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ONSITE WASTEWATER FEASIBILITY

AND

WATER QUALITY STUDY

FOR A PLANNING PROPOSAL

No.1 ABBOTSFORD ROAD, PICTON

Prepared for

Berten Pty Ltd

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Executive Summary

INTRODUCTION

Harvest Scientific Services Pty Ltd (Harvest) was commissioned by Berten Pty Ltd to carry out an Onsite Wastewater Feasibility and Water Quality 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 a re-zoning application for the Study Area.

The objective of this Study was to address the Specialist Study Requirements outlined under the heading '*5.15 Onsite Wastewater Feasibility & Water Quality'.* Accordingly, this Study has been undertaken to address the following components:

- 'Water Quality'; and
- 'Onsite Wastewater Feasibility'.

Whilst these components were assessed separately, these components are interconnected and should not be considered in isolation of each other. Areas of connectivity are noted and recommendations to address the constraints identified are included in this Study.

CATCHMENT AND DRAINAGE FEATURES OF THE STUDY AREA

The Study Area is located within the catchment of the Hawkesbury-Nepean River system.

A total of eight Watercourses were identified to be associated with the Study Area and these may be 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 3rd 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.

Each of the above features is either located within the Study Area or within 40 metres of the boundary of the Study Area and therefore will need to be considered in subsequent development.

Stonequarry Creek and the unnamed 3rd Order Watercourse met the criteria published by the NSW Department of Fisheries and Aquaculture (DOFA) to be Key Fish Habitats (KFHs).

GOVERNMENT ENDORSED OBJECTIVES AND STRATEGIES

This Study has been prepared with reference to the following Government endorsed objectives and strategies:

- State Regional Environmental Plan 20 (SREP 20) No.2 – Hawkesbury- Nepean River;
- Wollondilly Shire Council Local Environmental Plan (LEP) (2011);
- Wollondilly Shire Council Development Control Plan (DCP) (2011);
- Wollondilly Shire Council Onsite Sewerage Management Strategy (2004);
- Wollondilly Shire Council On-site Sewerage Management System and Greywater re-use (2011);
- Water Management Act (NSW) (2000);
- NSW Office of Water guidelines for riparian corridors (2010);
- Fisheries Management Act (NSW) (1994);
- NSW DPI Policy guidelines for Aquatic Management and Fish Conservation Policy (1999);
- The Hawkesbury Nepean River System Habitat Protection Plan No.3 (1998);
- NSW DPI brochure entitled 'Policy and guidelines for fish friendly water crossings' (undated);
- The Department of Local Government guidelines entitled 'Environment and Health Protection Guidelines (1998); and
- Australian/New Zealand (AS/NZ) 1547:2000 entitled 'Onsite Domestic Wastewater Management (Standards Australia, 2000)

ONSITE WASTEWATER FEASIBILITY STUDY

This Onsite Wastewater Feasibility Study (OWFS) has been prepared based on the assumption that:

- a standard four bedroom residence and associated improvements is to be established on each proposed future lot; and
- all household wastewater flows (black and grey water) from each proposed residence are to be treated via an Aerated Wastewater Treatment System (AWTS) and disposed of onsite via either surface-spray, surface-drip or sub-surface methods of effluent irrigation.

The sites soils, groundwater and other constraints were then assessed to determine the suitability of the Study Area for onsite effluent disposal.

Study Objectives

The objective of the OWFS was to address the first 4 objectives of the Specialist Study Requirements (refer to Section 1.2 for Specialist Study Requirements). The specific objectives of this Study are therefore as follows:

- *'To assess the onsite wastewater feasibility of the site based on soils and geotechnical constraints;*
- *To provide information on the management requirements of an effluent disposal area, with the appropriate guideline and any additional requirements;*
- *To recommend the most suitable effluent treatment system to be used on the site, as well as including information about other possible units; and*
- *To provide information regarding nutrient loading and water balance calculations based on the Environment and Health Protection Guidelines 1998.'*

Assessment methodology

This assessment consisted of the following methodology:

- A review of the 1:100,000 Wollongong to Port Hacking Soil Landscape Map Sheet (Hazelton and Tille, 1990) for the study area (results are reported in Section 2 of this Study);
- A soil test-pitting and laboratory analysis regime;
- Installation of groundwater piezometers and a groundwater monitoring and analysis regime;
- Field mapping of site features;
- Assessment of site features against site assessment criteria outlined in the Environment and Health Protection guidelines of 1998; and
- Undertaking nutrient loading and water balance calculations to determine the minimum area required for onsite effluent irrigation. Calculations were based upon the Environment and Health Protection guidelines of 1998.

Site and soil constraints to onsite effluent irrigation

This assessment identified a number of potential site and soil constraints to onsite effluent irrigation. Potential site constraints that were identified in this Study include:

- Depth to permanent or intermittent groundwater;

- Flood;
- Slope;
- Up-slope run-on waters;
- Mass movement (slope instability) and erosion; and
- Buffer distances to site features.

Potential soil constraints that were identified include:

- Soil permeability;
- Sodium exchange capacity;
- Cation exchange capacity; and
- Phosphorus absorption capacity.

OWFS Development Controls

The OWFS included a number of proposed Development Controls to address the site and soil constraints identified in this Study.

OWFS Conclusions

Providing the recommended Development Controls outlined in this OWFS are implemented, domestic wastewater (black and grey-water) from the proposed residences are considered to be capable of being managed by onsite treatment with a domestic AWTS with onsite disposal via either surface-spray of sub-surface effluent irrigation.

With regard to the four objectives of the Specialist Study Requirements that are of relevance to onsite wastewater treatment and disposal, the following is noted:

- The onsite wastewater feasibility of the Study Area was assessed in Section 4 of this Study;
- Recommendations for the management of Effluent Management Areas (EMAs) was provided in Section 4.8 of this Study;
- The most suitable wastewater treatment system for the treatment of domestic wastewater from each proposed residence was found to be an Aerated Wastewater Treatment System (AWTS). Alternative wastewater treatment systems were discussed and these are included in Section 4.6.3.2 of this Study; and
- Nutrient loading and water balance calculations were undertaken and based on these calculations, the minimum areas required for onsite effluent irrigation to dispose of the effluent load from a standard AWTS for a standard four bedroom residence are as follows:
    - Sub-surface effluent irrigation = 1034 m^2; and
    - Surface methods of effluent irrigation = 1500 m^2.

No onsite wastewater treatment and disposal impediments to the re-zoning of the Study Area were identified in this Study.

INTEGRATED WATER QUALITY MANAGEMENT PLAN (IWQMP)

An Integrated Water Quality Management Plan (IWQMP) has been prepared which aims to ensure that the re-zoning and subsequent development of the Study Area will not result in adverse water quality impacts on the receiving waters of Stonequarry Creek and more generally the Hawkesbury Nepean River System. To this end, the IWQMP recommends Development Controls to manage onsite domestic wastewater treatment and disposal and stormwater runoff within the Study Area. In brief, these Development Controls include, but are not limited to, the following:

- All domestic wastewater (black- and grey-water) treatment and disposal must comply with Wollondilly Shire Council's existing policy and strategy for onsite wastewater management;
- Stormwater modeling is to be undertaken on all sub-division Development Applications and must demonstrate a Neutral of Beneficial Effect (NorBE) of the development on water quality in the receiving waters of Stonequarry Creek and more generally the Hawkesbury-Nepean River System;
- All Grass Swales and Bio-retention Swales installed for the purpose of improving water quality from effluent irrigation areas should be excluded from the buffer distance requirements of Wollondilly Shire Council's policy and strategy for onsite wastewater management. This exclusion should only apply to construction of structures that have been explicitly included for the management of water quality run-off;
- All Core Riparian Zones (CRZs) and Vegetative Buffers (VBs) as outlined in this Study should be adopted;
- All stream crossings and works within 40metres of the high bank of a Watercourse should comply with the following guidelines:
    - '*Policy and guidelines. Aquatic Management and Fish Conservation guidelines*' dated 1999; and
    - '*Policy and guidelines for fish friendly water crossings*' (Undated); and
- The Wollondilly LEP and DCP (2011) should be reviewed in the context of the recommendations outlined in this Study for the Study Area.

The IWQMP also incorporated the principles of Water Sensitive Urban Design (WSUD) and Managing Urban Stormwater together with Riparian Enhancement Activities (REA). Consequently, it is anticipated that a typical sub-division will include one or more of the following WSUD options:

- collection of roof water in a rainwater tank and re-use of this water for permissible domestic purposes;
- treatment of stormwater run-off from hardstand areas and effluent disposal areas with a combination of the follows grass buffer strips, grass swales and/or a bio-retention swales or other similar equivalent stormwater treatment devices;
- diversion of surface stormwater run-off waters from one or more allotments to a sediment pond that is located in the lowest point in the sub-division catchment and outside of any CRZs; and
- Grass Swales and/or Bioretention Swales are to be installed to treat surface water run-off from constructed public roads. These structures are typically located on either side of the road on road verges or centrally between the two lanes of traffic. These features may be installed in combination with slotted gutters or in the absence or a constructed gutter. The fall of the road

is to be designed to promote drainage of surface waters towards these water treatment devices.

Providing that the recommendations of the IWQMP are implemented, it was found that in the context of the existing legislative framework that applies to the Study Area, the re-zoning of the Study Area for the proposed large-lot residential land-use will not result in a negative impact on stormwater quality within Stonequarry Creek and more generally the broader Hawkesbury-Nepean River System.

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

CONCLUSIONS

Based on the findings of this Study it was found that in the context of the existing legislative framework that applies to the Study Area, the re-zoning of the Study Area for the proposed rural/residential land-use will not result adversely on stormwater quality within Stonequarry Creek and/or more generally the broader Hawkesbury-Nepean river system.

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

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ABBREVIATIONS

AWQGFMW	Australian Water Quality Guidelines for Fresh and Marine Waters (1992)
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
EMA	Effluent Management Area
FMA 1994	Fisheries Management Act 1994
Harvest	Harvest Scientific Services Pty Ltd
LGA	Local Government Area
LEP	Local Environmental Plan
LEP 2011	Wollondilly Shire Council's Local Environmental Plan 2011
MHRDC	Maximum Harvestable Rights Dam Capacity
NorBE	Neutral or Beneficial Effect
NOW	NSW Office of Water
REA	Riparian Enhancement Activities
SREP 20	State Regional Environmental Plan No. 20 – Hawkesbury-Nepean River
WMA 2000	Water Management Act 2000
WSC	Wollondilly Shire Council

DEFINITIONS

The definitions adopted in the text of this Study are outlined in the following table. These definitions were adopted to allow for the use of consistent terminology within this Study and therefore to avoid ambiguity and confusion.

It is noted, however, that adopted definitions may conflict with definitions provided in legislation, guidelines and/or other published literature. Words and/or terms that are taken directly from cited literature are presented in *italics* and the definitions provided below may not apply to those words.

Furthermore, the words and/or phrases presented below may, and often does, have different definitions in different literature, guidelines and/or legislation.

Word or phrase	**Adopted definition**
Bioretention swale	Bioretention swales are a typical Water Sensitive Urban Design structure used for both stormwater treatment and stormwater conveyance. They are typically provided within median strips or footpaths and/or may be incorporated into the base of a grass swale. Bioretention swales employ a more permeable filter media (such as sand) as a treatment media and an agricultural-pipe in their base to drain treated stormwater/s.
'Blue Line'	Any natural channel or a natural channel artificially improved whether perennial or intermittent that is depicted as a 'Blue Line' on the 1:25,000 Topographic Map series.
Core Riparian Zone (CRZ)	Definition is as per **NSW Office of Water (2010)**: *'The **core riparian zone (CRZ)** is the land contained within and adjacent to the channel. The CRZ should be retained, or revegetated with fully structured native vegetation (including groundcovers, shrubs and trees).'*
Greenfield Site	Means a large parcel of undeveloped land proposed to be developed in the future for a more intensive land-use such as residential houses. Parcels of land already developed for any purpose other than grazing (i.e. green fields) cannot be Greenfield Sites.
Neutral or Beneficial Effect (NorBE)	The term Neutral or Beneficial Effect (NorBE) is used with reference to stormwater quality as a result of development. For NorBE to be demonstrated stormwater modelling must indicate that stormwater quality is less than the government endorsed targets for the Study Area. Government endorsed targets are to be determined in consultation with the NSW Office of Water.
Stream Order	The Watercourse hierarchy classification system as originally proposed by **Strahler (1952).** To reduce confusion, when referencing a specific Watercourse in this Study, the word 'Stream' is replaced with the word 'Watercourse', even though in the original publication and other publications use the word '*Stream*'.
Study Area	The portion of land delineated as the 'Study Area' on **Figure 1** of this Study.
Study	Means this document and its associated tasks.
Vegetated Buffer (VB)	Definition is as per **NSW Office of Water (2010)**: *'The **vegetated buffer (VB)** protects the environmental integrity of the CRZ. The VB should be wide enough to protect the CRZ from weed invasion, micro-climate changes, litter, trampling and pollution and the recommended width is 10 metres although this is subject to merit assessment.'*
Watercourse	Any natural channel or a natural channel artificially improved whether perennial or

Word or phrase	Adopted definition
	intermittent that is depicted as a 'Blue Line' on the 1:25,000 Topographic Map series.
Water Sensitive Urban Design (WSUD)	The integration of management of the urban water cycle with urban planning and design is '*Urban Sensitive Urban Design (WSUD)', adopted from* **Melbourne Water (2005**).
Water Quality Infrastructure	Infrastructure that is to be conditioned as part of the Development Approval process that is required to be installed to manage potential water quality impacts from a development. This may include items such as sedimentation ponds, grass swales and/or bioretention swales.

1.0 OVERVIEW

1.1 Introduction

Harvest Scientific Services Pty Ltd (Harvest) was commissioned by Berten Pty Ltd to carry out an Onsite Wastewater Feasibility and Water Quality 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.

