	Yellowish red	FSLC	Nil.	Weak	R	N/A	N/A	+ Diffuse and nodular Mn	Pedo-logically organised. Mottled red/grey

ASC: Australian Soil Classification

Notes:

1. Alluvium overlying a residual soil profile.
2. Profile terminated at a depth of 3.2 metres in $B2_1$ FSLC clay horizon.

Abbreviations:

CL = Clay Loam
MC = Medium Clay
HC = Heavy Clay
FSLC = Fine Sandy Light Clay
N/A = Not assessed
R = Rough
S = Smooth
OM = Organic Matter
Mn = Ferromagniferous Manganese
WS = Weathered shale

Author	JC
Date Logged	09/01/2013

SOIL PROFILE LOG 201368-13

Project	Re-zoning	**Method of Investigation**	Mechanical excavation
Job Number	201368	**Aspect**	
Location	No. 1 Abbotsford Road, Abbotsford	**Slope**	
Land Use	Grazing	**Topography**	
Geology	Ashfield Shale	**Soil Landscape Unit**	
ASC Classification		**External Drainage**	

Horizon	Depth (mm)	Boundary	Munsell Colour	Colour Class	Texture	Coarse Fraction	Structure	Fabric	$CaCO_3$	pH	H_2O_2 test	Comments
A1	0 - 400	Gradual Gradual	2.5YR 6/3	Light Yellowish Brown	CL	Nil.	Weak	-	N/A	N/A	+ Diffuse Mn or OM	Topsoil, pedo-logically organised.
$B2_1$	400 - 800	Gradual Gradual	7.5YR 5/6	Strong Brown	LC	Nil.	Weak	R	N/A	N/A	+ Nodular Mn	Pedo-logically organised. Porous. Periodically saturates.
$B2_2$	800- 4300	Gradual	Gley 1 7/N	Light grey	MC	Nil.	Weak	R	N/A	N/A	-	Pedo-logically organised. Porous. Mottled grey/red.

ASC: Australian Soil Classification

Notes:

1. Residual soil profile.
2. Profile terminated at a depth of 4.3 metres in $B2_3$ medium clay horizon.
3. Free flowing groundwater present at 4.2 metres

Abbreviations:

CL = Clay Loam
MC = Medium Clay
HC = Heavy Clay
N/A = Not assessed
R = Rough
S = Smooth
WS = Weathered shale
OM = Organic Matter
Mn = Ferromagniferous Manganese
LC = Light Clay

Author	JC
Date Logged	09/01/2013

SOIL PROFILE LOG 201368-14

Project	Re-zoning	**Method of Investigation**	Mechanical excavation
Job Number	201368	**Aspect**	
Location	No. 1 Abbotsford Road, Abbotsford	**Slope**	
Land Use	Grazing	**Topography**	
Geology	Alluvium overlying Ashfield Shale	**Soil Landscape Unit**	
ASC Classification		**External Drainage**	

Horizon	Depth (mm)	Boundary	Munsell Colour	Colour Class	Texture	Coarse Fraction	Structure	Fabric	$CaCO_3$	pH	H_2O_2 test	Comments
A1	0 - 300	Gradual Gradual	7.5YR 4/4	Strong Brown	FSCL	Nil.	Massive	-	N/A	N/A	-	Alluvium Hard-setting and porous.
A2	300 - 1200	Gradual Gradual	7.5YR 5/6	Strong Brown	Sandy Clay	Nil	Massive	-			+ Diffuse	Bleached Alluvium Hard-setting Porous
$B2_1$	1200- 2900	Gradual	5YR 5/6	Yellowish red	Sandy Clay	Nil.	Weak	R	N/A	N/A	+ Diffuse and nodular Mn	Pedo-logically organised. Mottled Yellow/grey

ASC: Australian Soil Classification

Notes:

1. Alluvium overlying a residual soil profile.
2. Profile terminated at a depth of 2.9 metres in $B2_1$ Sandy Clay horizon.

Abbreviations:

CL = Clay Loam
MC = Medium Clay
HC = Heavy Clay
FSLC = Fine Sandy Light Clay
N/A = Not assessed
R = Rough
S = Smooth
OM = Organic Matter
Mn = Ferromagniferous Manganese
WS = Weathered shale

Author	JC
Date Logged	09/01/2013

Grant Alexander & Associates Pty. Ltd.

CLIENT	Job No.	Borehole No.	Rig		Logged
		15	Digga	✓	S.W.
PROJECT			Gemco		
			Fox		Date
	Lot No.	R.L.	Hand Auger		22/01/13
	–	E/S			

LAYER		1	2	3	4	5	6
GEOL PROFILE	Fill	✓					
	Topsoil						
	Alluvium	✓	✓	✓			
	Indurated Sand						
	Colluvium						
	Residual Soil						
	EW Rock						
	Other						
Depth to base of layer		0.10 m	1.20 m	4.30 m	m	m	m

SOIL Components	1 Primary	1 Second	2 Primary	2 Second	3 Primary	3 Second	4 Primary	4 Second	5 Primary	5 Second	6 Primary	6 Second
Gravel												
Sand	✓		✓			✓						
Silt		✓		✓		✓						
Clay					✓							
Peat												

	1	2	3	4	5	6
USC SYMBOL	SM/	SM/	CL/CH			
PLASTICITY (L - M - H)			M ✓ - H ✓			
GRANULAR MATERIAL Grading (Poor Gap Well)						
Grain Size (F - M - C) Primary	F ✓, M ✓	F ✓, M ✓				
Grain Size (F - M - C) Second			✓ ✓ 35%			
MINOR MATERIAL (Some / Trace) Gravel						
Sand						
Silt						
Clay						
COLOUR Brown			✓			
Red-Brown						
Yellow-Brown						
Grey	✓	light	✓			
White						
Black						
Other						
MOISTURE CONTENT (W < pl > D)	D ✓	D ✓	pl ✓ > ✓			
RELATIVE DENSITY (VL L MD D VD)		MD ✓				
CONSISTENCY (VS S F St Vst)			St ✓ Vst ✓			
ORGANIC MATTER Roots	GRASS					
Plant						
Finely Disseminated						

Termination of Hole						
TC-Bit	V-Bit	Full Depth	Water	X	Collapse	X	Cobbles
Boulders	Hard Clays		NIL		NIL	

GROUNDWATER

General Notes

DCP/SPT RESULTS																															
Depth	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
Reading																														
Depth	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0
Reading																														

Grant Alexander & Associates Pty. Ltd.

CLIENT	Job No.	Borehole No.	Digga ✓	Logged
PROJECT		16	Gemco	S.W.
	Lot No.	R.L.	Fox	Date
	—	E/S	Hand Auger	22/01/13

LAYER	1	2	3	4	5	6
GEOL PROFILE – Fill						
Topsoil	✓					
Alluvium		✓	✓	✓		
Indurated Sand						
Colluvium						
Residual Soil						
EW Rock						
Other						
Depth to base of layer	0.15 m	1.30 m	1.90 m	4.30 m	m	m

SOIL Components	1 Primary	1 Second	2 Primary	2 Second	3 Primary	3 Second	4 Primary	4 Second	5 Primary	5 Second	6 Primary	6 Second
Gravel												
Sand	✓		✓			✓						
Silt		✓		✓		✓		✓				
Clay				✓	✓		✓					
Peat												

	1	2	3	4	5	6
USC SYMBOL	SM	SM/CL	CL/CH	CL/CH		
PLASTICITY (L - M - H)		M	M/H	M/H		
GRANULAR MATERIAL – Grading (Poor Gap Well)						
Grain Size (F - M - C) – Primary	F, M	F, M				
Grain Size (F - M - C) – Second			F, M	F / 30%		
MINOR MATERIAL (Some / Trace) – Gravel						
Sand						
Silt						
Clay						
COLOUR – Brown	light ✓	✓	✓ DARK			
Red-Brown						
Yellow-Brown				✓		
Grey				✓		
White						
Black						
Other						
MOISTURE CONTENT (W < pl > D)	D/W	>	pl/>	>		
RELATIVE DENSITY (VL L MD D VD)						
CONSISTENCY (VS S F St Vst)		Vst	Vst	Vst		
ORGANIC MATTER – Roots	LARES					
Plant						
Finely Disseminated						

Termination of Hole	TC-Bit	V-Bit	Full Depth	Water	Collapse	Cobbles
	Boulders	Hard Clays				

GROUNDWATER

General Notes

DCP/SPT RESULTS

Depth	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
Reading																														
Depth	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0
Reading																														

Grant Alexander & Associates Pty. Ltd

CLIENT	Job No.	Borehole No.	Digga ✓	Logged
PROJECT		17	Gemco	S.F.W
	Lot No.	R.L.	Fox	Date
	—	E/S	Hand Auger	22/07/13

LAYER		1	2	3	4	5	6
GEOL PROFILE	Fill						
	Topsoil	✓					
	Alluvium		✓ 32				
	Indurated Sand						
	Colluvium						
	Residual Soil		✓	✓			
	EW Rock						
	Other						
Depth to base of layer		0.10 m	1.30 m	4.30 m	m	m	m

SOIL Components	1 Primary	1 Second	2 Primary	2 Second	3 Primary	3 Second	4 Primary	4 Second	5 Primary	5 Second	6 Primary	6 Second
Gravel												
Sand	✓			✓		✓						
Silt		✓		✓		✓						
Clay			✓		✓							
Peat												