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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

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The objective of this Study was to address the Specialist Study Requirements outlined under the heading '*5.15 Onsite Wastewater Feasibility & Water Quality*'. The requirements issued in relation to Onsite Wastewater Feasibility and Water Quality are as follows:

"5.15.1 Output

- *A report prepared by a suitably qualified and experienced consultant incorporating the onsite wastewater feasibility of the development site in terms of land capability and an integrated water quality management plan that details measures to be adopted for the waste water management systems and future stormwater management systems. This assessment must include:*
- *A description and analysis of the potential effluent management and treatment units to be used on site.*
- *A description of the management requirements necessary for the use of an effluent disposal area.*

5.15.2 Objectives

- *To assess the onsite wastewater feasibility of the site based on soils and geotechnical constraints;*

- *To provide information on the management requirements of an effluent disposal area, with the appropriate guideline and any additional requirements;*
- *To recommend the most suitable effluent treatment system to be used on the site, as well as including information about other possible units.*
- *To provide information regarding nutrient loading and water balance calculations based on the Environment and Health Protection Guidelines 1998.*
- *To prepare an integrated water quality management plan for the study area.*
- *To recommended actions and strategies to ameliorate potential negative impacts on the receiving waters.*
- *To identify water quality management needs that developer contributions and/or development works may address.*
- *To incorporate the principles of Water Sensitive Urban Design and Managing Urban Stormwater as outlined in OEH's General Guidelines for Strategic Planning.*

5.15.3 Tasks/Methodology

- *'Desk top' review of available information including soil profile mapping;*
- *Conduct a site assessment including sampling of soils in locations suitable for wastewater irrigation;*
- *Obtain water samples from study site drainage and samples from the nearby Stonequarry Creek as well as sample stormwater runoff from an adjoining site that has been developed with R5 large lots;*
- *Laboratory assessment of samples;*
- *Recommend minimum subsurface and surface spray irrigation area requirements;*
- *Recommend maximum slopes, minimum setbacks for dwellings, residential infrastructure and other sensitive land uses and natural features to irrigation areas;*
- *Document and map the nature of the existing catchments identifying natural drainage systems (permanent and intermittent) and man-made drainage systems from existing topographic mapping supplied by the proponent.*
- *Summarise Government endorsed objectives and strategies for water quality and catchment management pertaining to the proposed development.*
- *Identify riparian enhancement activities and their role in stormwater treatment and design in this regard the principles contain in the publication, Water Sensitive Urban Design should be incorporated into the report.*
- *Develop a water balance equation for the study area incorporating wastewater, stormwater that optimises reuse and minimises potable use."*

1.3 Study overview

This Study has been partitioned based on the Specialist Study Requirements that are associated with either onsite wastewater treatment and disposal or water quality. Accordingly, this Study consists of the following Sections:

- **Section 1:** An introduction.
- **Section 2:** A review of the biophysical and site constraints that are of relevance to both onsite wastewater disposal and water quality.
- **Section 3:** A review of government endorsed policy and legislation that are of relevance to either onsite wastewater disposal and/or water quality.
- **Section 4:** An Onsite Wastewater Feasibility Study (OWFS) that assesses the capacity of the Study Area to host onsite wastewater treatment and disposal from the proposed residential development.

  This Study section aims at addressing the first four objectives of the Specialist Study Requirements as outlined in Section 1.2 of this Study.

  This section includes a number of recommended Development Controls for the management of onsite effluent irrigation associated with the future development of the Study Area.
- **Section 5:** An Integrated Water Quality Management Plan (IWQMP) that assesses the capacity of the Study area to host onsite wastewater treatment and disposal from the proposed development.

  This Study section aims at addressing the last four objectives of the Specialist Study Requirements as outlined in Section 1.2 of this Study.

  This section includes recommended Development Controls for the management of water quality run-off from the future development of the Study Area.
- **Section 6:** Study limitations.
- **Section 7:** A summary of Specialist Study Requirements and a table outlining the location in this document where the requirement has been addressed.
- **Section 8:** Study conclusions.

2.0 THE STUDY AREA – BIOPHYSICAL FEATURES AND SITE CONSTRAINTS

2.1 Location

The Study Area comprises of a portion of land within Lot 1 DP 1086066 and is located immediately west of the 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.

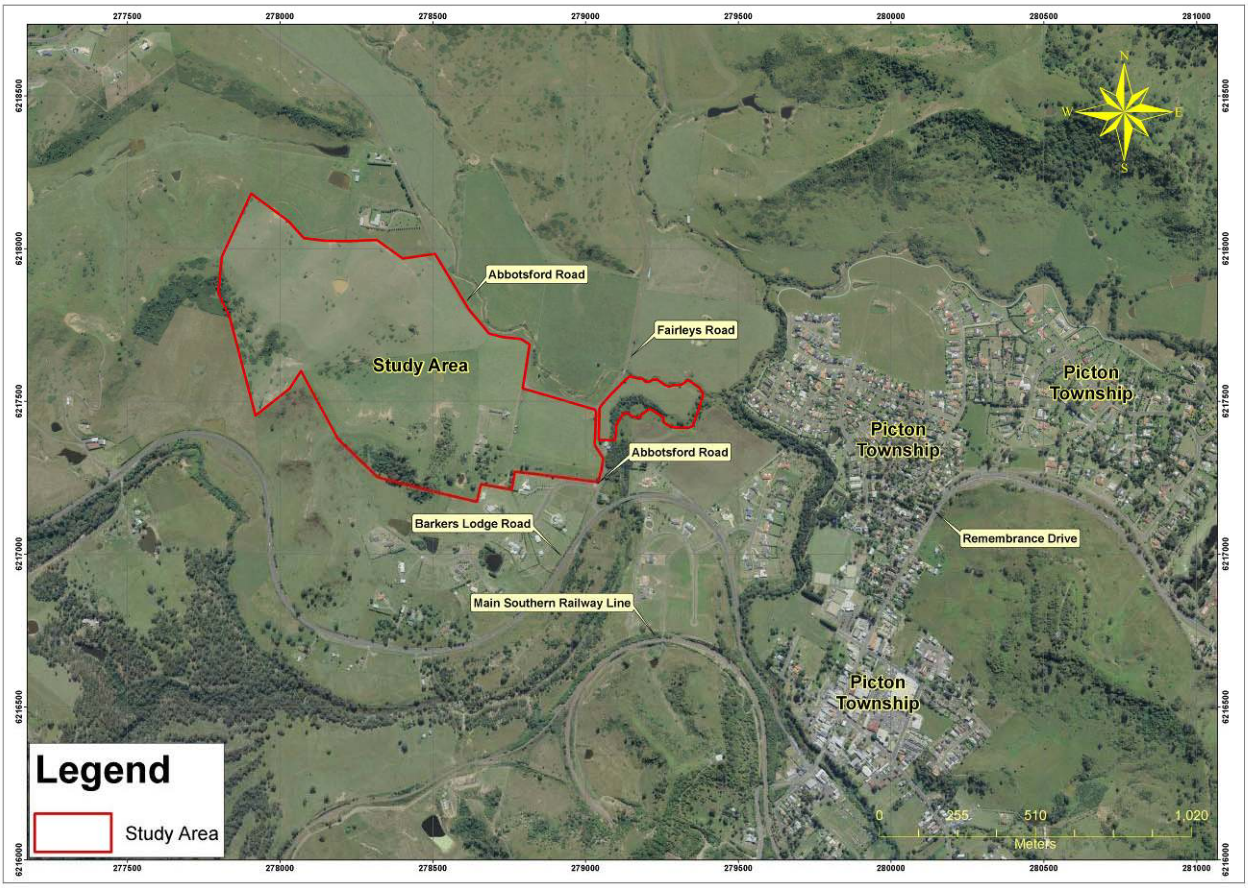


Figure 1: Study Area location. Source of aerial photo: Department of Lands circa 2008.

2.2 Current land-use

The Study Area is currently used for cattle and sheep grazing activities. The land associated with the Study Area consists of relatively flat foot-slopes (Plate 1), side-slopes (Plate 2), steep side-slopes (Plate 3) and hill crests (Plate 4).

2.3 Infrastructure

Infrastructure associated with the Study Area is depicted in Figure 2 and includes:

- A former dairy (Plates 5, 6 and 7)
- A former feed shed (Plates 8 and 9)

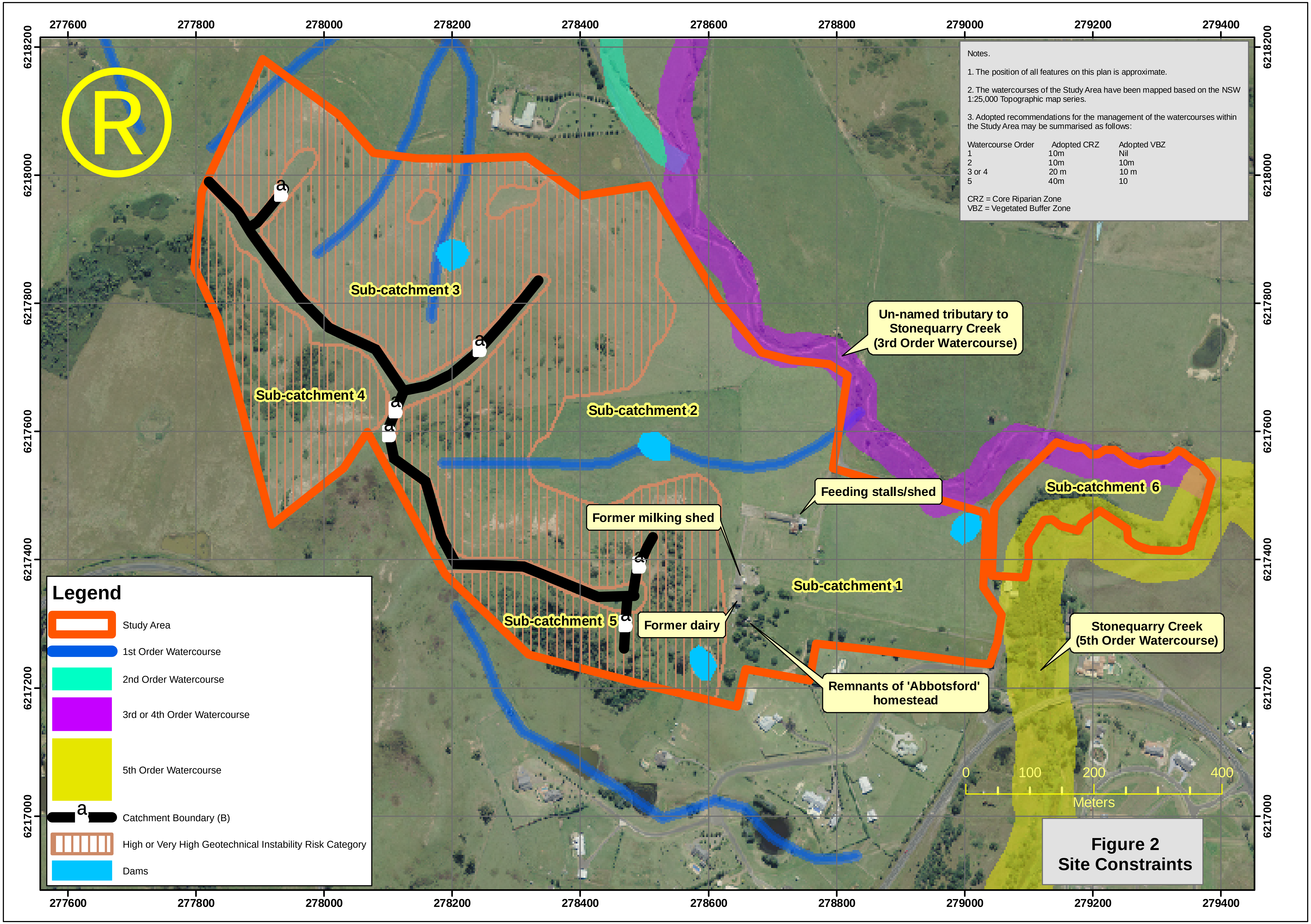


Figure 2
Site Constraints

- A derelict residence (Plate 10); and
- Stock holding yards and an associated loading ramp (Plate 11).

2.4 Zoning

Land zoning is depicted on Figure 3.

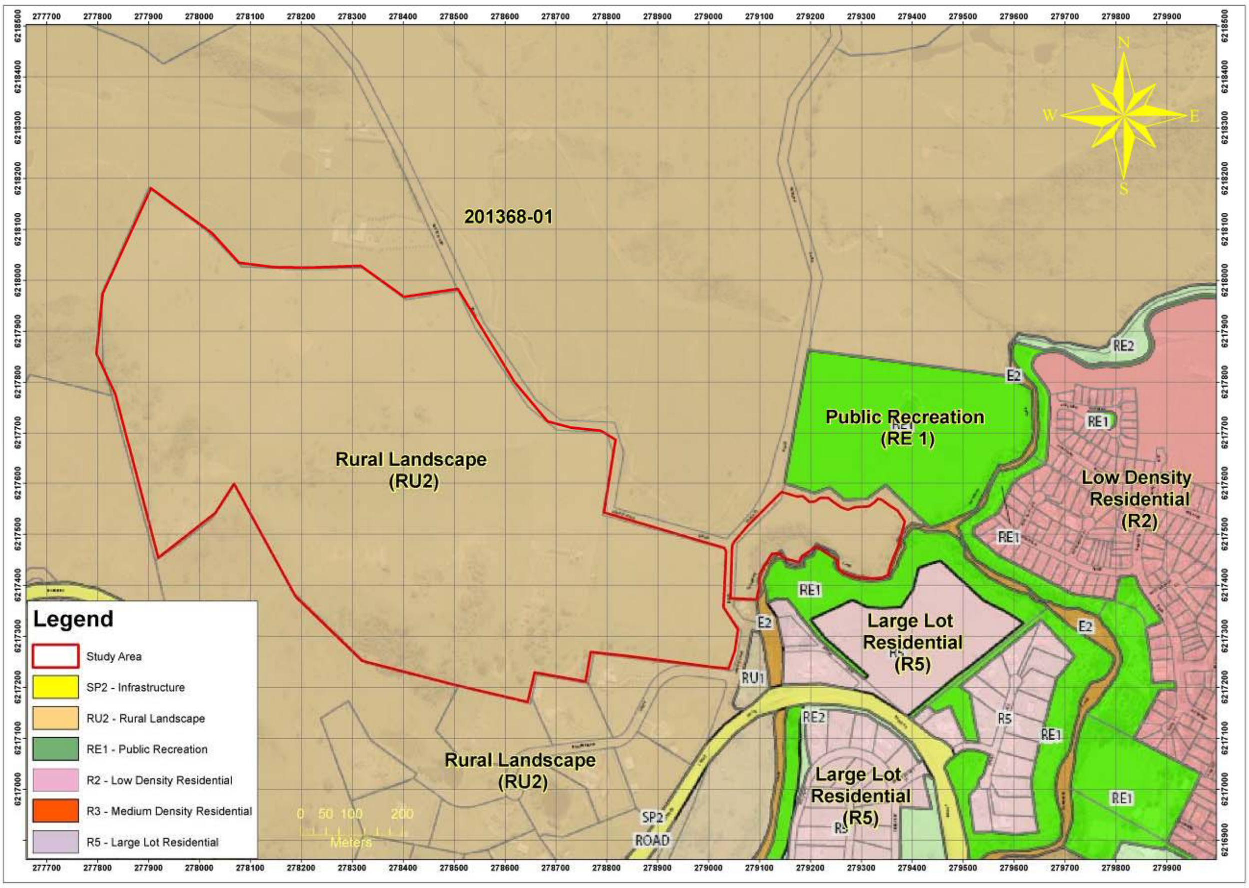


Figure 3: Land zoning map.

The Study Area is zoned as 'RU2 Rural Landscape' and permissible agricultural land-uses may be summarised as follows:

- Extensive agriculture (grazing, bee keeping, pasture based dairy) are permitted without Consent;
- With the exception of turf farming, intensive plant production activities (e.g. horticulture, etc) are permitted with Consent;
- Animal boarding and training establishments are permitted with Consent;
- Intensive livestock agriculture activities (e.g. poultry farms, feedlots) are permitted with Consent; and.
- Forestry is prohibited.