	1	2	3	4	5	6
USC SYMBOL	SM	CL/CH	CL/CH			
PLASTICITY (L - M - H)		M ✓ H ✓	M ✓ H ✓			
GRANULAR MATERIAL Grading (Poor Gap Well)						
Grain Size (F - M - C) Primary	F ✓ M ✓					
Grain Size (F - M - C) Second		✓ ✓ 3 20%	✓ 3 25%			
MINOR MATERIAL Gravel (Some / Trace)			Some: IRON STONE, Trace ✓			
MINOR MATERIAL Sand						
MINOR MATERIAL Silt						
MINOR MATERIAL Clay						
COLOUR Brown	✓	✓				
Red-Brown			✓			
Yellow-Brown			✓			
Grey			light ✓			
White						
Black						
Other						
MOISTURE CONTENT (W < pl > D)		✓ (pl / >)	✓ (>)			
RELATIVE DENSITY (VL L MD D VD)						
CONSISTENCY (VS S F St Vst)		Vst ✓	Vst ✓✓	VS ✗		
ORGANIC MATTER Roots	GRASS	HARD	MOTTLED			
Plant						
Finely Disseminated						

Termination of Hole											
TC-Bit		V-Bit		Full Depth		Water	X	Collapse	X	Cobbles	
Boulders		Hard Clays				NIL		NIL			

GROUNDWATER

General Notes

DCP/SPT RESULTS

Depth	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
Reading																														

Depth	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0
Reading																														

CLIENT	Job No.	Borehole No. 18	Digga ✓	Logged S.F.W.
PROJECT			Gemco	
			Fox	Date
	Lot No. –	R.L. E/S	Hand Auger	22/01/13

LAYER		1	2	3	4	5	6
GEOL PROFILE	Fill						
	Topsoil	✓					
	Alluvium						
	Indurated Sand						
	Colluvium						
	Residual Soil		✓				
	EW Rock						
	Other						
Depth to base of layer		0.10 m	4.30 m	m	m	m	m
SOIL Components (Primary / Second)	Gravel						
	Sand	Primary ✓	Second ✓				
	Silt	Second ✓	Second ✓				
	Clay		Primary ✓				
	Peat						
USC SYMBOL		SM	CL				
PLASTICITY (L - M - H)			M ✓				
GRANULAR MATERIAL	Grading (Poor / Gap / Well)						
	Grain Size (F - M - C)						
	Primary	F ✓ M ✓					
	Second		F ✓ M ✓ 3-25%?				
MINOR MATERIAL (Some / Trace)	Gravel						
	Sand						
	Silt						
	Clay						
COLOUR	Brown		✓ light				
	Red-Brown						
	Yellow-Brown						
	Grey	✓ light	✓ light				
	White						
	Black						
	Other						
MOISTURE CONTENT (W < pl > D)		D ✓	< m				
RELATIVE DENSITY (VL L MD D VD)							
CONSISTENCY (VS S F St Vst)			St ✓ Vst ✓				
ORGANIC MATTER	Roots	GRASS	MOTTLED				
	Plant		>3.0m				
	Finely Disseminated		≤PL				

Termination of Hole						
TC-Bit	V-Bit	Full Depth ✓	Water ✗	Collapse ✗	Cobbles	
Boulders	Hard Clays		NIL	NIL		

GROUNDWATER

General Notes

DCP/SPT RESULTS

Depth	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
Reading																														
Depth	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0
Reading																														

CLIENT	Job No.	Borehole No.	Digga	✓	Logged
		19	Gemco		S.F.L.W
PROJECT	Lot No.	R.L.	Fox		Date
	—	E/S	Hand Auger		22/0?/13

LAYER	1	2	3	4	5	6
GEOL PROFILE – Fill						
Topsoil	✓					
Alluvium		✓	✓			
Indurated Sand						
Colluvium						
Residual Soil						
EW Rock						
Other						
Depth to base of layer	0.15 m	0.70 m	4.30 m	m	m	m

SOIL Components	1 Primary	1 Second	2 Primary	2 Second	3 Primary	3 Second	4 Primary	4 Second	5 Primary	5 Second	6 Primary	6 Second
Gravel												
Sand	✓		✓			✓						
Silt		✓		✓		✓						
Clay					✓							
Peat												

	1	2	3	4	5	6
USC SYMBOL	SM	SM	CL			
PLASTICITY (L - M - H)			M			
GRANULAR MATERIAL – Grading (Poor / Gap / Well)						
Grain Size Primary (F - M - C)	F, M	F, M				
Grain Size Second (F - M - C)			F, M 325%			
MINOR MATERIAL (Some / Trace) – Gravel			Some: IRON			
Sand			STONE			
Silt			GRAVEL			
Clay						
COLOUR – Brown	light					
Red-Brown		✓	✓			
Yellow-Brown						
Grey			✓			
White						
Black						
Other						
MOISTURE CONTENT (W < pl > D)	D	D	M			
RELATIVE DENSITY (VL L MD D VD)		D/VD				
CONSISTENCY (VS S F St Vst)			Vst			
ORGANIC MATTER – Roots	GRASS		HARD			
Plant						
Finely Disseminated						

Termination of Hole					
TC-Bit	V-Bit	Full Depth	Water X	Collapse X	Cobbles
Boulders	Hard Clays	✓	NIL	NIL	

GROUNDWATER

General Notes

DCP/SPT RESULTS

Depth	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0
Reading																														

Depth	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0
Reading																														

APPENDIX 3 Soil laboratory analysis results

Reference: 201368
Horizon: A
Soil Type: Alluvial

Location	ph (1:5)	Chloride (ppm)	Sulphate (1:5) (ppm)	Resistivity (ohm.m)	Resistivity (ohm.cm)	EC (1:5)	Texture class	ECe (dS/m)	ESP (%)	PRI (mg/kg)	eCEC
12 (0-300)	6.5	30	20	113.9	11390	0.02	14	0.28	0.8	535.4	4.9
14 (0-300)	6.7	50	10	106.2	10620	0.02	14	0.28	0.8	639.7	5.7
Min	**6.5**	**30**	**10**	**106.2**	**10620**	**0.02**	**14**	**0.3**	**0.8**	**535.4**	**4.9**
Max	**6.7**	**50**	**20**	**113.9**	**11390**	**0.02**	**14**	**0.3**	**0.8**	**639.7**	**5.7**

Reference: 201368
Horizon: A
Soil Type: Residual Soils

Location	ph (1:5)	Chloride (ppm)	Sulphate (1:5) (ppm)	Resistivity (ohm.m)	Resistivity (ohm.cm)	EC (1:5)	Texture class	ECe (dS/m)	ESP (%)	PRI (mg/kg)	eCEC
02 (0-300)	6.1	30	70	42.8	4280	0.06	9	0.54	0.8	1120.4	9.5
08 (0-300)	6.7	40	40	53	5300	0.03	9	0.27	0.5	530.4	9.2
09 (0-500)	7.4	40	20	56.2	5620	0.03	9	0.27	1.9	381.7	8.5
10 (0-250)	6.3	30	30	27.9	2790	0.11	9	0.99	1.3	809.4	7.6
11 (0-400)	6.8	50	20	65.2	6520	0.02	8.5	0.17	0.8	741.5	0.2
13 (0-300)	6.9	230	20	26.4	2640	0.04	7	0.28	5.1	783.1	10.2
Min	**6.1**	**30**	**20**	**26.4**	**2640**	**0.02**	**7**	**0.2**	**0.5**	**381.7**	**0.2**
Max	**7.4**	**230**	**70**	**65.2**	**6520**	**0.11**	**9**	**1.0**	**5.1**	**1120.4**	**10.2**

Reference: 201368
Horizon: B
Soil Type: Residual Soils

Location	ph (1:5)	Chloride (ppm)	Sulphate (1:5) (ppm)	Resistivity (ohm.m)	Resistivity (ohm.cm)	EC (1:5)	Texture class	ECe (dS/m)	ESP (%)	PRI (mg/kg)	CEC
02 (800-1000)	7.1	130	40	47.6	4760	0.03	7	0.21	3.8	869.4	12.8
08 (600-800)	7.2	120	50	48.5	4850	0.03	7	0.21	2.7	1662.2	15.3
09 (1000-1200)	8.8	790	170	7.3	730	0.28	7	1.96	35.2	940.2	12.8
10 (400-600)	6	410	170	6.7	670	0.32	7	2.24	5.5	991.8	18.3
11 (800-1000)	7.2	100	20	68	6800	0.02	7	0.14	1.5	1241.2	12.2
13 (600-800)	6.9	1110	120	3.4	340	0.69	7	4.83	29.8	841.5	15.8
Min	**6**	**100**	**20**	**3.4**	**340**	**0.02**	**7**	**0.14**	**1.5**	**841.5**	**12.2**
Max	**8.8**	**1110**	**170**	**68**	**6800**	**0.69**	**7**	**4.83**	**35.2**	**1662.2**	**18.3**