The land zoning surrounding the Study Area may be summarised as follows:

- Immediately to the south, west and north of the investigation area is 'RU2 Rural Landscape';
- 'RE1 – Public Recreation' and 'R5 – Large Lot Residential' to the east;
- 'R2 Low Density Residential' – further to the east; and

A small island of 'RU1' Primary Production immediately to the south-east, which then extends in an arc further to the south.

2.5 Catchment and drainage systems

The following sections describe the nature of the existing catchments and drainage systems that are associated with the Study Area.

2.5.1. 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.

2.5.2. Localised sub-catchments

The Study Area is broadly divided into 6 localised sub-catchments, illustrated on Figure 2 as '*Sub-catchment 1', 'Sub-catchment 2', 'Sub-catchment 3', 'Sub-catchment 4*' and *'Sub-catchment 5*'. The size of each of these catchments is summarised in Table 1.

Table 1: Summary of Sub-catchments within the Study Area

Sub-catchment	**Surface area (ha)[1]**
Sub-catchment 1	14.5
Sub-catchment 2	26.7
Sub-catchment 3	14.7
Sub-catchment 4	7.3
Sub-catchment 5	3.0
Sub-catchment 6	3.8
Total	**70**

Notes:

1. Stated surface areas are approximate only.

Sub-catchments 1 and 2 are located on the relatively flatter portions of the site that will be most suitable for urban development. *Sub-catchment 1* drains partially to Stonequarry Creek and partially to an un-named 3rd Order watercourse. *Sub-catchment 2* drains to the north-east directly to an un-named 3rd Order watercourse.

Sub-catchments 3, 4 and 5 contain land that is largely encumbered by steep land that is unlikely to be extensively developed for residential development due to slope constraints. Some limited development, however, may occur along ridge lines (i.e. catchment boundaries depicted on Figure 2).

Sub-catchments 3 and 4 catchments drain to the north and south-east respectively. *Sub-catchment 5* drains to the south.

Sub-catchment 6 is located to the east of *sub-catchment 1* and is separated from this catchment by the man-made drainage system associated with Abbotsford Road. The extent of development of this area is considered to be limited with flood constraints potentially being a significant constraint in this area.

2.5.3. Existing drainage systems

2.5.3.1 Natural drainage watercourses

The natural drainage of the Study Area was investigated via a field assessment in early 2013, a review of the 1:25,000 topographic map series and 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 view of a 1st Order watercourse that is located centrally within the Study Area is depicted in Plate 12;
- 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 3rd order watercourse was identified to the north-east of the Study Area. A view of this 3rd Order watercourse at sampling location 201368-SW02 is depicted in Plate 13.
- Stonequarry Creek, a 5th Order watercourse was identified to the east of Study Area.

  A view of Stonequarry Creek at sampling location 201368-SW01 (Figure 4) is depicted in Plate 14.

  A view of Stonequarry Creek at sampling location 201368-SW03 (Figure 4) is depicted in Plate 15.

These features are summarised in Table 2 and their location is depicted on Figure 2**.**

Table 2: Summary of Natural Drainage Systems within the Study Area

Mapped Strahler Stream Order	Number of features		Name(s) of features
	Within the Study Area	Outside the Study Area but within 40 metres	
1st	4	1	Un-named
2nd	0	1	Un-named
3rd or 4th	0	1	1 un-named tributary of Stonequarry Creek
5th or greater	0	1	Stonequarry Creek
Total	**4**	**4**	

Notes:

1. Mapped Strahler Stream Order is based on Strahler (1952).
2. Natural drainage Watercourses are based on the 'blue lines' depicted on the 1:25,000 topographic map series.

2.5.3.2 Anthropogenic (man-made) drainage systems

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

2.5.4. Baseline water quality

2.5.4.1 Sampling locations

A baseline water sampling regime was undertaken to provide base-line water quality data for the local drainage system. Water samples were collected at four locations (201368 SW1, 201368 SW2, 201368 SW3 and 201368 SW4 – Figure 4) and their location details are summarised as follows:

- Up-stream of the Study Area within Stonequarry Creek (201368-SW1);
- Immediately down-stream of the Study Area within an un-named 3rd Order Watercourse (201368-SW2);
- Down-stream of both the Study Area and a nearby existing R5 zoned large-lot sub-division and collected within Stonequarry Creek (201368-SW3); and
- Within a 1st Order Stream located within the Study Area (201368-SW4).

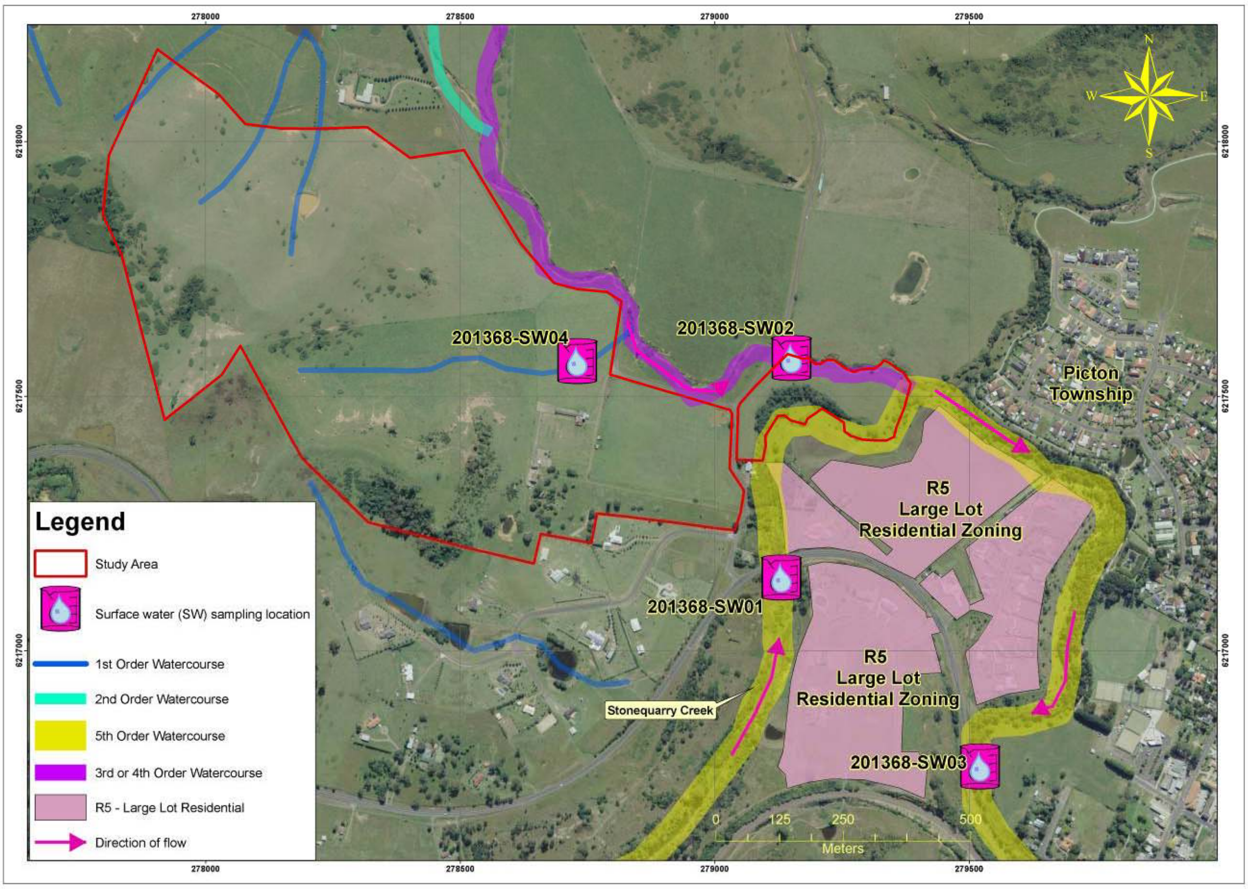


Figure 4: Water quality sampling locations

2.5.4.2 Sampling methodology and laboratory analysis

Water quality samples were collected on 18 February 2013. This sampling regime was conducted after a recent extended period of heavy rain. Samples were stored in an esky (on ice) and transported direct to Australian Laboratory Services (ALS) located at Smithfield for analysis.

All samples were analysed for pH, electrical conductivity @ 25^{o}C, suspended solids, ammonia as N, Nitrite as N, Total Kjeldahl as N, Total Phosphorus as P and Total Phosphorus filtered as P, enterococci and faecal coliforms.

2.5.4.3 Water quality laboratory analysis results

Laboratory analysis results are attached as Appendix 1 and are summarized in Table 3.

Table 3: Summary of surface water quality laboratory analysis results

Parameter	Location			
	Up-stream of the Study Area within Stonequarry Creek (201368 SW1)	Down-stream of the Study Area within an un-named 3rd Order Watercourse (201368 SW2)	Down-stream of the Study Area and R5 zoned development within Stonequarry Creek (201368 SW3)	Within Study Area within 1st Order Watercourse (201368 SW4)
pH	7.36	7.56	7.76	7.23
EC (uS m^{-1})	453	800	596	205
Suspended Solids (mg L^{-1})	<5	5	<5	29
Ammonia as N (mg L^{-1})	0.02	0.06	0.11	0.10
NOX as N (mg L^{-1})	0.06	3.66	5.47	5.61
TKN as N (mg L^{-1})	0.4	1.8	2.8	3.6
Total Nitrogen (mg L^{-1})	0.5	5.5	8.3	9.2
Total Phosphorus as P (mg L^{-1})	0.02	0.02	0.03	0.59
Total Phosphorus as P (filtered) (mg L^{-1})	0.04	0.46	0.21	0.70
Enterococci (CFU $100mL^{-1}$)	34	32	140	~10
Faecal Coliforms (CFU $100mL^{-1}$)	~88	~200	~200	~400

Based on Table 3, the following observations are made:

- The pH of surface water at all locations is slightly alkaline and ranged from 7.23 within the Study Area (201368 SW4) to 7.76 down stream from the existing R5 large-lot residential development (201368 SW3);
- Salinity level classes based on Australian Water Quality Guidelines for Fresh and Marine Waters (1992) may summarised as follows:
    - ‘Low salinity level’ - 201368-SW04 (i.e. within the Study Area); and
    - ‘Medium’ salinity water - 201368-SW01, 201368-SW02 and 201368-SW03 (i.e. within Stonequarry Creek and the 3rd Order Watercourse) ;

  The relatively lower salinity levels in run-off waters from within the Study Area are reflection of the low Order of the Watercourse.
- Suspected solids were highest in the run-off from the Study Area (29mg/L) compared to <5 mg/L within Stonequarry Creek and 5 mg/L within the down-stream 3rd Order Watercourse. It is considered that the relatively higher levels of suspended solids are a reflection of the agricultural land-use within the Study Area;
- Nutrient levels (nitrogen and phosphorus) in run-off water from within the Study Area (201368-SW4) were greater than the nutrient levels within Stonequarry Creek and the down-stream un-named 3rd Order Watercourse. The elevated nutrient levels are more than likely a result of an agricultural land-use within the Study Area;
- Nutrient levels (nitrogen and phosphorus) in run-off water from within the Stonequarry Creek down-stream of the R5 Residential land (201368-SW3) were elevated compared to up-stream of the R5 zoned land (i.e. 201368-SW1 and 201368-SW2) but were less than the nutrient levels in run-off water from within the Study Area (201368-SW4);

- Entercocci are typically considered to be an indicator of potential human disease causing organisms and are an indicator of human derived waste within the surface waters.

  Enterococci counts in run-off water from within the Study Area (Count of 10 CFU 100mL^{-1} at 201368-SW4) were lower than the counts within Stonequarry Creek and the down-stream un-named 3rd Order Watercourse. The lower counts are more than likely a reflection of the low level of human occupancy within the Study Area.

  Enterococci counts were greatest in run-off water down-slope of the R5 zoned residential land (~140CFU 100mL^{-1} at 201368-SW03) and lower counts were obtained up-stream of the Study Area within Stonequarry Creek (~34 CFU 100mL^{-1} at 201368-SW01). The elevated counts down-stream of the R5 zoned residential land are likely to be a reflection of the high level of human occupancy within the R5 zoned land.

  For Secondary Contact, the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZGFRMQ) (2000) recommend a maximum median Enterococci count of 230 CFU 100mL^{-1} and a maximum amount in any one sample of 450-700 CFU 100mL^{-1}. All measured values, including down-stream of the R5 zoned residential land, were less than the values for a Secondary Contact use, indicating that run-off waters from the R5 zoned residential land did not reduce water quality to a level that prohibits the use of Stonequarry Creek for Secondary Contact activities.

- Faecal Coliforms are typically found within the lower intestine of warm blooded organisms and when measured are considered to be indicator of animal derived waste (not necessarily human) within the surface waters.

  Faecal Coliform counts in run-off water from within the Study Area (Count of 400 CFU 100mL^{-1} at 201368-SW4) were greater than any of the counts within Stonequarry Creek, including down-stream of the R5 zoned land (Count of ~200 CFU 100mL^{-1} at 201368-SW3) and down-stream of the Study area within an un-named 3rd Order Watercourse (~200 CFU 100mL^{-1} at 201368-SW02).

  For Secondary Contact, ANZGFRMQ (2000) recommend a maximum median faecal coliform count of 1000 CFU 100mL^{-1} and a maximum amount in any one sample of 4000 CFU 100mL^{-1}. All measured values, included down-stream of the R5 zoned residential land, were less than these values.

  The elevated counts in run-off waters within the Study Area are likely to be caused by animal manures in run-off waters and are derived from an agricultural land-use within the Study Area.

2.6 Geomorphic features

2.6.1. 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 is illustrated on Figure 5.

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 of sediments 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.