Reference: 201368
Horizon: B
Soil Type: Alluvial

Location	ph (1:5)	Chloride (ppm)	Sulphate (1:5) (ppm)	Resistivity (ohm.m)	Resistivity (ohm.cm)	EC (1:5)	Texture class	ECe (dS/m)	ESP (%)	PRI (mg/kg)	eCEC
12 (600-800)	6.6	10	5	365.9	36590	0.02	10	0.2	1.6	125.7	1.6
14 (800-1000)	6.7	40	20	177.7	17770	0.02	9	0.18	1.4	795.2	4.8
Min	**6.6**	**10**	**5**	**177.7**	**17770**	**0.02**	**9**	**0.18**	**1.4**	**125.7**	**1.6**
Max	**6.7**	**40**	**20**	**365.9**	**36590**	**0.02**	**10**	**0.2**	**1.6**	**795.2**	**4.8**

Reference: 201368
Horizon: B/C
Soil Type: Alluvial

Location	ph (1:5)	Chloride (ppm)	Sulphate (1:5) (ppm)	Resistivity (ohm.m)	Resistivity (ohm.cm)	EC (1:5)	Texture class	ECe (dS/m)	ESP (%)	CEC
12 (1200-1800)	7.3	80	40	68.9	6890	0.02	8.5	0.17	2	**10.4**
Min	**7.3**	**80**	**40**	**68.9**	**6890**	**0.02**	**8.5**	**0.2**	**2**	**10.4**
Max	**7.3**	**80**	**40**	**68.9**	**6890**	**0.02**	**8.5**	**0.2**	**2**	**10.4**

Reference: 201368
Horizon: B/C
Soil Type: Residual Soils

Location	ph (1:5)	Chloride (ppm)	Sulphate (1:5) (ppm)	Resistivity (ohm.m)	Resistivity (ohm.cm)	EC (1:5)	Texture class	ECe (dS/m)	ESP (%)	CEC
02 (2400-2800)	7.4	170	10	38.7	3870	0.04	8.5	0.34	6.7	12.5
08 (1000-1200)	5.4	20	130	50.7	5070	0.06	7	0.42	7.9	8.2
09 (2500-2800)	8.4	1330	550	3	300	0.93	7	6.51	27.5	21.5
10 (1000-1200)	8.5	1300	40	3.8	380	0.82	8.5	6.97	11	24.5
11 (1500-1700)	7.3	110	40	41.1	4110	0.04	8.5	0.34	8	9.3
13 (4000-4300)	8.3	440	40	15.5	1550	0.12	8.5	1.02	13.2	11.4
Min	**5.4**	**20**	**10**	**3**	**300**	**0.04**	**7**	**0.3**	**6.7**	**8.2**
Max	**8.5**	**1330**	**550**	**50.7**	**5070**	**0.93**	**8.5**	**7.0**	**27.5**	**24.5**

SESL AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Effluent Subdivison Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 1** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-02 (0-300)**
Address:	**PO Box 427** **NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	6.1	Slight Acidity
pH in $CaCl_2$ 1:5	5.3	Strong Acidity
EC mS/cm 1:5	0.06	Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.075	0.8	
Potassium			0.79	8.3	
Calcium			6.8	71.8	
Magnesium			1.8	19	
Aluminium			-	-	
		ECEC	9.5		Low
		Ca/Mg	6.2		Normal

Phosphate Retention Index (%): 19.50 Low **PRI (mgP/kg):** 1120.4 **PRI (kg/ha):** 2185 to 150mm

PHYSICAL CHARACTERISTICS **Comment**

Texture:	Clay Loam	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test	**Particle Size Analysis (PSA)**	
Approx. Clay Content (%):	25 - 35%	> 2mm	Gravel
Potential infiltration rate:	Moderate	2 - 0.2 mm	Coarse Sand
Gravel Content:	Soil is Not gravelly	0.2 - 0.02 mm	Fine Sand
Additional comments:		0.02 - 0.002 mm	Silt
		< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 | **Sample N°: 2** | **Date Received: 29/1/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-02 (800-1000)**
Address:	**PO Box 427** **NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	7.1	Neutral pH
pH in $CaCl_2$ 1:5	6.2	Slight Acidity
EC mS/cm 1:5	0.03	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.49	3.8	
Potassium			0.12	0.9	
Calcium			8.4	65.6	
Magnesium			3.8	29.7	
Aluminium			-	-	
		ECEC	12.8		Moderate
		Ca/Mg	3.6		Normal

Phosphate Retention Index (%): 15.10 Low **PRI (mgP/kg):** 869.4 **PRI (kg/ha):** 1695 to 150mm

PHYSICAL CHARACTERISTICS — **Comment**

Texture:	Medium Clay	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test	**Particle Size Analysis (PSA)**	
Approx. Clay Content (%):	40 - 55%	> 2mm	Gravel
Potential infiltration rate:	Very Slow	2 - 0.2 mm	Coarse Sand
Gravel Content:	Soil is Not gravelly	0.2 - 0.02 mm	Fine Sand
Additional comments:		0.02 - 0.002 mm	Silt
		< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

SESL AUSTRALIA — AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 | **Sample N°: 3** | **Date Received: 29/1/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-08 (0-300)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	6.7	Very Slight Acidity
pH in $CaCl_2$ 1:5	5.9	Medium Acidity
EC mS/cm 1:5	0.03	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.049	0.5	
Potassium			0.74	8.1	
Calcium			6.5	70.7	
Magnesium			1.9	20.7	
Aluminium			-	-	
		ECEC	9.2		Low
		Ca/Mg	5.6		Normal

Phosphate Retention Index (%): 9.20 Very Low **PRI (mgP/kg):** 530.4 **PRI (kg/ha):** 1034 to 150mm

PHYSICAL CHARACTERISTICS — **Comment**

Texture: Clay Loam
Texture comment:
Size:
Aggregate strength: Did not test
Structural unit: Did not test
Approx. Clay Content (%): 25 - 35%
Potential infiltration rate: Moderate
Gravel Content: Soil is Not gravelly
Additional comments:

Field Density (g/mL):
Emerson Stability Class: H20
High SAR/Low Iconic Strength:
Med SAR/High Iconic Strength:

Particle Size Analysis (PSA)

> 2mm	Gravel	
2 - 0.2 mm	Coarse Sand	
0.2 - 0.02 mm	Fine Sand	
0.02 - 0.002 mm	Silt	
< 0.002 mm	Clay	

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992) Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

SESL AUSTRALIA — AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 4** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ **Final**

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-08 (600-800)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	7.2	Neutral pH
pH in $CaCl_2$ 1:5	6.1	Slight Acidity
EC mS/cm 1:5	0.03	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.42	2.7	
Potassium			1.3	8.5	
Calcium			7.5	49	
Magnesium			6.1	39.8	
Aluminium			-	-	
		ECEC	15.3		Moderate
		Ca/Mg	2		Low - Magnesic

Phosphate Retention Index (%): 28.90 Low **PRI (mgP/kg):** 1662.2 **PRI (kg/ha):** 3241 to 150mm

PHYSICAL CHARACTERISTICS — **Comment**

Texture: Medium Clay
Texture comment:
Size:
Aggregate strength: Did not test
Structural unit: Did not test
Approx. Clay Content (%): 40 - 55%
Potential infiltration rate: Very Slow
Gravel Content: Soil is Not gravelly
Additional comments:

Field Density (g/mL):
Emerson Stability Class: H20
High SAR/Low Iconic Strength:
Med SAR/High Iconic Strength:

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Effluent Subdivison Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 | **Sample N°: 5** | **Date Received: 29/1/13** | **Report Status:** ○ Draft ◉ **Final**

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-09 (0-500)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	7.4	Slight Alkalinity
pH in $CaCl_2$ 1:5	6.4	Slight Acidity
EC mS/cm 1:5	0.03	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.16	1.9	
Potassium			0.54	6.4	
Calcium			4.4	51.8	
Magnesium			3.4	40	
Aluminium			-	-	
		ECEC	8.5		Low
		Ca/Mg	2.1		Low - Magnesic

Phosphate Retention Index (%): 6.60 Very Low **PRI (mgP/kg):** 381.7 **PRI (kg/ha):** 744 to 150mm

PHYSICAL CHARACTERISTICS **Comment**

Texture:	Clay Loam
Texture comment:	
Size:	
Aggregate strength:	Did not test
Structural unit:	Did not test
Approx. Clay Content (%):	25 - 35%
Potential infiltration rate:	Moderate
Gravel Content:	Soil is Not gravelly
Additional comments:	

Field Density (g/mL):	
Emerson Stability Class:	H20
High SAR/Low Iconic Strength:	
Med SAR/High Iconic Strength:	

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992) Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Effluent Subdivison Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 6** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-09 (1000-1200)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	8.8	Strong Alkalinity
pH in $CaCl_2$ 1:5	7.3	Slight Alkalinity
EC mS/cm 1:5	0.28	Elevated Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			4.5	35.2	
Potassium			0.29	2.3	
Calcium			3.1	24.2	
Magnesium			4.9	38.3	
Aluminium			-	-	
		ECEC	12.8		Moderate
		Ca/Mg	1		Low - Magnesic

Phosphate Retention Index (%): 15.90 Low **PRI (mgP/kg):** 914.2 **PRI (kg/ha):** 1783 to 150mm

PHYSICAL CHARACTERISTICS **Comment**

Texture:	Medium Clay	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test		
Approx. Clay Content (%):	40 - 55%		
Potential infiltration rate:	Very Slow		
Gravel Content:	Soil is Not gravelly		
Additional comments:			

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992) Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Effluent Subdivison Profile

Batch N°: 25211 | **Sample N°: 7** | **Date Received: 29/1/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-10 (0-250)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	6.3	Slight Acidity
pH in $CaCl_2$ 1:5	5.5	Strong Acidity
EC mS/cm 1:5	0.11	Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.098	1.3	
Potassium			1.4	18.4	
Calcium			4.1	54	
Magnesium			2	26.3	
Aluminium			-	-	
		ECEC	7.6		Low
		Ca/Mg	3.4		Normal

Phosphate Retention Index (%): 14.10 Low | **PRI (mgP/kg):** 809.4 | **PRI (kg/ha):** 1578 to 150mm

PHYSICAL CHARACTERISTICS | **Comment**

Texture:	Clay Loam	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test	**Particle Size Analysis (PSA)**	
Approx. Clay Content (%):	25 - 35%	> 2mm	Gravel
Potential infiltration rate:	Moderate	2 - 0.2 mm	Coarse Sand
Gravel Content:	Soil is Gravelly	0.2 - 0.02 mm	Fine Sand
Additional comments:		0.02 - 0.002 mm	Silt
		< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 | **Sample N°: 8** | **Date Received: 29/1/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-10 (400-600)**
Address:	**PO Box 427** **NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	6.0	Medium Acidity
pH in $CaCl_2$ 1:5	5.5	Strong Acidity
EC mS/cm 1:5	0.32	Elevated Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			1	5.5	
Potassium			1.1	6	
Calcium			6.5	35.5	
Magnesium			9.7	53	
Aluminium			-	-	
		ECEC	18.3		Moderate
		Ca/Mg	1.1		Low - Magnesic

Phosphate Retention Index (%): 17.20 Low **PRI (mgP/kg):** 991.8 **PRI (kg/ha):** 1934 to 150mm

PHYSICAL CHARACTERISTICS — **Comment**

Texture:	Medium Clay	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test		
Approx. Clay Content (%):	40 - 55%		
Potential infiltration rate:	Very Slow		
Gravel Content:	Soil is Not gravelly		
Additional comments:			

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

SESL AUSTRALIA — AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System — Quality ISO 9001

Batch N°: 25211 | **Sample N°: 9** | **Date Received: 29/1/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-11 (0-400)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	6.8	Very Slight Acidity
pH in $CaCl_2$ 1:5	5.9	Medium Acidity
EC mS/cm 1:5	<0.02	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.061	0.8	
Potassium			0.35	4.9	
Calcium			4.8	66.6	
Magnesium			2	27.7	
Aluminium			-	-	
		ECEC	7.2		Low
		Ca/Mg	4		Normal

Phosphate Retention Index (%): 12.90 Low **PRI (mgP/kg):** 741.5 **PRI (kg/ha):** 1446 to 150mm

PHYSICAL CHARACTERISTICS | **Comment**

Texture:	Light Clay	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test		
Approx. Clay Content (%):	35 - 40%		
Potential infiltration rate:	Slow		
Gravel Content:	Soil is Gravelly		
Additional comments:			

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992) Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 | **Sample N°: 10** | **Date Received: 29/1/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-11 (800-1000)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	7.2	Neutral pH
pH in $CaCl_2$ 1:5	6.1	Slight Acidity
EC mS/cm 1:5	<0.02	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.18	1.5	
Potassium			0.16	1.3	
Calcium			6.4	52.3	
Magnesium			5.5	44.9	
Aluminium			-	-	
		ECEC	12.2		Moderate
		Ca/Mg	1.9		Low - Magnesic

Phosphate Retention Index (%): 21.60 Low **PRI (mgP/kg):** 1241.2 **PRI (kg/ha):** 2420 to 150mm

PHYSICAL CHARACTERISTICS — Comment

Texture:	Medium Clay	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test	**Particle Size Analysis (PSA)**	
Approx. Clay Content (%):	40 - 55%	> 2mm	Gravel
Potential infiltration rate:	Very Slow	2 - 0.2 mm	Coarse Sand
Gravel Content:	Soil is Gravelly	0.2 - 0.02 mm	Fine Sand
Additional comments:		0.02 - 0.002 mm	Silt
		< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992) Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

sesl AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Effluent Subdivison Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 11** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ **Final**

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-12 (0-300)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	6.5	Slight Acidity
pH in $CaCl_2$ 1:5	5.3	Strong Acidity
EC mS/cm 1:5	<0.02	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.038	0.8	
Potassium			0.16	3.3	
Calcium			3.5	71.5	
Magnesium			1.2	24.5	
Aluminium			-	-	
		ECEC	4.9		Very Low
		Ca/Mg	4.8		Normal

Phosphate Retention Index (%): 9.30 Very Low **PRI (mgP/kg):** 535.4 **PRI (kg/ha):** 1044 to 150mm

PHYSICAL CHARACTERISTICS **Comment**

Texture:	Fine Sandy Clay Loam
Texture comment:	
Size:	
Aggregate strength:	Did not test
Structural unit:	Did not test
Approx. Clay Content (%):	20 - 30%
Potential infiltration rate:	Moderate
Gravel Content:	Soil is Not gravelly
Additional comments:	

Field Density (g/mL):	
Emerson Stability Class:	H20
High SAR/Low Iconic Strength:	
Med SAR/High Iconic Strength:	

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

SESL AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 12** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-12 (600-800)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	6.6	Very Slight Acidity
pH in $CaCl_2$ 1:5	5.7	Medium Acidity
EC mS/cm 1:5	<0.02	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.025	1.6	
Potassium			0.073	4.7	
Calcium			1.1	70.2	
Magnesium			0.37	23.6	
Aluminium			-	-	
		ECEC	1.6		Very Low
		Ca/Mg	4.9		Normal

Phosphate Retention Index (%): 2.20 Very Low **PRI (mgP/kg):** 125.7 **PRI (kg/ha):** 245 to 150mm

PHYSICAL CHARACTERISTICS **Comment**

Texture:	Sandy Loam	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test		
Approx. Clay Content (%):	10 - 20%		
Potential infiltration rate:	Rapid		
Gravel Content:	Soil is Not gravelly		
Additional comments:			

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 13** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-13 (0-300)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	6.9	Neutral pH
pH in $CaCl_2$ 1:5	5.8	Medium Acidity
EC mS/cm 1:5	0.04	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.52	5.1	
Potassium			0.65	6.4	
Calcium			5	49.2	
Magnesium			4	39.3	
Aluminium			-	-	
		ECEC	10.2		Low
		Ca/Mg	2.1		Low - Magnesic

Phosphate Retention Index (%): 13.60 Low **PRI (mgP/kg):** 783.1 **PRI (kg/ha):** 1527 to 150mm

PHYSICAL CHARACTERISTICS **Comment**

Texture:	Medium Clay	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test		
Approx. Clay Content (%):	40 - 55%		
Potential infiltration rate:	Very Slow		
Gravel Content:	Soil is Not gravelly		
Additional comments:			

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Effluent Subdivison Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 | **Sample N°: 14** | **Date Received: 29/1/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-13 (600-800)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	6.9	Neutral pH
pH in $CaCl_2$ 1:5	6.4	Slight Acidity
EC mS/cm 1:5	0.69	Very High Salinity (saline)

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			4.7	29.8	
Potassium			0.056	0.4	
Calcium			5.5	34.9	
Magnesium			5.5	34.9	
Aluminium			-	-	
		ECEC	15.8		Moderate
		Ca/Mg	1.6		Low - Magnesic

Phosphate Retention Index (%): 14.60 Low | **PRI (mgP/kg):** 841.5 | **PRI (kg/ha):** 1641 to 150mm

PHYSICAL CHARACTERISTICS — Comment

Texture:	Medium Clay	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test	**Particle Size Analysis (PSA)**	
Approx. Clay Content (%):	40 - 55%	> 2mm	Gravel
Potential infiltration rate:	Very Slow	2 - 0.2 mm	Coarse Sand
Gravel Content:	Soil is Gravelly	0.2 - 0.02 mm	Fine Sand
Additional comments:		0.02 - 0.002 mm	Silt
		< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992) Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 15** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-14 (0-300)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	6.7	Very Slight Acidity
pH in $CaCl_2$ 1:5	5.5	Strong Acidity
EC mS/cm 1:5	<0.02	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.045	0.8	
Potassium			0.26	4.6	
Calcium			4.4	77.1	
Magnesium			1	17.5	
Aluminium			-	-	
		ECEC	5.7		Low
		Ca/Mg	7.2		Normal

Phosphate Retention Index (%): 11.10 Low **PRI (mgP/kg):** 639.7 **PRI (kg/ha):** 1247 to 150mm

PHYSICAL CHARACTERISTICS **Comment**

Texture:	Sandy Loam	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test		
Approx. Clay Content (%):	10 - 20%		
Potential infiltration rate:	Rapid		
Gravel Content:	Soil is Not gravelly		
Additional comments:			

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 | **Sample N°: 16** | **Date Received: 29/1/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-14 (800-1000)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water 1:5	6.7	Very Slight Acidity
pH in $CaCl_2$ 1:5	5.8	Medium Acidity
EC mS/cm 1:5	<0.02	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.068	1.4	
Potassium			0.083	1.7	
Calcium			3.4	71.6	
Magnesium			1.2	25.3	
Aluminium			-	-	
		ECEC	4.8		Very Low
		Ca/Mg	4.7		Normal

Phosphate Retention Index (%): 13.80 Low **PRI (mgP/kg):** 795.2 **PRI (kg/ha):** 1550 to 150mm