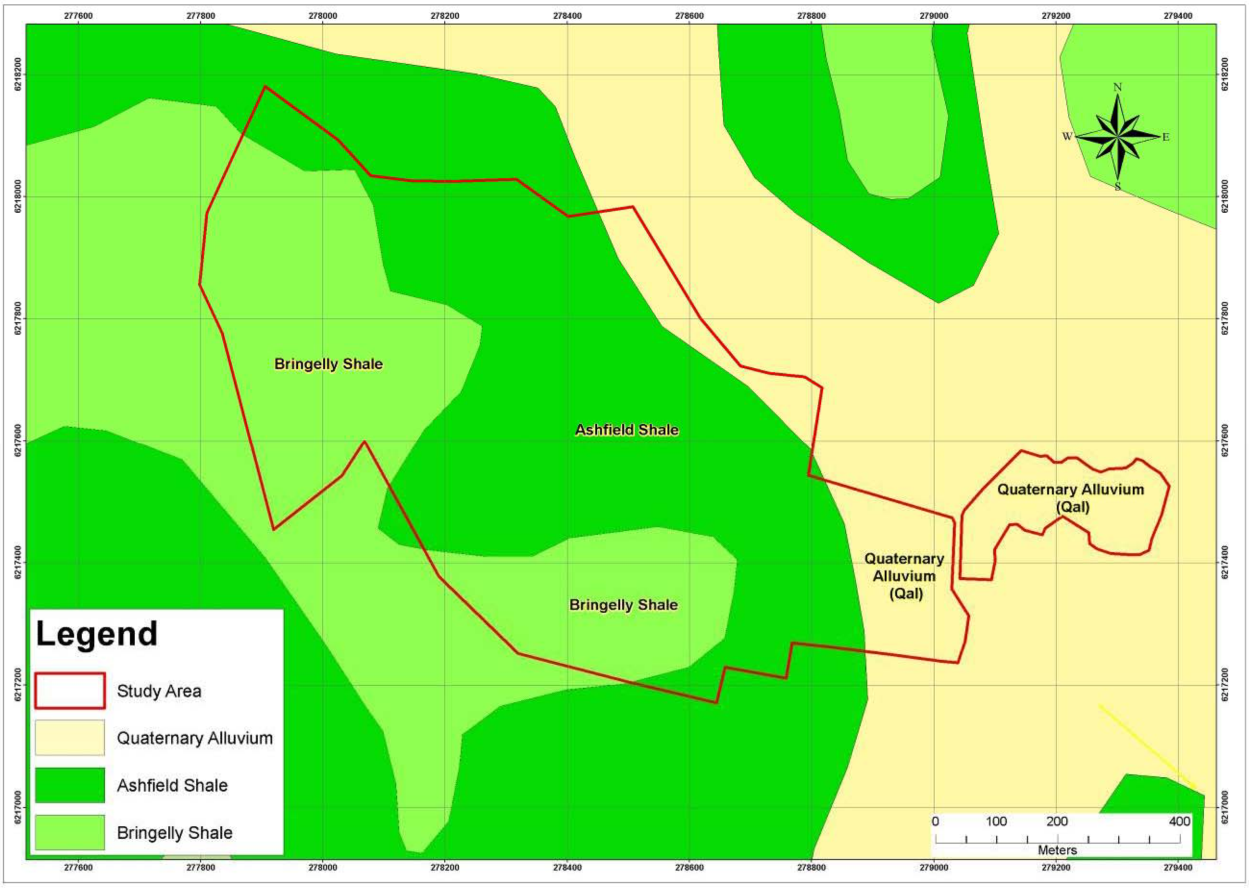


Figure 5: Geology (Sherwin and Holmes, 1982).

2.6.2. 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 6.

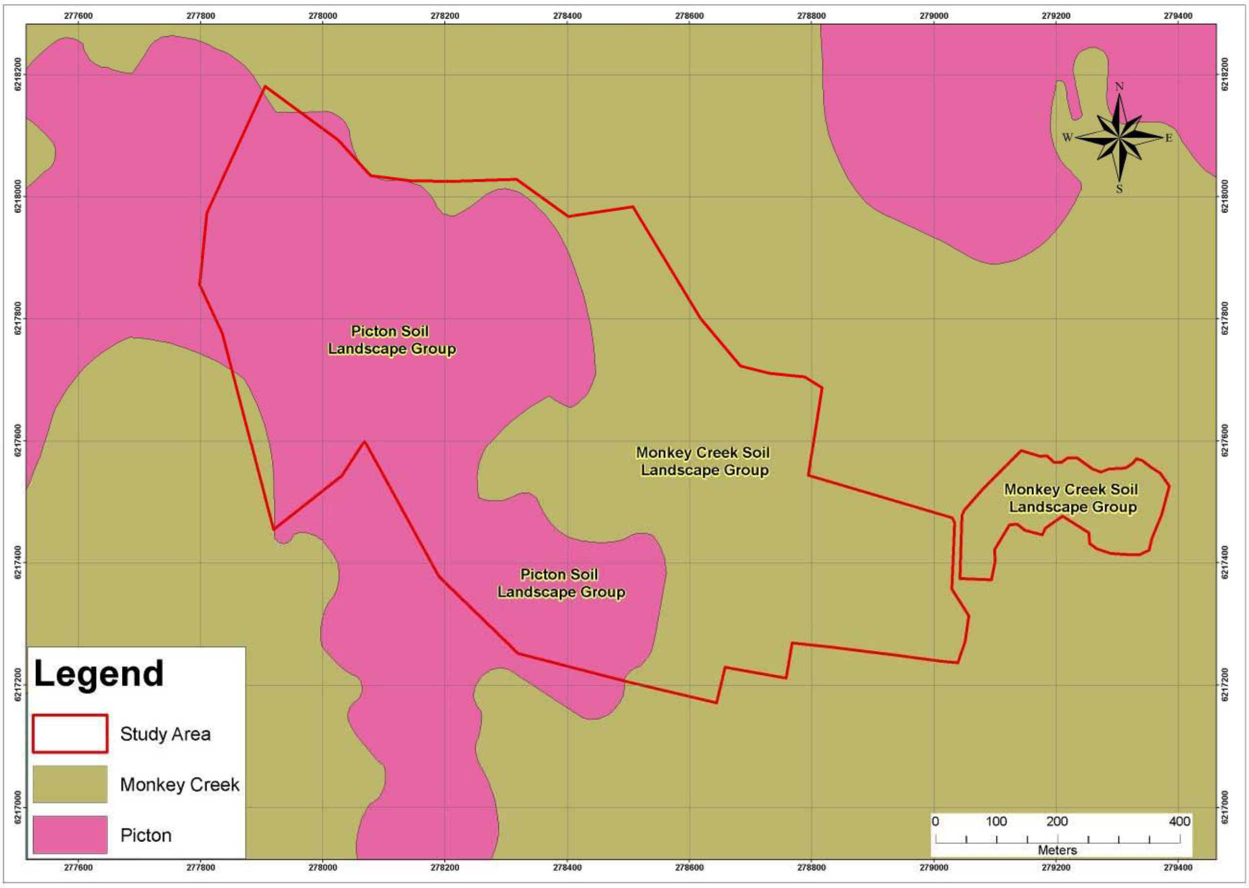


Figure 6: Soil Landscape Groups (Hazelton and Tille, 1990).

General characteristics/constraints of each soil landscape group as described by Hazelton and Tille (1990) are outlined in Table 4. It should be noted that all published 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 4: 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 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 watertables and seasonal waterlogging.
	Urban capability	Not recommended for urban development due to flood hazard.

3.0 LITERATURE REVIEW – GOVERNMENT ENDORSED OBJECTIVES, STRATEGIES AND POLICIES

3.1 Introduction

The following sections summarise Government endorsed objectives and strategies for onsite effluent irrigation, water quality and catchment management pertaining to the re-zoning proposal.

3.2 State Regional Environmental Plan No. 20 (SREP 20) – Hawkesbury-Nepean River

The Study Area is located within the catchment of the Hawkesbury-Nepean River system and is subject to the requirements of the State Regional Environmental Plan 20 (SREP 20) No.2 – Hawkesbury-Nepean River (NSW Government, 1997).

The stated aim of this plan is to:

> *'protect the environment of the Hawkesbury-Nepean River system by ensuring that the impacts of future land uses are considered in a regional context"*

Specific clauses relating to water quality are as follows:

Future development must not prejudice the achievement of the goals of use of the river for primary contact recreation (being recreational activities involving direct water contact, such as swimming) and aquatic ecosystem protection in the river system. If the quality of the receiving waters does not currently allow these uses, the current water quality must be maintained, or improved, so as not to jeopardise the achievement of the goals in the future….
Strategies:

- *Quantify, and assess the likely impact of, any predicted increase in pollutant loads on receiving waters.*
- *Consider the need to ensure that water quality goals for primary contact recreation and aquatic ecosystem protection are achieved and monitored.*
- *Approve development involving primary contact recreation or the withdrawal of water from the river for human contact (not involving water treatment), such as showers, only in locations where water quality is suitable (regardless of water temperature).*
- *Do not carry out development involving on-site disposal of sewage effluent if it will adversely affect the water quality of the river or groundwater. Have due regard to the nature and size of the site.*
- *Develop in accordance with the land capability of the site and do not cause land degradation.*
- *Consider the need for an Erosion and Sediment Control Plan (to be in place at the commencement of development) where the development concerned involves the disturbance of soil.*
- *Minimise or eliminate point source and diffuse source pollution by the use of best management practices.*
- *Site and orientate development appropriately to ensure bank stability. Plant appropriate native vegetation along banks of the river and tributaries of the river, but not so as to prevent or inhibit the growth of aquatic plants in the river, and consider the need for a buffer of native vegetation.*
- *Consider the impact of the removal of water from the river or from groundwater sources*

associated with the development concerned.

- *Protect the habitat of native aquatic plants.*

Specific clauses relating to water quantity are as follows:

'Aquatic ecosystems must not be adversely affected by development which changes the flow characteristics of surface or groundwater in the catchment. Strategies:

(a) Future development must be consistent with the interim or final river flow objectives that are set for the time being by the Government.

(b) Ensure the amount of stormwater run-off from a site and the rate at which it leaves the site does not significantly increase as a result of development. Encourage on-site stormwater retention, infiltration and (if appropriate) reuse.

(c) Consider the need for restricting or controlling development requiring the withdrawal or impoundment of water because of the effect on the total water budget of the river.

(d) Consider the impact of development on the level and quality of the water table.

Accordingly, any future development and development controls issued as a result of the proposed re-zoning must consider the requirements of SREP 20, in particular, clauses relating to water quality and quantity as stated above.

3.3 Atlas of Classified Waters in New South Wales (1980)

The Atlas of Classified Water in NSW (State Pollution Control Commission, 1980) classifies the receiving waters of the Nepean River immediately down stream (i.e. the receiving waters from the Study Area) of the Study Area as 'Class 2' (protected) waters. This Study was unable to source any current published government endorsed water quality objectives for this classification of receiving waters.

There are no classified waters within the Study Area.

3.4 Wollondilly Local Environmental Plan (LEP) 2011

Section 7.3 of the **Wollondilly Local Environmental Plan (LEP) 2011** relates to water quality objectives within the Wollondilly Local Government Area (LGA), details of which are outlined below:

'(1) The objective of this clause is to maintain the hydrological functions of riparian land, waterways and aquifers, including protecting the following:

(a) water quality,

(b) natural water flows,

(c) the stability of the bed and banks of waterways,

(d) groundwater systems.

(2) This clause applies to land identified as "sensitive land" on the Natural Resources—Water Map.

(3) Before determining a development application for development on land to which this clause applies, the consent authority must consider any adverse impact of the proposed development on the following:

(a) the water quality of receiving waters,

(b) the natural flow regime,

(c) the natural flow paths of waterways,

(d) the stability of the bed, shore and banks of waterways,

(e) the flows, capacity and quality of groundwater systems.

(4) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that:

(a) the development is designed, sited and will be managed to avoid any adverse environmental impact, or

(b) if that impact cannot be avoided—the development is designed, sited and will be managed to minimise that impact, or

(c) if that impact cannot be minimised—the development will be managed to mitigate that impact.'

For a subdivision application, items 1 to 4 above are required to be demonstrated at the Development Application (DA) stage. Items relating to the water quality of receiving waters and the natural flow regime are typically demonstrated by undertaking stormwater modeling in a computer program such as MUSIC™. This program enables various Water Sensitive Urban Design features to be modeled and the impact on water quality to be assessed. During this process, the site layout is iteratively reconfigured until the water quality objectives on the receiving water are met.

The stability of the bed, shore and banks of waterways are maintained by prohibiting development near the banks and beds of waterways.

The capacity and quality of groundwater systems are managed by conducting onsite effluent disposal in accordance with Wollondilly Shire Council's Policy and Strategy for onsite domestic wastewater management.

The relevant plan that accompanies Wollondilly LEP (2011) for the Study Area is the *'Natural Resource Water Map sheet NRW 008'* and an extract of the relevant section of the plan is depicted as Figure 7.

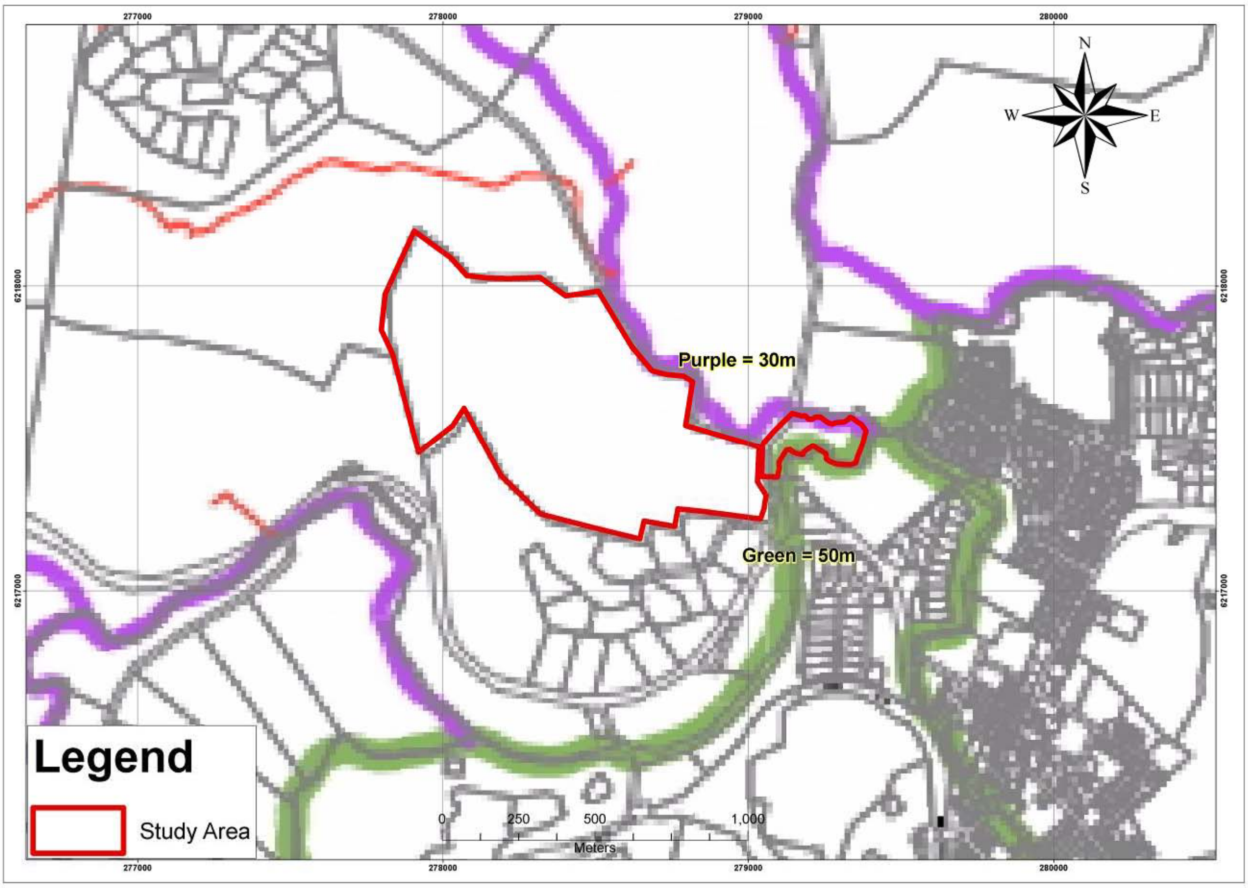


Figure 7: Extract from Wollondilly LEP (2011) Natural Resource Water Map Sheet. Red = 10m sensitive land, purple = 30m sensitive land, Green = 50m and blue = 100m sensitive land.