PHYSICAL CHARACTERISTICS — **Comment**

Texture: Sandy Clay Loam
Texture comment:
Size:
Aggregate strength: Did not test
Structural unit: Did not test
Approx. Clay Content (%): 20 - 30%
Potential infiltration rate: Moderate
Gravel Content: Soil is Not gravelly
Additional comments:

Field Density (g/mL):
Emerson Stability Class: H20
High SAR/Low Iconic Strength:
Med SAR/High Iconic Strength:

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992) Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

SESL AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 17** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-02 (2400-2800)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST	RESULT	COMMENTS
pH in water 1:5	7.4	Slight Alkalinity
pH in $CaCl_2$ 1:5	6.2	Slight Acidity
EC mS/cm 1:5	0.04	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.84	6.7	
Potassium			0.14	1.1	
Calcium			7.4	59.3	
Magnesium			4.1	32.9	
Aluminium			-	-	
		ECEC	12.5		Moderate
		Ca/Mg	3		Normal

Phosphate Retention Index (%): **PRI (mgP/kg):** **PRI (kg/ha):**

PHYSICAL CHARACTERISTICS **Comment**

Texture: Light Clay
Texture comment:
Size:
Aggregate strength: Did not test
Structural unit: Did not test
Approx. Clay Content (%): 35 - 40%
Potential infiltration rate: Slow
Gravel Content: Soil is Not gravelly
Additional comments:

Field Density (g/mL):
Emerson Stability Class: H20
High SAR/Low Iconic Strength:
Med SAR/High Iconic Strength:

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Tel: 02 9980 6554
Fax: 02 9484 2427
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211	**Sample N°: 18**	**Date Received: 29/1/13**	**Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-08 (1000-1200)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST	RESULT	COMMENTS
pH in water 1:5	5.4	Strong Acidity
pH in $CaCl_2$ 1:5	4.2	Very Strong Acidity
EC mS/cm 1:5	0.06	Low Salinity

CATION ANALYSIS

TEST	SOLUBLE meq%	SOLUBLE Comment	EXCHANGEABLE meq%	EXCHANGEABLE % of ECEC	EXCHANGEABLE Comment
Sodium			0.65	7.9	
Potassium			0.37	4.5	
Calcium			2.5	30.4	
Magnesium			4.7	57.2	
Aluminium			-	-	
		ECEC	8.2		Low
		Ca/Mg	.9		Low - Magnesic

Phosphate Retention Index (%): **PRI (mgP/kg):** **PRI (kg/ha):**

PHYSICAL CHARACTERISTICS **Comment**

Texture:	Medium Clay	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test		
Approx. Clay Content (%):	40 - 55%		
Potential infiltration rate:	Very Slow		
Gravel Content:	Soil is Not gravelly		
Additional comments:			

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 | **Sample N°: 19** | **Date Received: 29/1/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-09 (2500-2800)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST	RESULT	COMMENTS
pH in water 1:5	8.4	Moderate Alkalinity
pH in $CaCl_2$ 1:5	7.8	Slight Alkalinity
EC mS/cm 1:5	0.93	Very High Salinity (saline)

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			5.9	27.5	
Potassium			0.16	0.7	
Calcium			4.6	21.4	
Magnesium			10.8	50.3	
Aluminium			-	-	
		ECEC	21.5		Moderate
		Ca/Mg	.7		Low - Magnesic

Phosphate Retention Index (%): **PRI (mgP/kg):** **PRI (kg/ha):**

PHYSICAL CHARACTERISTICS — **Comment**

Texture:	Medium Clay	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test		
Approx. Clay Content (%):	40 - 55%		
Potential infiltration rate:	Very Slow		
Gravel Content:	Soil is Not gravelly		
Additional comments:			

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992) Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 20** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-10 (1000-1200)**
Address:	**PO Box 427** **NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST	RESULT	COMMENTS
pH in water 1:5	8.5	Moderate Alkalinity
pH in $CaCl_2$ 1:5	8.1	Moderate Alkalinity
EC mS/cm 1:5	0.82	Very High Salinity (saline)

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			2.7	11	
Potassium			0.17	0.7	
Calcium			8.4	34.3	
Magnesium			13.2	53.9	
Aluminium			-	-	
		ECEC	24.5		Moderate
		Ca/Mg	1		Low - Magnesic

Phosphate Retention Index (%): **PRI (mgP/kg):** **PRI (kg/ha):**

PHYSICAL CHARACTERISTICS **Comment**

Texture:	Silty Clay	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test		
Approx. Clay Content (%):	40 - 50%		
Potential infiltration rate:	Very Slow		
Gravel Content:	Soil is Not gravelly		
Additional comments:			

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992) Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Effluent Subdivison Profile

Certified System Quality ISO 9001

Batch N°: 25211	Sample N°: 21	Date Received: 29/1/13	Report Status: ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-11 (1500-1700)**
Address:	**PO Box 427** **NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST	RESULT	COMMENTS
pH in water 1:5	7.3	Slight Alkalinity
pH in $CaCl_2$ 1:5	5.3	Strong Acidity
EC mS/cm 1:5	0.04	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.74	8	
Potassium			0.12	1.3	
Calcium			3.9	42.1	
Magnesium			4.5	48.6	
Aluminium			-	-	
		ECEC	9.3		Low
		Ca/Mg	1.4		Low - Magnesic

Phosphate Retention Index (%): **PRI (mgP/kg):** **PRI (kg/ha):**

PHYSICAL CHARACTERISTICS **Comment**

Texture:	Light Clay	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test		
Approx. Clay Content (%):	35 - 40%		
Potential infiltration rate:	Slow		
Gravel Content:	Soil is Gravelly		
Additional comments:			

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992) Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

SESL AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 | **Sample N°: 22** | **Date Received: 29/1/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-12 (1200-1800)**
Address:	**PO Box 427** **NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST	RESULT	COMMENTS
pH in water 1:5	7.3	Slight Alkalinity
pH in $CaCl_2$ 1:5	6.2	Slight Acidity
EC mS/cm 1:5	0.02	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.21	2	
Potassium			0.83	8	
Calcium			5.3	50.8	
Magnesium			4.1	39.3	
Aluminium			-	-	
		ECEC	10.4		Low
		Ca/Mg	2.1		Low - Magnesic

Phosphate Retention Index (%): **PRI (mgP/kg):** **PRI (kg/ha):**

PHYSICAL CHARACTERISTICS — **Comment**

Texture: Light Clay
Texture comment:
Size:
Aggregate strength: Did not test
Structural unit: Did not test
Approx. Clay Content (%): 35 - 40%
Potential infiltration rate: Slow
Gravel Content: Soil is Not gravelly
Additional comments:

Field Density (g/mL):
Emerson Stability Class: H20
High SAR/Low Iconic Strength:
Med SAR/High Iconic Strength:

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

SESL Australia
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 | **Sample N°: 23** | **Date Received: 29/1/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-13 (4000-4300)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST	RESULT	COMMENTS
pH in water 1:5	8.3	Moderate Alkalinity
pH in $CaCl_2$ 1:5	7.1	Neutral
EC mS/cm 1:5	0.12	Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			1.5	13.2	
Potassium			0.17	1.5	
Calcium			5.7	50.1	
Magnesium			4	35.2	
Aluminium			-	-	
		ECEC	11.4		Low
		Ca/Mg	2.3		Low - Magnesic

Phosphate Retention Index (%): **PRI (mgP/kg):** **PRI (kg/ha):**

PHYSICAL CHARACTERISTICS — **Comment**

Texture:	Light Clay	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test		
Approx. Clay Content (%):	35 - 40%		
Potential infiltration rate:	Slow		
Gravel Content:	Soil is Not gravelly		
Additional comments:			

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992)
Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Effluent Subdivison Profile

sesl AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211	**Sample N°: 24**	**Date Received: 29/1/13**	**Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-14 (2600-2900)**
Address:	**PO Box 427** **NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST	RESULT	COMMENTS
pH in water 1:5	7.1	Neutral pH
pH in $CaCl_2$ 1:5	5.8	Medium Acidity
EC mS/cm 1:5	0.02	Very Low Salinity

CATION ANALYSIS

TEST	SOLUBLE		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	Comment
Sodium			0.11	2	
Potassium			0.074	1.3	
Calcium			2.7	49.2	
Magnesium			2.6	47.4	
Aluminium			-	-	
		ECEC	5.5		Low
		Ca/Mg	1.7		Low - Magnesic

Phosphate Retention Index (%): **PRI (mgP/kg):** **PRI (kg/ha):**

PHYSICAL CHARACTERISTICS **Comment**

Texture:	Sandy Clay	**Field Density (g/mL):**	
Texture comment:		**Emerson Stability Class:**	H20
Size:		**High SAR/Low Iconic Strength:**	
Aggregate strength:	Did not test	**Med SAR/High Iconic Strength:**	
Structural unit:	Did not test		
Approx. Clay Content (%):	35 - 45%		
Potential infiltration rate:	Slow		
Gravel Content:	Soil is Not gravelly		
Additional comments:			

Particle Size Analysis (PSA)

> 2mm	Gravel
2 - 0.2 mm	Coarse Sand
0.2 - 0.02 mm	Fine Sand
0.02 - 0.002 mm	Silt
< 0.002 mm	Clay

Recommendations

Analysed by SESL Australia NATA #15633

No commentary requested from SESL.