In relation to the stated '*sensitive land'* categories, this plan identifies the following as being relevant to the Study Area:

- an un-named 3rd Order watercourse is delineated as Sensitive Land = 30m; and
- Stonequarry Creek (Green) is delineated as Sensitive Land = 50m.

It is noted that this plan does not depict the four 1st Order Watercourses that occur within the Study Area (Figure 2) or the 1st and 2nd Order Watercourses located adjacent to the Study Area. These Watercourses are therefore not considered to be '*sensitive land*' in the context of the LEP (2011).

With regard to the boundaries of sensitive land as depicted on Figure 7, this Study has assumed:

- '*sensitive land*' associated with red lines refer to land 10 metres wide either side of the high bank of the mapped Watercourse;
- '*sensitive land*' associated with purple lines refer to land 30 metres wide either side of the high bank of the mapped Watercourse; and
- '*sensitive land*' associated with green lines refer to land 50 metres wide either side of the high bank of the mapped Watercourse.

3.5 Wollondilly Development Control Plan (DCP) (2011)

3.5.1. Introduction

Section 2.6 of Volume 1 of Wollondilly Shire Councils DCP (2011) outlines the requirements relating to Water Protection. Those requirements are outlined in the following sections.

3.5.2. General requirements

Section 2.6.1 of Volume 1 of Wollondilly DCP 2011 states:

> *Under the LEP* ***clause 7.3 Water Protection*** *applies to land identified as 'Sensitive Land' on the Natural Resources – Water Map of the LEP. Any development application within the area identified as sensitive land on the maps and described in this section must meet the requirements of the LEP clause as well as the requirements of this clause of the DCP. Land identified as sensitive land for Water reasons may also contain land identified as 'sensitive land' for Biodiversity as described under Clause 2.5 of this Volume.'*

Section 2.6.2 of Volume 1 of Wollondilly DCP 2011 states:

> *'Sensitive land for water includes riparian land, waterways and ground water systems.*
>
> *Potentially sensitive land for water means land identified on the DCP Natural Resources – Potential Water Map. It is land with the potential to feature surface and ground water systems or have some link with the flow, capacity and quality of surface and ground water systems but is yet to be ground-truthed by detailed, qualified and independently verified field work.*
>
> *The maps are kept in the office of Wollondilly Council and amended from time to time as development applications and planning proposals supported by specialist studies are independently assessed and verified. Once ground-truthed and surveyed, these maps may be used to make future amendments to the Natural Resources – Water Map in the LEP.'*

It is noted that Wollondilly Shire Council has highlighted that the *'Natural Resources – Potential Water Map'* is proposed to be updated from time to time as development applications and planning proposals supported by specialist studies are independently assessed and verified. It should therefore not be considered a definitive map of all potentially sensitive land for water within the investigation area. This map should be reviewed in the context of the findings of this Study.

In terms of classification of riparian land, s2.6.3 of Volume 1 of Wollondilly DCP 2011 states:

> *'Three different minimum riparian buffer distances were identified for riparian land based on the relative importance of the watercourse within the catchment and its functioning. Each stream order in the Natural Resources - Water Map has been linked to a specific riparian buffer distance with some orders requiring the same buffer distance as indicated in Table 8* (note: reproduced as Table 5)*.*

Table 5: Riparian buffer distances (reproduced from Wollondilly Shire Council DCP)

Stream Order	***Minimum riparian buffer distance***
1	*10 metres each side*
2	*10 metres each side*
3	*30 metres each side*
4	*30 metres each side*
5	*50 metres each side*
6	*100 metres each side*
7	*100 metres each side*
Nepean River, Bargo River, Cataract River and Georges River	*A minimum 100 metres each side*

Notes: 1.The distances in this table are measured from the top of bank of the relevant watercourse
2 Reproduced from Wollondilly Shire Council DCP

It is noted that whilst the DCP states '*Three different minimum riparian buffer distances were identified'*, four (4) '*minimum riparian buffer distances'* are presented in Table 5 (i.e. 10, 30, 50 and 100 metres each side). The reason for this discrepancy is not clarified in the DCP.

It is also not clear from the documentation associated with the DCP whether the recommended '*minimum riparian buffer distance*' is made up of a Core Riparian Zone (CRZ) with a 10 metre Vegetative Buffer Zone (VBZ) or if the stated buffer distance relates only to the CRZ.

This plan does not depict the four 1st Order Watercourses that occur within the Study Area (Figure 2), these areas are therefore not considered to be '*sensitive land*' in the context of the DCP (2011).

3.5.3. Requirements for 1st and 2nd Order watercourses

In terms of requirements for 1st and 2nd Order Watercourses, Section 2.6.5 of Volume 1 of Wollondilly DCP 2011 states the following:

'Objective

(a) To minimise sedimentation and nutrient transfer to:

- *provide bank stability,*
- *protect water quality, and*
- *protect native vegetation.*

Controls

1. Where a site contains a riparian buffer distance as identified on the Natural Resources - Water Map and in accordance with this Section, the applicant must undertake an accurate survey of riparian buffer distances to determine the exact location of the buffer distance in accordance with Table 5 (Table number updated to reflect Study table numbering, stated table number in the DCP 2011 is Table 1) *in this Section (i.e. measured from top of bank).*

2. The waterbody must emulate wherever possible a naturally functioning stream.

3. Where possible, must provide opportunity for vegetated habitat refuges (terrestrial and aquatic).

4. All stormwater generated from any development shall be treated to an acceptable standard. In determining the "acceptable standard" the consent authority shall be mindful of the relevant guidelines of the State and Federal Governments.

5. If possible, services and other infrastructure must be located outside of the riparian buffer distance. Where this can not be achieved the assessing officer will only consent to works within the riparian buffer distance if it is satisfied that the integrity of the riparian buffer distance is maintained or has minimal impact on its riparian functions.'

The Study Area contains four 1st Order Watercourses (Figure 2, Table 2). It is noted however, as the four 1st Order watercourses are not marked on the '*Natural Resources - Water Map'* the requirements of the Wollondilly DCP (2011) do not apply to these Watercourses.

3.5.3.1 Requirements for 3rd, 4th, 5th, 6th and 7th Order watercourses, including the Nepean, Bargo, Cataract and Georges Rivers

In terms of requirements for 3rd, 4th, 5th, 6th and 7th Order watercourses, including the Nepean, Bargo, Cataract and Georges Rivers, Section 2.6.5 of Volume 1 of Wollondilly DCP 2011 states the following:

'Objectives

(a) To maximise the protection of terrestrial and aquatic habitat to:

- *provide a continuous corridor width for the movement of flora and fauna,*
- *provide extensive habitat (and connectivity between habitat nodes) for terrestrial and aquatic fauna,*
- *maintain the viability of native riparian vegetation,*
- *manage edge effects at the riparian/urban interface,*
- *provide bank stability, and*
- *protect water quality.*

Controls

1. Where a site contains a riparian buffer distance as identified on the Natural Resources - Water Map and in accordance with this Section, the applicant must undertake an accurate survey of riparian buffer distances to determine the exact location of the buffer distance in accordance with Table 1 in this Section (i.e. measured from top of bank).

2. The riparian buffer distance as specified in this clause and as identified on the Natural Resources - Water Map is the minimum distance specified for the retention of trees and vegetation. The assessing officer, in consultation with relevant government departments, may require greater distances to be retained or connecting linkages to be formed to protect and improve existing natural flora and fauna corridors where significant stands of vegetation are located on the site.

3. For the purposes of primary agricultural land uses where already operating on alluvial floodplains, any proposed changes to land uses where a development application is required may be exempted from these controls where improved best practice farming is proposed, at the discretion of the assessing officer.

4. Any requirements for a Bushfire Asset Protection Zone must not encroach into any riparian buffer distance.

5. Land within the riparian buffer must be developed/used only if the assessing officer is satisfied that the use will not result in adverse impacts on the functions of the buffer distance.

6. All stormwater generated from any development shall be treated to an acceptable standard. In determining the "acceptable standard" the consent authority shall be mindful of the relevant guidelines of the State and Federal Governments.

7. In cases where a riparian buffer has been degraded by noxious or environmental weeds any developer of the subject land must undertake weed management to the satisfaction of the assessing officer.

8. Where a site contains significant stands of indigenous vegetation in proximity to a watercourse the assessing officer will determine if the riparian buffer distance will be extended to incorporate a corridor or link to that vegetation.

9. If possible, services and other infrastructure must be located outside of the riparian buffer. Where this can not be achieved the assessing officer will only consent to works within the riparian buffer distance if it is satisfied that the integrity of the riparian buffer is maintained or has minimal impact on its riparian functions.

10. Road crossings must maintain riparian connectivity by using piered crossings in preference to pipes or culverts.

11. The assessing officer may require the applicant to restore and/or rehabilitate the riparian zone by retaining as far as practicable, the vegetation, geomorphic structure, hydrology and water quality of the original (pre European) condition of the stream.

12. Walkways and cycleways or shared pathways may be permitted within the riparian buffer distance subject to consideration of ecologically informed design principles.'

The Study Area is immediately adjacent to one 3rd Order Watercourse and Stonequarry Creek is a 5th Order Watercourse. Development Controls outlined in this section therefore apply to these areas.

There are no Watercourses within the Study Area of 6th Order or greater.

3.5.4. Biodiversity map

No Sensitive Land was identified within the Study Area on the Biodiversity Map for the DCP.

3.5.4.1 Wollondilly Shire Council's policies entitled 'Onsite Sewerage Management Strategy' and 'On-site Sewerage Management System and Greywater re-use'

Onsite domestic wastewater treatment and disposal are regulated under Wollondilly Shire Council's policy and strategy entitled as follows:

- Onsite Sewerage Management Strategy (Wollondilly Shire Council, 2004); and
- On-site Sewerage Management System and Greywater re-use (Wollondilly Shire Council, 2011).

The capacity of the Study Area to deal with onsite wastewater treatment and disposal is assessed in Section 4 of this Study.

3.5.5. Water Management Act 2000

The Water Management Act 2000 (WMA) (NSW Government, 2000) is the main Act for managing the State's water resources.

Objectives:

'The objects of this Act are to provide for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations and, in particular:

(a) to apply the principles of ecologically sustainable development, and

(b) to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality, and

(c) to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including:

(i) benefits to the environment, and

(ii) benefits to urban communities, agriculture, fisheries, industry and recreation, and

(iii) benefits to culture and heritage, and

(iv) benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water,

(d) to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources,

(e) to provide for the orderly, efficient and equitable sharing of water from water sources,

(f) to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna,

(g) to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users,

(h) to encourage best practice in the management and use of water.

Principles:

'(1) The principles set out in this section are the water management principles of this Act.

(2) Generally:

(a) water sources, floodplains and dependent ecosystems (including groundwater and wetlands) should be protected and restored and, where possible, land should not be degraded, and

(b) habitats, animals and plants that benefit from water or are potentially affected by managed activities should be protected and (in the case of habitats) restored, and

(c) the water quality of all water sources should be protected and, wherever possible, enhanced, and

(d) the cumulative impacts of water management licences and approvals and other activities on water sources and their dependent ecosystems, should be considered and minimised, and

(e) geographical and other features of indigenous significance should be protected, and

(f) geographical and other features of major cultural, heritage or spiritual significance should be protected, and

(g) the social and economic benefits to the community should be maximised, and

(h) the principles of adaptive management should be applied, which should be responsive to monitoring and improvements in understanding of ecological water requirements.

(3) In relation to water sharing:

(a) sharing of water from a water source must protect the water source and its dependent ecosystems, and

(b) sharing of water from a water source must protect basic landholder rights, and

(c) sharing or extraction of water under any other right must not prejudice the principles set out in paragraphs (a) and (b).

(4) In relation to water use:

(a) water use should avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land should be rehabilitated, and

(b) water use should be consistent with the maintenance of productivity of land in the long term and should maximise the social and economic benefits to the community, and

(c) the impacts of water use on other water users should be avoided or minimised.

(5) In relation to drainage management:

(a) drainage activities should avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land should be rehabilitated, and

(b) the impacts of drainage activities on other water users should be avoided or minimised.

(6) In relation to floodplain management:

(a) floodplain management must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and

(b) the impacts of flood works on other water users should be avoided or minimised, and

(c) the existing and future risk to human life and Study Area arising from occupation of floodplains must be minimised.

(7) In relation to controlled activities:

(a) the carrying out of controlled activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability,

contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and

(b) the impacts of the carrying out of controlled activities on other water users must be avoided or minimised.

(8) In relation to aquifer interference activities:

(a) the carrying out of aquifer interference activities must avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, decline of native vegetation or, where appropriate, salinity and, where possible, land must be rehabilitated, and

(b) the impacts of the carrying out of aquifer interference activities on other water users must be avoided or minimised.

Activities carried out under what is referred to in the WMA 2000 as '*waterfront land'* require what is referred to as a Controlled Activity Approval. Under the *WMA 2000* '*waterfront land'* means:

'(a) the bed of any river, together with any land lying between the bed of the river and a line drawn parallel to, and the prescribed distance inland of, the highest bank of the river, or

(a1) the bed of any lake, together with any land lying between the bed of the lake and a line drawn parallel to, and the prescribed distance inland of, the shore of the lake, or

(a2) the bed of any estuary, together with any land lying between the bed of the estuary and a line drawn parallel to, and the prescribed distance inland of, the mean high water mark of the estuary, or

(b) if the regulations so provide, the bed of the coastal waters of the State, and any land lying between the shoreline of the coastal waters and a line drawn parallel to, and the prescribed distance inland of, the mean high water mark of the coastal waters,

where the prescribed distance is 40 metres or (if the regulations prescribe a lesser distance, either generally or in relation to a particular location or class of locations) that lesser distance. Land that falls into 2 or more of the categories referred to in paragraphs (a), (a1) and (a2) may be waterfront land by virtue of any of the paragraphs relevant to that land.'

In practise, unless an exemption is granted under Section 400 of the WMA 2000, works on land within 40 metres of the top of a bank of any of the mapped watercourses, as depicted on Figure 2 of this Study require a Controlled Activity Approval issued from the NSW Office of Water (NOW) before commencing the activity.

3.6 NSW Office of Water (2010) guidelines for riparian corridors

The NSW Office of Water produced guidelines entitled 'Controlled Activities – Guidelines for Riparian Corridors' dated August 2010 (**NSW Office of Water, 2010**). Those guidelines provide general (i.e. not site-specific) guidance on the management of typical riparian corridors.

The **NSW Office of Water (2010)** guidelines define a riparian corridor as:

'*a transition zone between the land, also known as the terrestrial environment, and the river or watercourse or aquatic environment. Riparian corridors were reported to perform a range of important environmental functions such as:*

- *providing bed and bank stability and reducing bank and channel erosion*
- *protecting water quality by trapping sediment, nutrients and other contaminants*
- *providing diversity of habitat for terrestrial, riparian and aquatic plants (flora) and animals (fauna)*
- *providing connectivity between wildlife habitats*
- *conveying flood flows and controlling the direction of flood flows*
- *providing an interface or buffer between developments and waterways.'*

The protection, restoration or rehabilitation of vegetated riparian corridors is important for maintaining or improving the shape, stability (or geomorphic form) and ecological functions of a watercourse.

NSW Office of Water (2010) also recommends that when determining an appropriate width for a riparian corridor and the quantity of riparian vegetation that should be protected or re-established on a site, the following three riparian zones (Figure 8) should be considered.

- *'The **core riparian zone (CRZ)** is the land contained within and adjacent to the channel. The CRZ should be retained, or revegetated with fully structured native vegetation (including groundcovers, shrubs and trees). The width of the CRZ from the banks of the stream is determined by assessing the importance and riparian functionality of the watercourse, merits of the site and long-term land use. Infrastructure such as roads, drainage, stormwater structures, services, etc should not be located within a CRZ;*
- *The **vegetated buffer (VB)** protects the environmental integrity of the CRZ. The VB should be wide enough to protect the CRZ from weed invasion, micro-climate changes, litter, trampling and pollution and the recommended width is 10 metres although this is subject to merit assessment. Infrastructure such as roads, drainage, stormwater structures, services, etc should be located outside the VB; and*
- *The **asset protection zone (APZ)** is a requirement of the NSW Rural Fire Service and is designed to protect assets (houses, buildings, etc.) from potential bushfire damage. The APZ is measured from the asset to the outer edge of the vegetated buffer (VB). The APZ should contain cleared land which means that it cannot be part of the CRZ or VB. The APZ must not result in clearing of the CRZ or VB. Infrastructure such as roads, drainage, stormwater structures, services, etc can be located within the APZ.'*

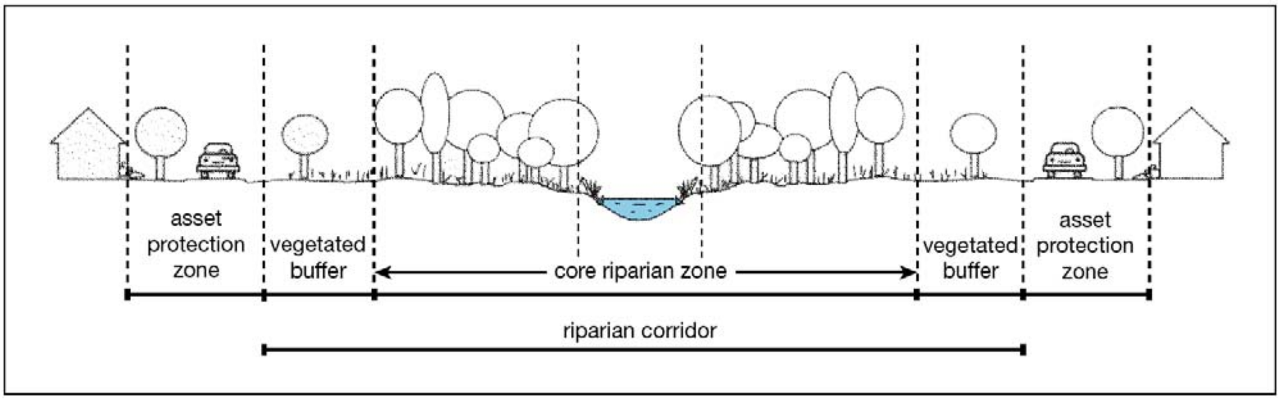


Figure 8: *'Riparian corridor zones'* as defined by NSW Office of Water (2010)

NSW Office of Water (2010) further recommends a vegetated CRZ width based on watercourse order as classified under the Strahler System of ordering watercourses and based on current 1:25 000 topographic maps. The width of the CRZ should be measured from the top of the highest bank and on both sides of the watercourse. Recommended Core Riparian Zone widths are outlined in Table 6.

Table 6: NSW Office of Water (2010) recommended Core Riparian Zone (CRZ) widths.

Type of watercourse	Width of CRZ
Any first order watercourse and where there is a defined channel where water flows intermittently or any 'river' not identified on a topographic map	10 metres
■ any permanently flowing first order watercourse, or ■ any second order watercourse and where there is a defined channel where water flows intermittently or permanently.	20 metres
Any third order or greater watercourse, where there is a defined channel and where water flows intermittently or permanently. Includes estuaries, wetlands and any parts of rivers influenced by tidal waters.	20 - 40 metres[1]

[1] merit assessment based on riparian functionality of the river, lake or estuary, the site and long-term land use.

3.7 Fisheries Management Act 1994

3.7.1. Introduction

The Fisheries Management Act 1994 (FMA) was developed to conserve, develop and share the fisheries resources of the State for the benefits of present and future generations. The stated objectives of the FMA are:

> *'(1) The objects of this Act are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations.*
>
> *(2) In particular, the objects of this Act include:*
>
> *(a) to conserve fish stocks and key fish habitats, and*
>
> *(b) to conserve threatened species, populations and ecological communities of fish and marine vegetation, and*
>
> *(c) to promote ecologically sustainable development, including the conservation of biological diversity,*
>
> *and, consistently with those objects:*
>
> *(d) to promote viable commercial fishing and aquaculture industries, and*
>
> *(e) to promote quality recreational fishing opportunities, and*
>
> *(f) to appropriately share fisheries resources between the users of those resources, and*
>
> *(g) to provide social and economic benefits for the wider community of New South Wales, and*
>
> *(h) to recognise the spiritual, social and customary significance to Aboriginal persons of fisheries resources and to protect, and promote the continuation of, Aboriginal cultural fishing.'*

Of the above objectives, in the context of the Study Area, Objective 2a – '*to conserve fish stocks and Key Fish Habitats' is* relevant.

It is noted that the NSW Department of Primary Industries and Aquaculture (DPI & A) administers the FMA and makes policy under part 7 of the FMA. These policies are outlined in the document entitled 'Policy and Guidelines Aquatic Habitat Management & Fish Conservation 1999 Update' (NSW Department of Primary Industries, 1999). The main habitat-related provisions of the FMA are outlined as follows:

- *'Habitat protection plans - which allow for the preparation and gazettal of management plans for the protection of specific aquatic habitats. NSW Fisheries has gazetted two plans to date. The first plan is essentially an advisory document summarising various protective measures in the Act, but also protects "snags" such as fallen trees and logs. The second plan dealt specifically with the protection of seagrasses. A further plan on the Hawkesbury Nepean river system has been completed.*
- *Aquatic reserves - which allows for the creation and management of aquatic reserves.*
- *Dredging and reclamation - which allows for the control and regulation of dredging and reclamation activities which may be harmful to fish and fish habitats. It establishes requirements to obtain a permit from, or to consult with, NSW Fisheries.*
- *Protection of mangroves and certain other marine vegetation - which allows for the regulation of damage to, or removal of, certain marine vegetation. At this stage, mangroves, seagrasses and macroalgae (seaweed) are the only forms of marine vegetation protected in this way. A permit is required to remove or damage marine vegetation.*
- *Protection of spawning of salmon, trout and certain other fish - which allows for the protection of fish spawning areas.*
- *Noxious fish - which allows for the declaration of undesirable fish as noxious; once declared noxious these fish may be liable to be seized and destroyed. Species may be declared noxious either in: (1) all state waters, or (2) specific waters. The Pacific oyster (Crassostrea gigas) has been declared noxious in all waters other than Port Stephens, and the mouthbrooding fish (Tilapia spp) and black striped mussel (Mytilopsis spp) have been declared noxious in all waters.*
- *Release or importation of fish - which allows for the control of the release, import, sale or possession of fish (e.g. live fish trade, aquarium fish) not originating from NSW waters. The purpose is to prevent the spread of disease and the introduction of undesirable species. A permit is required to import fish into, or release fish in, NSW waters.*
- *Miscellaneous (including fish passage) – which provides for the free passage of fish past barriers such as dams and weirs. This facilitates the installation of fishways, and/or implementation of appropriate operational procedures for weirs.'*

The following provisions are of relevance to the Study Area:

- *'Habitat protection plans - which allow for the preparation and gazettal of management plans for the protection of specific aquatic habitats.... A further plan on the Hawkesbury Nepean river system has been completed'*. The Habitat Protection Plan applies to the Study Area because the Study Area is located within the Catchment of the Hawkesbury Nepean River system;

- '*Miscellaneous (including fish passage) – which provides for the free passage of fish past barriers such as dams and weirs'* is relevant to the Study Area.

3.8 Aquatic Management and Fish Conservation policy and guidelines

The NSW DPI Policy Guidelines (**NSW Fisheries, 1999)** relating to the Fisheries Management Act relevant to the Study Area are outlined below:

General policies:

'a) Fish and their aquatic habitats are important natural resources, and impacts on these resources must be assessed, in all development and planning procedures, using a precautionary approach.

b) Aquatic habitats must be protected when the habitat is important to maintain biodiversity at the ecosystem, species or genetic levels or is required to maintain harvestable fish populations.

c) Habitats of protected or threatened fish must be afforded special protection.

d) Protected areas (such as Aquatic Reserves and Marine Parks) and critical fish habitats should be given priority consideration in the development of plans, in assessing the impacts of developments, and in determining applications.

e) Terrestrial areas adjoining freshwater, estuarine and coastal habitats should be carefully managed in order to minimise land-use impacts on these aquatic habitats. As a precautionary approach, foreshore buffer zones at least 50 m wide should be established and maintained, with their natural features and vegetation preserved. Such buffer zones may need to be fenced or marked by signs.

The width of these buffer zones may need to be increased to 100 m or more where they are adjacent to ecologically sensitive areas.

f) Pollution of waterways should be a voided by:

– identification of point-source and diffuse pollutant discharges

– prevention or minimisation of such discharges

– effective treatment of any continuing discharges

– disposal of wastes to alternative land sites, or to processing facilities.

g) Free passage should be maintained for migratory fish species. Unlicensed barriers should be removed or fish passage facilities installed.

h) Alien, exotic or introduced fish species (see Glossary) should not be released into any waterway without the approval of NSW Fisheries.

i) Where developments or activities are likely to affect fish or fish habitats, NSW Fisheries needs to be provided with sufficient information to assess their impacts, including: contact details; type, purpose and time of activity; location (map and photographs);habitat type and area affected; monitoring and proposed environmental compensation.

j) Environmental compensation needs to be integrated into the planning process. Where, despite mitigation, a significant environmental impact is unavoidable, environmental compensation should be provided. This would normally require the creation of new habitat (of the type lost), and on a 2:1 basis to account for the indirect as well as the direct impacts of development.

k) Degraded aquatic habitats should be rehabilitated, wherever possible, to repair past environmental damage.

l) Environmental monitoring is needed to determine if the assessment of the environmental impacts of a development were accurate. Monitoring needs to be undertaken in a scientifically rigorous manner, with impact and multiple control sites, surveys over time and statistical analyses. As a general rule, a change of 20% in a biological indicator (e.g. abundance, richness, biomass) one year after the impact should be regarded as a major impact and require environmental compensation.'

In relation to freshwater water-front development, the following specific guidelines are stated:

- *'To the greatest extent possible, riparian vegetation should be retained in an undamaged and unaltered condition.*
- *The recommended foreshore or river frontage buffer distance of 50 m should be increased wherever appropriate, for example when the riparian zone is unstable, susceptible to erosion or the proposed development is particularly threatening.*
- *Buffer zones should be clearly delineated by fences or other markers. Grazing stock should generally be excluded to promote growth and regeneration. If it is not possible to establish a 50 m buffer zone, a lesser distance may in some cases be appropriate, providing that the buffer is negotiated with NSW Fisheries, and subsequently managed and protected.*
- *Revegetation of disturbed areas with local native species should be undertaken at the completion of works and subsequently monitored to ensure successful establishment. Exotic species, such as willows, should not be used unless there are sound justifications, e.g. a temporary solution in areas of rapid erosion.*
- *Mesh fences that may obstruct fish passage will not be allowed to cross waterways.'*

In relation to bridges, roads, causeways, culverts and similar structures, the following policy applies:

- *'Roads and bridges must be constructed to minimise habitat loss, changes in sediment transport and stream siltation, and to maintain natural tidal exchange or river flow.*
- *A bridge is preferred over a causeway or culvert to cross a stream or tidal creek.*
- *Where a culvert structure is constructed, large box culverts are preferred to round pipes.*
- *There should be no drop, or 'waterfall', at the end of the structure. The water levels above and below the crossing should be the same.'*

General guidelines applicable to bridges, roads, causeways, culverts and similar structures include:

- *'The cross-sectional area of the box culverts should equal or exceed the cross-sectional area of the stream, to avoid funnelling the flow and creating any difference in hydraulic head across the structure (i.e. use three or four sets of culverts placed side by side rather than one).*
- *The structures should be as wide across the stream and narrow along the length of the stream as possible to maximise water flow and to minimise discontinuities. Maximum length should be 10 m so that fish are not required to swim through dark passages.*
- *The culvert should be placed as level as possible to ensure that the water flow velocities through the culvert do not exceed 0.25 metres per second during low flows, or that natural flow velocities are maintained.*

- *The base of the culvert should be set into (rather than on) the stream bed so that natural sediments (mud, sand, gravel, etc.) can cover the bottom, providing a less alien habitat. The impacts can be further minimised by adding a few large rocks to the base of the culvert.*
- *A tunnel may be a viable alternative to a bridge, road or pipeline crossing of a waterway.'*

The general policy guidelines in relation to water pollution are outlined as follows:

- *NSW Fisheries endorses the 'polluter pays' principle.*
- *The cumulative impact of new developments upon water quality should be assessed and evaluated.*
- *NSW Fisheries supports efforts to reduce pollution of waterways and achieve an overall improvement in water quality - including the fitting of gross-pollutant traps to stormwater drains, construction of artificial wetlands at creek outfalls, fitting of multi-level offtakes on weirs and dams, control of catchment erosion and reestablishment of riparian vegetation communities.*
- *NSW Fisheries supports the fencing of buffer strips along streams and adjacent to lakes and estuaries to allow control of grazing and to prevent stock fouling the water and damaging riparian vegetation.*
- *NSW Fisheries does not support discharge of effluent to a waterway where land application (by irrigation or exfiltration) is a feasible alternative. In particular, disposal of effluent to enclosed bodies of water with poor flushing characteristics is not supported. Where land application is not feasible and discharge to a waterway is the only viable alternative a high level of treatment should be undertaken.*
- *NSW Fisheries opposes any proposal to discharge effluent (including waste discharge from vessels) directly into any Marine Park, Aquatic Reserve or the habitat of endangered fish species, or directly into water-bodies supporting Posidonia seagrass beds.*
- *NSW Fisheries will oppose developments on coastal floodplains proceeding in a way that will cause exposure of acid sulfate soils and result in acidic drainage to estuaries.*
- *NSW Fisheries opposes the spraying of waterways with pesticides to control aquatic plant growth where other viable alternatives (e.g. manual methods) exist.*