Please refer to Corrosion and Scaling Assessment profile for other laboratory data.

Method References:
pH, EC, Soluble Cations, Nitrate: Bradley et al (1983). Exchangeable Cations, ECEC: Method 15A1 Rayment & Higginson (1992) Chloride: Vogel (1961). Aluminium: Method 3500 APHA (1992). Phosphate: Method 9E1 Rayment & Higginson (1992). Wax Block Density: Method 30-4 Black (1983), Texture: "Northcote" (1992), Emerson's Aggregate Test: Charman & Murphy (1991), Particle Size Analysis: Modified Black (1983) Method 43-1 to 43-6.

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 8 Feb 2013

Corrosion & Scaling Assessment:

Soil Reporting Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 1** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ **Final**

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-02 (0-300)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	6.1	Slight Acidity
EC mS/cm (1:5)	0.06	Low Salinity
Texture Class	Clay Loam	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) $mgSO_4$ / kg	70	Low (non-aggressive)
Chloride (1:5) mgCl / kg	30	Low (non-aggressive)
* Resistivity Ω.□	42.8	Moderate Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows slight acidity, low salinity, low sulphate and low chloride levels and moderate resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is low.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

 Total No Pages:

Corrosion & Scaling Assessment:

Soil Reporting Profile

sesl AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211	**Sample N°: 2**	**Date Received: 29/1/13**	**Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-02 (800-1000)**
Address:	**PO Box 427** **NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	7.1	Neutral pH
EC mS/cm (1:5)	0.03	Very Low Salinity
Texture Class	Medium Clay	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) mgSO_4/ kg	40	Low (non-aggressive)
Chloride (1:5) mgCl / kg	130	Low (non-aggressive)
* Resistivity Ω.□	47.6	Moderate Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows a neutral pH, very low salinity, low sulphate and low chloride levels and moderate resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is low.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

sesl AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Corrosion & Scaling Assessment:

Soil Reporting Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211	**Sample N°: 3**	**Date Received: 29/1/13**	**Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-08 (0-300)**
Address:	**PO Box 427** **NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	6.7	Very Slight Acidity
EC mS/cm (1:5)	0.03	Very Low Salinity
Texture Class	Clay Loam	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) mgSO_4/ kg	40	Low (non-aggressive)
Chloride (1:5) mgCl / kg	40	Low (non-aggressive)
* Resistivity Ω.□	53.0	High Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows very slight acidity, very low salinity, low sulphate and low chloride levels and high resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is low.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser	Authorised Signatory: Ryan Jacka	Date of Report: 08/02/2013

Corrosion & Scaling Assessment:
Soil Reporting Profile

SESL AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 4** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-08 (600-800)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	7.2	Neutral pH
EC mS/cm (1:5)	0.03	Very Low Salinity
Texture Class	Medium Clay	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) $mgSO_4$ / kg	50	Low (non-aggressive)
Chloride (1:5) mgCl / kg	120	Low (non-aggressive)
* Resistivity Ω.□	48.5	Moderate Resistivity

* Resistivity tested on a saturated sample/paste (Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows a neutral pH, very low salinity, low sulphate and low chloride levels and moderate resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is low.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

Corrosion & Scaling Assessment:
Soil Reporting Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 5** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-09 (0-500)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	7.4	Slight Alkalinity
EC mS/cm (1:5)	0.03	Very Low Salinity
Texture Class	Clay Loam	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) $mgSO_4$ / kg	20	Low (non-aggressive)
Chloride (1:5) mgCl / kg	40	Low (non-aggressive)
* Resistivity Ω.□	56.2	High Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows slight alalkinity, very low salinity, low sulphate and low chloride levels and high resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is low.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

 Total No Pages:

Corrosion & Scaling Assessment:
Soil Reporting Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Quality ISO 9001

Batch N°: 25211 **Sample N°: 6** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-09 (1000-1200)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	8.8	Strong Alkalinity
EC mS/cm (1:5)	0.28	Elevated Salinity
Texture Class	Medium Clay	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) mgSO_4/ kg	170	Low (non-aggressive)
Chloride (1:5) mgCl / kg	790	Low (non-aggressive)
* Resistivity Ω.□	7.3	Very Low Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows strong alkalinity, elevated salinity, low sulphate and low chloride levels and very low resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be moderately-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is moderate.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

 Total No Pages:

SESL AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Corrosion & Scaling Assessment:

Soil Reporting Profile

Sample Drop Off: 16 Chilvers Road
Thornleigh NSW 2120
Mailing Address: PO Box 357
Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System
Quality ISO 9001

Batch N°: 25211	**Sample N°: 7**	**Date Received: 29/1/13**	**Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-10 (0-250)**
Address:	**PO Box 427** **NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	6.3	Slight Acidity
EC mS/cm (1:5)	0.11	Low Salinity
Texture Class	Clay Loam	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) mgSO_4/ kg	30	Low (non-aggressive)
Chloride (1:5) mgCl / kg	80	Low (non-aggressive)
* Resistivity Ω.□	27.9	Moderate Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows slight acidity, low salinity, low sulphate and low chloride levels and moderate resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is low.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant:
Chris Fraser

Authorised Signatory:
Ryan Jacka

Date of Report:
08/02/2013

Corrosion & Scaling Assessment:
Soil Reporting Profile

SESL Australia — Australia's Most Trusted Earth Science Services

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211	**Sample N°: 8**	**Date Received: 29/1/13**	**Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-10 (400-600)**
Address:	**PO Box 427** **NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	6.0	Medium Acidity
EC mS/cm (1:5)	0.32	Elevated Salinity
Texture Class	Medium Clay	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) mgSO_4/ kg	170	Low (non-aggressive)
Chloride (1:5) mgCl / kg	410	Low (non-aggressive)
* Resistivity Ω.m	6.7	Very Low Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows medium acidity, elevated salinity, low sulphate and low chloride levels and very low resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be moderately-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is moderate.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

Corrosion & Scaling Assessment:
Soil Reporting Profile

SESL Australia — Australia's Most Trusted Earth Science Services

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211	**Sample N°: 9**	**Date Received: 29/1/13**	**Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-11 (0-400)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	6.8	Very Slight Acidity
EC mS/cm (1:5)	<0.02	Very Low Salinity
Texture Class	Light Clay	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) $mgSO_4$ / kg	20	Low (non-aggressive)
Chloride (1:5) mgCl / kg	50	Low (non-aggressive)
* Resistivity Ω.	65.2	High Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows very slight acidity, very low salinity, low sulphate and low chloride levels and high resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is low.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

Corrosion & Scaling Assessment:
Soil Reporting Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 10** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-11 (800-1000)**
Address:	**PO Box 427** **NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	7.2	Neutral pH
EC mS/cm (1:5)	<0.02	Very Low Salinity
Texture Class	Medium Clay	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) $mgSO_4$ / kg	20	Low (non-aggressive)
Chloride (1:5) mgCl / kg	100	Low (non-aggressive)
* Resistivity Ω.m	68.0	High Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows neutral pH, low salinity, low sulphate and low chloride levels and high resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is low.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Corrosion & Scaling Assessment:

Soil Reporting Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 11** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-12 (0-300)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	6.5	Slight Acidity
EC mS/cm (1:5)	<0.02	Very Low Salinity
Texture Class	Fine Sandy Clay Loam	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) mgSO_4/ kg	20	Low (non-aggressive)
Chloride (1:5) mgCl / kg	30	Low (non-aggressive)
* Resistivity Ω.▯	113.9	Very High Resistivity

* Resistivity tested on a saturated sample/paste (Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows slight acidity, very low salinity, low sulphate and low chloride levels and very high resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is low.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

Corrosion & Scaling Assessment:
Soil Reporting Profile

sesl AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 | **Sample N°: 12** | **Date Received: 29/1/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-12 (600-800)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	6.6	Very Slight Acidity
EC mS/cm (1:5)	<0.02	Very Low Salinity
Texture Class	Sandy Loam	
Soil Permeability Class		High Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) mgSO_4 / kg	<5.0	Low (non-aggressive)
Chloride (1:5) mgCl / kg	10	Low (non-aggressive)
* Resistivity Ω.□	365.9	Very High Resitivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows very slight acidity, very low salinity, low sulphate and low chloride levels and very high resistivity.

According to AS2159-2009, the pH is considered mildly-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered mildly-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be mildly-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is mild.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

 Total No Pages:

sesl AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Corrosion & Scaling Assessment:
Soil Reporting Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120 **Tel:** 02 9980 6554 **Fax:** 02 9484 2427
Mailing Address: PO Box 357, Pennant Hills NSW 1715 **Em:** info@sesl.com.au **Web:** www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 13** **Date Received: 29/1/13** **Report Status:** ○ **Draft** ◉ **Final**

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-13 (0-300)**
Address:	**PO Box 427** **NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	6.9	Neutral pH
EC mS/cm (1:5)	0.04	Very Low Salinity
Texture Class	Medium Clay	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) mgSO_4/ kg	20	Low (non-aggressive)
Chloride (1:5) mgCl / kg	230	Low (non-aggressive)
* Resistivity Ω.▯	26.4	Moderate Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows a neutral pH, very low salinity, low sulphate and low chloride levels and moderate resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is low.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant:
Chris Fraser

Authorised Signatory:
Ryan Jacka

Date of Report:
08/02/2013

 Total No Pages:

Corrosion & Scaling Assessment:
Soil Reporting Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 14** **Date Received: 29/1/13** **Report Status:** ○ **Draft** ◉ **Final**

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-13 (600-800)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	6.9	Neutral pH
EC mS/cm (1:5)	0.69	Very High Salinity (saline)
Texture Class	Medium Clay	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) $mgSO_4$/ kg	120	Low (non-aggressive)
Chloride (1:5) mgCl / kg	1110	Low (non-aggressive)
* Resistivity Ω.▯	3.4	Very Low Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows a neutral pH, very high salinity, low sulphate and low chloride levels and very low resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be moderately-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is moderate.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

 Total No Pages:

Corrosion & Scaling Assessment:
Soil Reporting Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 | **Sample N°: 15** | **Date Received: 29/1/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-14 (0-300)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	6.7	Very Slight Acidity
EC mS/cm (1:5)	<0.02	Very Low Salinity
Texture Class	Sandy Loam	
Soil Permeability Class		High Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) mgSO_4 / kg	10	Low (non-aggressive)
Chloride (1:5) mgCl / kg	50	Low (non-aggressive)
* Resistivity Ω.m	106.2	Very High Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows very slight acidity, very low salinity, low sulphate and low chloride levels and very high resistivity.

According to AS2159-2009, the pH is considered mildly-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered mildly-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be mildly-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is mild.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

Corrosion & Scaling Assessment:
Soil Reporting Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 16** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ **Final**

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-14 (800-1000)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC, PRI**

TEST	RESULT	COMMENTS
pH in water (1:5)	6.7	Very Slight Acidity
EC mS/cm (1:5)	<0.02	Very Low Salinity
Texture Class	Sandy Clay Loam	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) mgSO_4/ kg	20	Low (non-aggressive)
Chloride (1:5) mgCl / kg	40	Low (non-aggressive)
* Resistivity Ω.□	177.7	Very High Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows very slight acidity, very low salinity, low sulphate and low chloride levels and very high resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is low.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; [e]**Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

Corrosion & Scaling Assessment:

Soil Reporting Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 17** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ **Final**

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-02 (2400-2800)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST	RESULT	COMMENTS
pH in water (1:5)	7.4	Slight Alkalinity
EC mS/cm (1:5)	0.04	Very Low Salinity
Texture Class	Light Clay	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) $mgSO_4$ / kg	10	Low (non-aggressive)
Chloride (1:5) mgCl / kg	170	Low (non-aggressive)
* Resistivity Ω.□	38.7	Moderate Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows slight alkalinity, very low salinity, low sulphate and low chloride levels and moderate resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is low.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **/Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

Corrosion & Scaling Assessment:
Soil Reporting Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 18** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-08 (1000-1200)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST	RESULT	COMMENTS
pH in water (1:5)	5.4	Strong Acidity
EC mS/cm (1:5)	0.06	Low Salinity
Texture Class	Medium Clay	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) mgSO_4/ kg	130	Low (non-aggressive)
Chloride (1:5) mgCl / kg	20	Low (non-aggressive)
* Resistivity Ω.	50.7	High Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows strong acidity, low salinity, low sulphate and low chloride levels and high resistivity.

According to AS2159-2009, the pH is considered mildly-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is mild.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

Corrosion & Scaling Assessment:
Soil Reporting Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 19** **Date Received: 29/1/13** **Report Status:** ○ **Draft** ◉ **Final**

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-09 (2500-2800)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST	RESULT	COMMENTS
pH in water (1:5)	8.4	Moderate Alkalinity
EC mS/cm (1:5)	0.93	Very High Salinity (saline)
Texture Class	Medium Clay	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) mgSO_4/ kg	550	Low (non-aggressive)
Chloride (1:5) mgCl / kg	1330	Low (non-aggressive)
* Resistivity Ω.m	3.0	Very Low Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows moderate alkalinity, very high salinity, low sulphate and low chloride levels and very low resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be moderately-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is moderate.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

Corrosion & Scaling Assessment:

Soil Reporting Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 20** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ **Final**

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-10 (1000-1200)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST	RESULT	COMMENTS
pH in water (1:5)	8.5	Moderate Alkalinity
EC mS/cm (1:5)	0.82	Very High Salinity (saline)
Texture Class	Silty Clay	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) $mgSO_4$ / kg	40	Low (non-aggressive)
Chloride (1:5) mgCl / kg	1300	Low (non-aggressive)
* Resistivity Ω.m	3.8	Very Low Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows moderate alkalinity, very high salinity, low sulphate and low chloride levels and very low resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be moderately-aggressive towards steel.

<u>Factors affecting concrete scaling are:</u> (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

<u>Factors affecting steel corrosivity are:</u> (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is moderate.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

 Total No Pages:

Corrosion & Scaling Assessment:
Soil Reporting Profile

sesl AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 21** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-11 (1500-1700)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST	RESULT	COMMENTS
pH in water (1:5)	7.3	Slight Alkalinity
EC mS/cm (1:5)	0.04	Very Low Salinity
Texture Class	Light Clay	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) $mgSO_4$ / kg	40	Low (non-aggressive)
Chloride (1:5) mgCl / kg	110	Low (non-aggressive)
* Resistivity Ω.m	41.1	Moderate Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows slight alkalinity, very low salinity, low sulphate and low chloride levels and moderate resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is low.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

sesl AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Corrosion & Scaling Assessment:

Soil Reporting Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 22** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-12 (1200-1800)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST	RESULT	COMMENTS
pH in water (1:5)	7.3	Slight Alkalinity
EC mS/cm (1:5)	0.02	Very Low Salinity
Texture Class	Light Clay	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) mgSO_4/ kg	40	Low (non-aggressive)
Chloride (1:5) mgCl / kg	80	Low (non-aggressive)
* Resistivity Ω.▯	68.9	High Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows slight alkalinity, very low salinity, low sulphate and low chloride levels and high resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is low.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant:
Chris Fraser

Authorised Signatory:
Ryan Jacka

Date of Report:
08/02/2013

AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Corrosion & Scaling Assessment:

Soil Reporting Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120 — **Tel:** 02 9980 6554 — **Fax:** 02 9484 2427

Mailing Address: PO Box 357, Pennant Hills NSW 1715 — **Em:** info@sesl.com.au — **Web:** www.sesl.com.au

Quality ISO 9001

Batch N°: 25211	**Sample N°: 23**	**Date Received: 29/1/13**	**Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-13 (4000-4300)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST		RESULT	COMMENTS
pH in water (1:5)		8.3	Moderate Alkalinity
EC mS/cm (1:5)		0.12	Low Salinity
Texture Class		Light Clay	
Soil Permeability Class			Low Permeability
SOLUBLE ANION ANALYSIS			
Sulphate (1:5)	$mgSO_4$ / kg	40	Low (non-aggressive)
Chloride (1:5)	mgCl / kg	440	Low (non-aggressive)
* Resistivity Ω.□		15.5	Moderate Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows moderate alkalinity, low salinity, low sulphate and low chloride levels and moderate resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be mildly-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is mild.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

Corrosion & Scaling Assessment:
Soil Reporting Profile

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211 **Sample N°: 24** **Date Received: 29/1/13** **Report Status:** ○ Draft ◉ **Final**

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-14 (2600-2900)**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Soil**
		Test Type:	**CSCSS, CECAC**

TEST	RESULT	COMMENTS
pH in water (1:5)	7.1	Neutral pH
EC mS/cm (1:5)	0.02	Very Low Salinity
Texture Class	Sandy Clay	
Soil Permeability Class		Low Permeability
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) $mgSO_4$ / kg	40	Low (non-aggressive)
Chloride (1:5) mgCl / kg	60	Low (non-aggressive)
* Resistivity Ω.m	115.9	Very High Resistivity

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows neutral pH, very low salinity, low sulphate and low chloride levels and very high resistivity.

According to AS2159-2009, the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The low chloride levels are considered non-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be non-aggressive towards concrete. The resistivity is considered to be non-aggressive towards steel.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is low.

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

 Total No Pages:

Corrosion & Scaling Assessment:
Soil Reporting Profile

SESL AUSTRALIA — AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211	**Sample N°: 25**	**Date Received: 29/1/13**	**Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-13 GW 09012013**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Water**
		Test Type:	**CMSCSW**

TEST	RESULT	COMMENTS
pH in water (1:5)	8.0	Slight Alkalinity
EC mS/cm (1:5)	2.73	Very High Salinity (Saline)
Texture Class		
Soil Permeability Class		
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) mgSO_4/ kg	340	Low (non-aggressive)
Chloride (1:5) mgCl / kg	4020	Low (non-aggressive)
* Resistivity Ω.□		

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows slight alkalinity, very high salinity, low sulphate and low chloride levels.

According to AS2159-2009, the pH is considered mildly-aggressive towards concrete and non-corrosive towards steel due to unknown permeability and resistivity. The low chloride levels are considered mildly-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be midly-aggressive towards concrete due to unknown permeability and resistivity.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is mild to moderate..