The general policy guidance for minimising water pollution are outlined as follows:

- *'Where land application of effluent by irrigation, evaporation or exfiltration is to be employed it should take place beyond the floodplain, or other strategies employed to minimise the likelihood of mobilisation of effluent during floods.*
- *The planning for and construction of new housing estates and other developments should include provisions for gross pollutant traps, sedimentation ponds and artificial wetlands to remove nutrients and sediments from stormwater as an integral component of the development. Existing natural or modified fish habitats must not be damaged, destroyed or alienated in the process of creating these facilities.*
- *Developments should aim to achieve no net impact upon the receiving waterway. Impact assessments should, as a minimum, include analysis of dissolved oxygen, pH, turbidity, temperature, toxicants, salinity and nutrients and take account of the existing water quality status of the receiving waterway.*

- *Where existing outfalls dispose of effluent to streams, disposal should not take place during low flow periods unless the effluent is of better quality than that already in the stream in all respects.*
- *Where impoundments will cause a change in downstream temperature regime of more than 2°C on average, a variable-level off-take or other structure or system should be installed to maintain the pre-impoundment temperature regime and the water quality in the river downstream. In some cases, de-stratification by aeration may be effective to maintain water quality in impoundments.*
- *Outfalls and drains should not discharge into, or within 50 m of natural wetlands or seagrass beds. Where existing outfalls or drains impact on aquatic habitats and fish, the relevant public authority and NSW Fisheries will work together to implement mitigating actions.*
- *Nutrient concentrations, particularly forms of nitrogen and phosphorus in stormwater and surface run-off must comply with ANZECC (1992) guidelines and should be minimised to prevent excessive growth of algae and vascular plants.*
- *Stormwater from roads, car parks and other paved surfaces should be channelled away from aquatic habitats into well established terrestrial vegetation which can act as a filter and adsorb nutrients and sediments.*
- *Spraying of pesticides should only be undertaken according to Environment Protection Authority requirements and under low wind conditions and when the likelihood of rainfall runoff is low. Suitable buffer distances should be maintained between the sprayed area and all waterways.*
- *Caution must be exercised when spraying aquatic plants. Although the herbicide may have a low toxicity for aquatic animals, the subsequent decomposition of plants may cause dissolved oxygen levels to fall below 4-5 mg/L, which can cause fish kills.*
- *The disposal to waterways of contaminants such as pesticides, heavy metals and pathogens which may accumulate in fish and result in fish tissue containing residues above the NHMRC levels, and thus posing a risk for human consumption, must be assessed and reduced.'*

3.9 Key Fish Habitats (KFH)

Policy definitions of 'Key Fish Habitats' are available on the DPI & A webpage, available at http://www.dpi.nsw.gov.au/fisheries/habitat/protecting-habitats and was viewed on 21 June 2012.

A KFH is defined as follows:

- '*Oceanic, bay, inlet and estuarine habitats up to the level defined by High Water Solstice Spring tides (so called 'King tides' or Highest Astronomical Tide).*
- *Intermittently Closing and Opening Lakes and Lagoons (ICOLLs) up to the level at which they would naturally break out to the sea (which may be 2 or 3 metres above mean sea level).*
- *Permanently flowing rivers and creeks including those where the flow is modified by upstream dam(s), up to the top of the natural bank regardless of whether the channel has been physically modified.*
- *Intermittently flowing rivers and creeks that retain water in a series of disconnected pools after flow ceases including those where the flow is modified by upstream*

dam(s), up to the top of the natural bank regardless of whether the channel has been physically modified.

- *Billabongs, lakes, lagoons, wetlands associated with other permanent fish habitats (eg permanent rivers and creeks, estuaries etc).*
- *Weir pools and dams (eg Hume, Blowering, Copeton, Menindee etc), up to full supply level, where the weir/dam is across a natural stream channel or waterway.*
- *Flood channels or flood runners that may normally be dry but would be used by fish to move/migrate across or along floodplains between habitats during high flow events.*
- *Mound springs*
- *Any water-body, regardless of whether or not it may be listed under the heading 'What is not included?' below, if it is known to support or could be confidently expected (based on predictive modelling) to support threatened species, threatened populations or threatened communities listed under the provisions of Part 7A of the* Fisheries Management Act 1994*.'*

A KFH does not include the following:

- *Unmapped gullies and first and second order streams (based on the Strahler method of stream ordering) as determined from the largest scale topographic map produced for the area concerned (i.e. use 1:25,000 rather than 1:50:000 and use 1:50:000 rather than 1:100,000 and include all depicted streams). Note that this methodology only applies to 'gaining systems' – those where streams are coming together and becoming progressively larger.*
- *Farm dams constructed on unmapped gullies and first and second order streams.*
- *Purpose built irrigation and other water supply channels and off-stream storages.*
- *Irrigation, agricultural or urban drains.*
- *Urban ponds including water pollution control ponds and detention basins.*
- *Sections of streams that have been concrete lined or piped (but not including where an otherwise natural stream passes through culverts).*
- *Purpose-built salt evaporation ponds or basins.*
- *Purpose-built aquaculture ponds.*
- *Intermittent lagoons or wetlands filled from localised runoff and not otherwise hydrologically connected to other permanent habitats such as rivers, creeks, estuaries and ocean.*

Based on the above adopted policy, the following notes are relevant to the Study Area:

- All 1st and 2nd Order watercourses depicted on Figure 2 do not fit with the definition of a KFH;
- Stonequarry Creek and the un-named 3rd Order Watercourse depicted on Figure 2 meet the criteria for KFHs as they contain a series of '*disconnected pools after flow ceases'.*

3.10 Habitat Protection Plan No.3 – Hawkesbury Nepean River System (1998)

The Habitat Protection Plan - Hawkesbury Nepean River System, which is made under the FMA, outlines the habitat protection policy provisions for the Hawkesbury Nepean River System and it's associated catchment areas. As the Study Area is within the Hawkesbury Nepean catchment, this plan applies to any future development within the Study Area.

The stated objectives of the plan are as follows:

> *'This plan aims to protect key fish habitats within the Hawkesbury-Nepean catchment (Figure 1) by:*
>
> > *i) building on HPPs Nos 1 and 2 in ways specific to the Hawkesbury-Nepean River System;*
> >
> > *ii) complementing existing policies, programs and strategies by focusing on fish and fish habitats;*
> >
> > *iii) mitigating habitat degradation within the Hawkesbury-Nepean catchment; and*
> >
> > *iv) assisting, where possible, the rehabilitation and/or restoration of previously degraded aquatic habitats.'*

Specific strategies relevant to the Study Area include:

> *'Any further development of the Hawkesbury-Nepean catchment should only occur if accompanied by adequate provisions for fish habitat conservation. Such provisions include (but are not limited to) the following:*
>
> > *i) the maintenance of natural creek channels and wetlands;*
> >
> > *ii) the preservation of the maximum amount of native vegetation possible, particularly riparian vegetation;*
> >
> > *iii) the avoidance of flood-prone land where levee banks might be needed;*
> >
> > *iv) the preservation of fish passage;*
> >
> > *v) systems for treating stormwater (such as gross pollutant traps, sedimentation ponds and artificial wetlands);*
> >
> > *vi) measures that minimise sediment escape during clearing and construction;*
> >
> > *vii) the adoption of Australian New Zealand Environment and Conservation Council (ANZECC) guidelines (including both biological and physicochemical factors) as water quality goals for all immediate receiving waters; and*
> >
> > *viii) appropriate monitoring of fish habitats liable to be affected.'*

3.11 Fish passage – Guidelines for fish friendly water crossings

The NSW DPI brochure entitled 'Policy and guidelines for fish friendly water crossings' (**NSW Department of Primary Industries, undated**) outlines the policy considerations that must be observed by those intending to plan, design and construct waterway crossings in NSW.

The activity of constructing waterway crossings may require approval under Part 7 (Division 3) of the *Fisheries Management Act 1994* (FM Act) to dredge and/or reclaim. Dredging works may be required to construct the footings or foundations for the crossing. Reclamation works could include the construction and replacement of pylons and abutments for bridges, creation of in-stream construction pads to access the works or the placement of material in a waterway to construct temporary or permanent waterway crossings.

The following policy guidelines that apply to waterway crossings in NSW:

- *'Waterway crossings must be designed and constructed in accordance with Fairfull and Witheridge (2003).*
- *For any waterway crossing proposal, an aquatic habitat and fish assessment should be undertaken.*
- *When proactively rehabilitating existing waterway crossings to improve fish passage, efforts should focus on those crossings located at the lowest end of the catchment where the numbers and diversity of fish species is generally greatest.*
- *The construction of waterway crossings will generally not be permitted if the work involves harm to marine vegetation (in particular mangroves and seagrass), unless rehabilitation or mitigation measures can compensate the harm in line with NSW DPI Policy and Guidelines for Aquatic Habitat Management and Fish Conservation (NSW DPI 1999).*
- *Fish passage must not be restricted at any time, unless the appropriate permit has been granted by NSW DPI. If a project requires fish passage to be temporarily blocked (e.g. construction of bunds, installation of silt fences across a waterway), and no feasible alternative exists, then NSW DPI must be informed and a permit obtained before the works are commenced. The timing of the works should also be determined so as to minimise the interference with the possible migration of fish within the waterway.*
- *Spawning grounds, such as gravel beds in areas where salmon or trout are likely to occur, must not be dredged or removed from within a waterway unless approval has been granted by NSW DPI.*
- *Generally, where a woody snag is in the site of the proposed waterway crossing, lopping should be considered as the first priority for the management of the snag. Where lopping will not solve the problem, re-alignment should be considered as the next possible management option, followed by relocation. Removal of a snag is the least desirable alternative and should only be adopted as a last resort. Local councils and other public authorities are required to notify NSW DPI of any proposed works, which involve the lopping, realignment, relocation or removal of snags.*
- *Where aquatic habitats are designated "critical habitat" under Part 7A of the FM Act, then the waters of that habitat must automatically be designated a Class 1 waterway (see Table 1 in Fairfull and Witheridge (2003)), and will be subject to the preferred engineering solutions outlined. A SIS must also be prepared for the works.*
- *Where a project is identified as being in the potential range of a listed threatened species, population or ecological community under the FM Act, and the area has not been declared a "critical habitat", the following should apply:*
    - *if the determining/consent authority determines that the project will not have a significant impact after considering an '8 part test', then the proposed water way crossing(s) will be accepted, subject to compliance with these guidelines, and any other relevant approvals, including those required from NSW DPI.*
    - *if the determining/consent authority determines that the project will have a significant impact via the '8 part test', modified where possible (e.g. causeway crossing changed to a culvert crossing, culvert changed to a bridge crossing or new site selected) and the '8 part test' reapplied.*
    - *If the modified project still results in a significant impact, then the waterway will be classified as a Class 1 waterway (see Table 1 in Fairfull and Witheridge (2003)) and*

the preferred engineering solutions outlined in the box below will apply. A SIS must also be prepared for the project.

- *if the determining/consent authority determines that the project will have a significant impact via the '8 part test' (even after the completion of step ii above), the waterway will be classified as a Class 1 waterway (see Table 1 in Fairfull and Witheridge (2003)) and the preferred engineering solutions outlined in Table 1 will apply. A SIS must also be prepared for the project.*
- *Where a road project is likely to involve the loss of aquatic habitat, NSW DPI will request that habitat rehabilitation or environmental compensation be used to mitigate the damage.*
- *All possible care should be taken to ensure that sediment from road works does not enter any water ways. Sediment and erosion control plans should be developed and implemented and copies made available to NSW DPI on request.*
- *In order to minimise sedimentation, fill or excavated material must not be stockpiled in flood prone areas. Particular care should be taken in siting stockpiles and dumps. Sites should be situated either above mean high water mark in tidal areas, or be secure from a 1 in 10 year flood level and have effective sediment control works to contain any runoff.'*

- *'Sediment to be used in dredging or reclamation should be tested for contaminants prior to any works (see ANZECC (2000)). Contaminated fill or dredge spoil containing toxic substances, such as heavy metals, organochlorines, acid sulphate soils, dinoflagellates, etc., must not be dredged or used in reclamation.*
- *Dredging or reclamation works should aim to have no net impact on the receiving watercourse. As a minimum, water quality assessments should include analysis of dissolved oxygen, pH, turbidity, temperature, nutrients and salinity and should take into account the existing water quality status of the receiving water course.*
- *Sediment controls along drainage lines should be left in place to control sediment entering a waterway after the construction phase is completed and until the site has been fully stabilised.'*

Generally, a local government authority or individual will require a permit to carry out any dredging or reclamation work unless the works are authorised by another public authority (other than a local government authority).

Part 7 (Division 3) requires that a public authority must notify the Minister for Fisheries before it carries out or authorises the carrying out of any such works and must consider any matters raised by the Minister. Waterway crossings constructed in tidal waters may also require a permit under Part 7 (Division 4) of the FM Act if the construction is likely to harm marine vegetation such as seagrass, mangroves or marine macroalgae (seaweeds).

Consideration must also be given to potential impacts of the crossing design and construction on threatened species, populations, ecological communities or their habitat (including 'critical habitat') listed under the FM Act.

A permit may also be required under s.219 of the FM Act for any works, which may result in the temporary or permanent blockage of fish passage within a waterway. Such blockages can include silt fencing across waterways for sediment and erosion control and bunding and dewatering works during construction of crossings.

A permit may by required under s.37 of the FM Act to undertake any sampling of fish or other aquatic macroinvertebrates (e.g. for environmental assessment or monitoring purposes). Permits may also be required under Part 5 (clauses 112- 115) of the Fisheries Management (General) Regulation 2002 for any works which may involve the use of explosives, electrical devices or other dangerous substances within waters.

Waterway crossing design and construction must also be consistent with Habitat Protection Plans (HPP) gazetted under Part 7 (Division 1) of the FM Act.

3.12 State Environmental Planning Policy (SEPP) (Sydney Drinking Water Catchment) 2011

The subject land is not in a SEPP (Sydney Drinking Water Catchment) 2011 catchment area and is therefore not regulated under this SEPP.

4.0 ONSITE WASTEWATER FEASIBILITY STUDY

4.1 Introduction

This Onsite Wastewater Feasibility Study (OWFS) has been prepared based on the following assumptions:

- a standard four bedroom residence and associated improvements is to be established on each proposed future lot; and
- all household wastewater flows (black and grey water) from each proposed residence are to be treated via an Aerated Wastewater Treatment System (AWTS) and disposed of onsite via either surface-spray, surface-drip or sub-surface methods of effluent irrigation.

The sites soils, groundwater and other constraints were then assessed to determine the suitability of the Study Area for onsite effluent disposal.