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

APPENDIX 4 Groundwater laboratory analysis results

Corrosion & Scaling Assessment:
Soil Reporting Profile

SESL Australia
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25211	**Sample N°: 25**	**Date Received: 29/1/13**	**Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-13 GW 09012013**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Water**
		Test Type:	**CMSCSW**

TEST	RESULT	COMMENTS
pH in water (1:5)	8.0	Slight Alkalinity
EC mS/cm (1:5)	2.73	Very High Salinity (Saline)
Texture Class		
Soil Permeability Class		
SOLUBLE ANION ANALYSIS		
Sulphate (1:5) $mgSO_4$/ kg	340	Low (non-aggressive)
Chloride (1:5) mgCl / kg	4020	Low (non-aggressive)
* Resistivity Ω.m		

* Resistivity tested on a saturated sample/paste

(Note:- 10,000 mg/kg = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of soils towards concrete structures with steel reinforcement, concrete and steel piles, this soil shows slight alkalinity, very high salinity, low sulphate and low chloride levels.

According to AS2159-2009, the pH is considered mildly-aggressive towards concrete and non-corrosive towards steel due to unknown permeability and resistivity. The low chloride levels are considered mildly-aggressive towards concrete and non-corrosive towards steel while the low sulphate levels are considered to be midly-aggressive towards concrete due to unknown permeability and resistivity.

Factors affecting concrete scaling are: (a) elevated sulphate, becoming mildly aggressive at >5000mg/kg SO4; and (b) low pH, becoming mildly aggressive at pH of <5.5.

Factors affecting steel corrosivity are: (a) elevated chloride, becoming mildly aggressive at >5,000mg/kg Cl; and (b) low pH, becoming mildly aggressive at pH of <5 and (c) low resistivity, becoming mildly aggressive with resistivity values less than 50Ω.m.

Overall, according AS2159:2009 the likelihood of aggressive corrosion is mild to moderate..

If you would like to discuss further please contact the office on 9980 6554.

Explanation of the Methods:
pH, EC, Soluble SO_4: Bradley et al., (1983); **Cl,** (4500-Cl- E; APHA, 1998); **Texture Class,** AS2159:2009; **Resistivity,** AS1289.4.4.1:1997,

Consultant: Chris Fraser

Authorised Signatory: Ryan Jacka

Date of Report: 08/02/2013

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Corrosion & Scaling Assessment: Water Reporting Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Quality ISO 9001

Batch N°: 25596 | **Sample N°: 1** | **Date Received: 5/3/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	**201368**	Sample Name:	**201368-15 GW 28/02/2013**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Water**
		Test Type:	**CMSCSW**

TEST		RESULT	COMMENTS
pH		6.5	Slight Acidity
EC mS/cm		0.48	Moderate
SOLUBLE CATION ANALYSIS			
Sodium	mg/L	36.1	Low
Calcium	mg/L	31.9	Low
Magnesium	mg/L	21	Low
Ammonium-N	mg/L	0.5	Low
SOLUBLE ANION ANALYSIS			
Sulphate	$mgSO_4$/L	18.4	Low
Chloride	mg/L	88.6	Low
Carbonate	mg/L	0.0	Very Low
Bicarbonate	mg/L	90.0	Low
Derived Values			
* Total Dissolved Salts mg/L		307.2	Class 2 Salinity for Irrigation
* Resistivity Ω.m		20.8	Moderate Resistivity
$CaCO_3$ Saturation Index (pH-pH$_C$)		-1.3	Moderate Potential for Concrete Corrosion
Total Hardness (mg/L as $CaCO_3$)		166.1	Slightly Hard

* derived value from EC

(Note:- 10,000 mg/L = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of water towards concrete structures with steel reinforcement, concrete and steel piles, this water shows a Class 2 salinity for irrigation water, which is considered moderately appropriate for irrigation and is a moderate salinity level.

According to AS2159:2009, DIN 4030:1991 and Basson (1989), the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The chloride level is considered to pose a low degree of aggressiveness towards concrete and steel.

The resistivity is considered to be moderately-aggressive towards unprotected steel.

The saturation index shows an increasing risk of concrete corrosion.

This assessment has been based on the assessment of the water sample provided to SESL.

Explanation of the Methods:
pH, EC, Soluble Na, Ca, Cl, Mg, NH_4, SO_4: Bradley et al (1983);
HCO_3, CO_3, $CaCO_3$ Saturation Index, Hardness: Rayment & Higginson, (1983);

SESL Australia ABN 70 106 810 708

Total No Pages: 1/1

Consultant — Chris Fraser

Authorised Signatory — Ryan Jacka

Date of Report 15/03/2013

AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Corrosion & Scaling Assessment: Water Reporting Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25596 **Sample N°: 2** **Date Received: 5/3/13** **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:	**201368**	Sample Name:	**201368-16 GW 28/02/2013**
Address:	**PO Box 427** **NARELLAN NSW 2567**	Description:	**Water**
		Test Type:	**CMSCSW**

TEST		RESULT	COMMENTS
pH		6.6	Very Slight Acidity
EC mS/cm		0.56	Moderate Salinity
SOLUBLE CATION ANALYSIS			
Sodium	mg/L	37.3	Low
Calcium	mg/L	35.2	Low
Magnesium	mg/L	23.2	Low
Ammonium-N	mg/L	0.5	Low
SOLUBLE ANION ANALYSIS			
Sulphate	$mgSO_4/L$	12.9	Low
Chloride	mg/L	111.8	Low
Carbonate	mg/L	0.0	Very Low
Bicarbonate	mg/L	100.0	Low
Derived Values			
* Total Dissolved Salts mg/L		358.4	Class 2 Salinity for Irrigation
* Resistivity Ω.m		17.9	Moderate Resistivity
$CaCO_3$ Saturation Index ($pH-pH_C$)		-1.1	Moderate Potential for Concrete Corrosion
Total Hardness (mg/L as $CaCO_3$)		183.4	Slightly Hard

* derived value from EC

(Note:- 10,000 mg/L = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of water towards concrete structures with steel reinforcement, concrete and steel piles, this water shows a Class 2 salinity for irrigation water, which is considered moderately appropriate for irrigation and is a moderate salinity level.

According to AS2159:2009, DIN 4030:1991 and Basson (1989), the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The chloride level is considered to pose a low degree of aggressiveness towards concrete and steel.

The resistivity is considered to be moderately-aggressive towards unprotected steel.

The saturation index shows an increasing risk of concrete corrosion.

This assessment has been based on the assessment of the water sample provided to SESL.

Explanation of the Methods:
pH, EC, Soluble Na, Ca, Cl, Mg, NH_4, SO_4: Bradley et al (1983);
HCO_3, CO_3, $CaCO_3$ Saturation Index, Hardness: Rayment & Higginson, (1983);

SESL Australia ABN 70 106 810 708

Total No Pages: 1/1

Consultant
Chris Fraser

Authorised Signatory
Ryan Jacka

Date of Report
15/03/2013

SESL AUSTRALIA
AUSTRALIA'S MOST TRUSTED EARTH SCIENCE SERVICES

Corrosion & Scaling Assessment: Water Reporting Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 02 9980 6554
Fax: 02 9484 2427
Em: info@sesl.com.au
Web: www.sesl.com.au

Certified System Quality ISO 9001

Batch N°: 25967 | **Sample N°: 1** | **Date Received: 9/4/13** | **Report Status:** ○ Draft ◉ Final

Client Name:	**Harvest Scientific Services**	Project Name:	**REF: 201368**
Client Contact:	**Jim Cupitt**	Location:	
Client Job N°:		SESL Quote N°:	
Client Order N°:		Sample Name:	**201368-17 GW 20/03/2013**
Address:	**PO Box 427 NARELLAN NSW 2567**	Description:	**Water**
		Test Type:	**CMSCSW**

TEST		RESULT	COMMENTS
pH		6.0	Medium Acidity
EC mS/cm		0.27	Elevated
SOLUBLE CATION ANALYSIS			
Sodium	mg/L	43.1	Low
Calcium	mg/L	8.3	Low
Magnesium	mg/L	5.5	Low
Ammonium-N	mg/L	0.4	Low
SOLUBLE ANION ANALYSIS			
Sulphate	$mgSO_4$/L	7.8	Low
Chloride	mg/L	58.3	Low
Carbonate	mg/L	0.0	Low
Bicarbonate	mg/L	50.0	Low
Derived Values			
* Total Dissolved Salts mg/L		172.8	Low
* Resistivity Ω.m		37.0	Moderate
$CaCO_3$ Saturation Index ($pH-pH_C$)		-2.6	Significant Potential for Concrete Corrosion
Total Hardness (mg/L as $CaCO_3$)		43.4	Very Soft

* derived value from EC

(Note:- 10,000 mg/L = 1%)

Recommendations

For the purpose of corrosion and scaling assessment of water towards concrete structures with steel reinforcement, concrete and steel piles, this water shows a Class 2 salinity for irrigation water, which is considered suitable for moderately sensitive plants and most plant species.

According to AS2159:2009, DIN 4030:1991 and Basson (1989), the pH is considered non-aggressive towards concrete and non-corrosive towards steel. The chloride level is considered to pose a low degree of aggressiveness towards concrete and steel.

The resistivity is considered to be mildly-aggressive towards unprotected steel.

The saturation index shows an increasing risk of concrete corrosion.

This assessment has been based on the assessment of the water sample provided to SESL.

Explanation of the Methods:
pH, EC, Soluble Na, Ca, Cl, Mg, NH_4, SO_4: Bradley et al (1983);
HCO_3, CO_3, $CaCO_3$ Saturation Index, Hardness: Rayment & Higginson, (1983);

SESL Australia ABN 70 106 810 708

Consultant — Chris Fraser

Authorised Signatory — Ryan Jacka

Date of Report 15/04/2013