4.2 Objectives

The objectives of this OWFS were to address the first 4 objectives of the Specialist Study Requirements (refer to Section 1.2 for Specialist Study Requirements). The specific objectives of this Study are therefore as follows:

- *'To assess the onsite wastewater feasibility of the site based on soils and geotechnical constraints;*
- *To provide information on the management requirements of an effluent disposal area, with the appropriate guideline and any additional requirements;*
- *To recommend the most suitable effluent treatment system to be used on the site, as well as including information about other possible units; and*
- *To provide information regarding nutrient loading and water balance calculations based on the Environment and Health Protection Guidelines 1998.'*

4.3 Guidelines

This OWFS was prepared with reference to the following guidelines and policy:

- Wollondilly Shire Council Onsite Sewerage Management Strategy (2004);
- Wollondilly Shire Council On-site Sewerage Management System and Greywater re-use (2011);
- The Department of Local Government guidelines entitled 'Environment and Health Protection Guidelines (1998); and
- Australian/New Zealand (AS/NZ) 1547:2000 entitled 'Onsite Domestic Wastewater Management (Standards Australia, 2000).

4.4 Methodology

This assessment consisted of the following methodology:

- A review of the 1:100,000 Wollongong to Port Hacking Soil Landscape Map Sheet (Hazelton and Tille, 1990) for the study area (results are reported in Section 2 of this Study);

- A soil test-pitting and laboratory analysis regime;
- Installation of groundwater piezometers and a groundwater monitoring and analysis regime;
- Field mapping of site features;
- Assessment of site features against site assessment criteria outlined in the Environment and Health Protection guidelines of 1998; and
- Undertaking nutrient loading and water balance calculations to determine the minimum area required for onsite effluent irrigation. Calculations were based upon the Environment and Health Protection guidelines of 1998.

4.5 Site constraints to onsite effluent irrigation

4.5.1. Introduction

The following sections outline potential site conditions that may present as a constraint to onsite effluent irrigation. Identified site constraints were then compared to the assessment rating outlined in the Environment and Health Protection guidelines of 1998.

4.5.2. Soils

Sub-surface soil features within the Study Area were investigated via an invasive soil survey. A total of fourteen (14) test-pits were excavated with a mechanical excavator and soil profiles were logged. Test-pit locations are depicted on Figure 9 and soil profile logs are attached as Appendix 2.

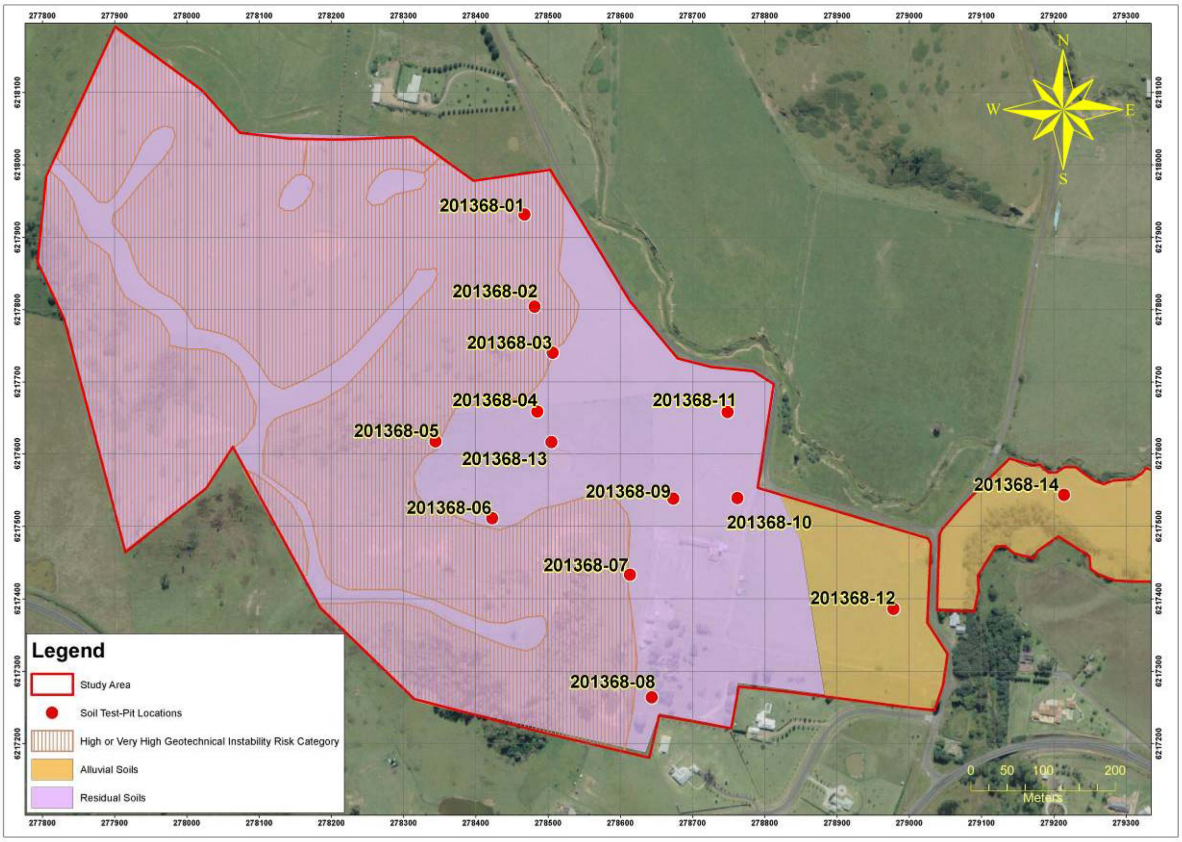


Figure 9: Soil test-pit locations

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 eight (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.

4.5.2.1 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).

Alluvial Soils were found on the relatively flat and associated with the lower lying portions 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.

The approximate location and boundary of these two soil types are illustrated in Figure 9.

4.5.2.2 Soil Physical properties

Soil physical characteristics are summarised in Table 7.

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.

Table 7: Summary of soil physical characteristics

Soil Type	Soil horizon	Depth[1] (mm)	Texture/s	Structure	Inferred permeability (m/day)
Alluvial Soils	A	0-1200	Fine Sandy Clay Loam, Clayey Sand	Massive	0.06– 3.0
	B	600-3200	Sandy Clay	Massive, Weak	<0.06
	B/C	Not encountered			
	C				
Residual Soils	A	0-900	Clay Loam	Weak, Moderate	0.06– 1.5
	B	250-4300	Light Clay, Medium Clay	Weak, Moderate	<0.06 – 0.5
	B/C	750-2700	Light Clay, Medium Clay	Weak	<0.06 – 0.5
	C	1100	Shale	N/A	N/A

Notes:

1. Permeability was inferred based on soil texture and structure with reference to Table 4.2A4 on page 125 of AS/NZ 1547:2000.

Alluvial Soils also included a bleached A2 horizon (location 201368-12), indicating that significant lateral water movement may occur after rain, which may cause water-logging and resulting in 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 relatively high clay content with an associated low inferred permeability which, which in turn may result in water-logging after periods of heavy rain.

The soil structure was poorly developed within all soils of the Study Area, with Alluvial soils being massive and Residual Soils having slightly improved structure but still only 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:
    - Potential soil depth constraints;
    - Water-logging; and
    - Soil structural constraints.

4.5.2.3 Soil Chemical properties

Soil pH, Salinity and Phosphorus Retention (PRI) characteristics are summarised in Table 8 and laboratory analysis results are appended as Appendix 3.

Table 8: Summary of soil pH, salinity (EC_e) and Phosphorus Retention Index

Soil Type	Soil horizon	pH	EC_E	Salinity Classification	Phosphorus Retention Index (PRI) (mg/kg)
Alluvial Soils	A	6.5-6.7	0.3	Non-saline	535.4-640
	B	6.6-6.7	0.2	Non-saline	126-795
	B/C	Not encountered			
	C				
Residual Soils	A	6.1-7.4	0.2-1.0	Non-saline	382-1120
	B	6-8.8	0.1-4.8	Moderately saline	841-1662
	B/C	5.4-8.5	0.3-7.0	Moderately saline	-

Notes:

1. Salinity classifications are based on Table 6.2 of NSW DLWC (2002) publication entitled '*Site Investigations for Urban Salinity*'.
2. Values highlighted by shading are outside the range non-saline.

Alluvial Soils have similar topsoil and subsoil chemical properties and contain a slightly acidic to neutral pH, are non-saline and have a very low capacity to retain phosphorus. Salinity and pH are not a limitation to agricultural production, but due to the low capacity of these soils to hold phosphorus, fertiliser applications will need to be carefully managed to maximise production and minimise environmental impacts due to the leaching of nutrients.

Topsoils of the Residual Soils exhibit a slightly acidic to neutral pH, are non-saline and have a low capacity to retain phosphorus. Subsoils exhibit a slightly acidic to alkaline pH, range from non-saline to moderately saline and have a low capacity to retain phosphorus.

Sodicity and Cation Exchange Capacity characteristics are summarised in Table 9 and laboratory analysis results are appended as Appendix 3.

Alluvial Soils have similar topsoil and subsoil characteristics and are non-sodic with a low cation exchange capacity. Sodicity levels are not a limitation to effluent irrigation, but due to the low capacity of these soils to hold cations, effluent applications would need to be managed by appropriately sizing Effluent Management Areas (EMAs) to maximise to minimise environmental impacts due to the leaching of nutrients.

Topsoils of the Residual Soil type are non-sodic but sub-soils are sodic to highly sodic. The high levels of sodicity within these sub-soils presents an erosion hazard risk if the topsoils are disturbed and the sub-soils are exposed. The Cation Exchange Capacity of topsoils and sub-soils of the Residual Soils is low, indicating a low capacity to hold plant nutrients, effluent applications would need to be managed by appropriately sizing Effluent Management Areas (EMAs) to maximise to minimise environmental impacts due to the leaching of nutrients.

TABLE 9: Summary of Sodicity and Cation Exchange Capacity

Soil Type	Soil horizon	Exchangeable Sodium Percentage (ESP) (%)	Sodicity Classification	Cation Exchange Capacity
Alluvial Soils	A	0.8	Non-sodic	4.9-5.7
	B	1.4-1.6	Non-sodic	1.6-4.8
	B/C	Not encountered		
	C			
Residual Soils	A	0.5-5.1	Non-sodic	0.2-10.2
	B	1.5-35.2	Non-sodic to highly sodic	12.2-18.3
	B/C	6.7-27.5	Sodic to highly sodic	8.2-24.5

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.

4.5.3. Topography and slope

The slope and topography of the Study Area is dominated by a northwest-southeast trending ridge line with a centrally located and northerly trending sub-ridge line. The maximum vertical relief across the Study Area is approximately 60 metres.

Very steep slopes occur in approximately the western half of the Study Area.

Due to excessive run-off risks, effluent should not be irrigation on slopes exceeding the following limits:

- Sub-surface methods of effluent irrigation <15%; and
- Surface-spray methods of effluent irrigation <10%.

The above thresholds are based on accepted industry practice and are in turn based on the mid-point *'Moderate'* slope constraint category outlined in the Environment and Health Protection Guidelines of 1998.

4.5.4. 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 '*High'* or *'Very High'* Geotechnical Instability Risk Category. The location of these areas is delineated on Figure 2. These areas are considered to be un-suitable for onsite effluent irrigation due to geotechnical constraints.

4.5.5. Groundwater

Five (5) piezometers were installed within the Study Area and the locations of these are depicted on Figure 10. 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.

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.

Results of groundwater monitoring are summarised in Table 10.

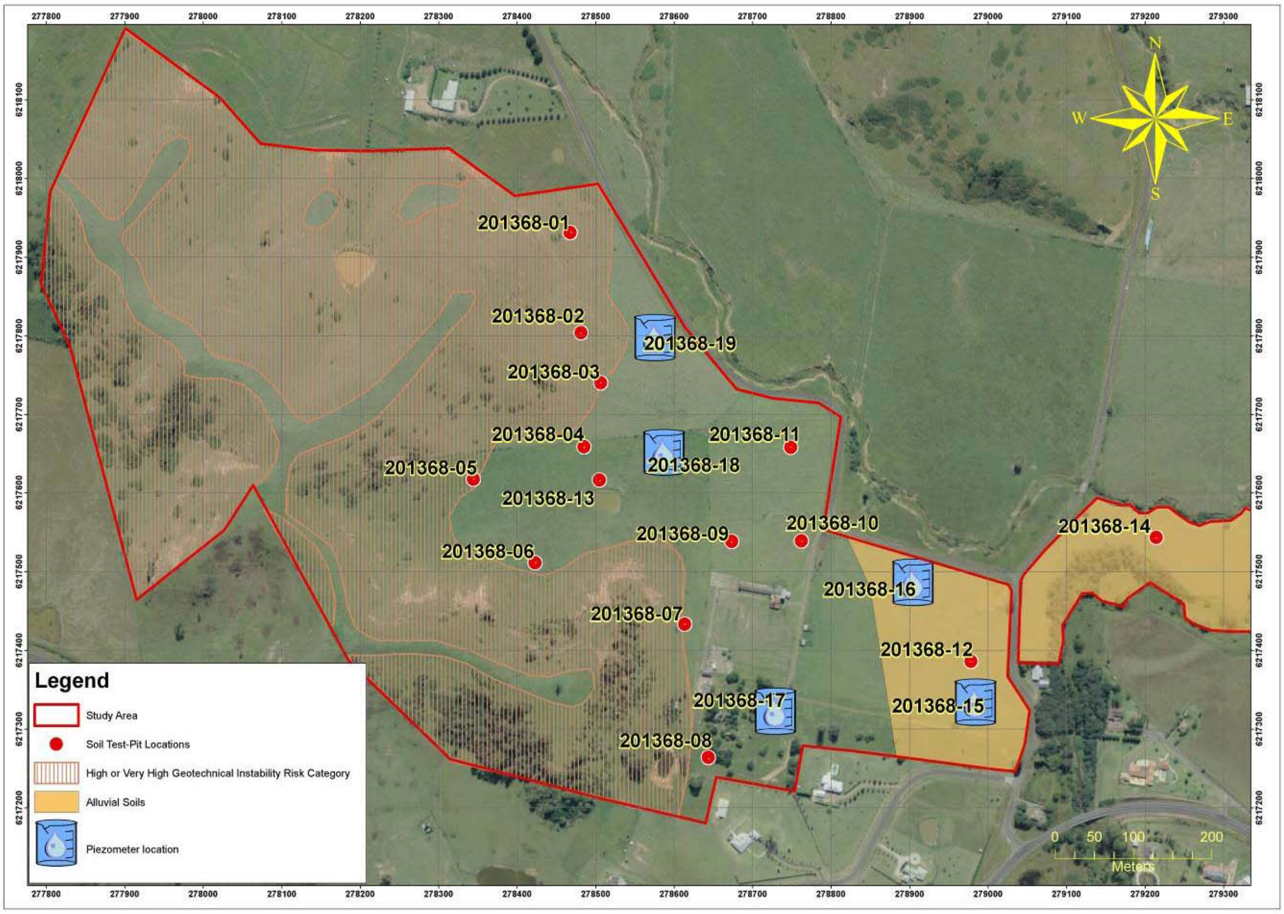


Figure 10: Groundwater piezometer locations

TABLE 10: 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.

4.5.5.1 Groundwater regime 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 in the Alluvial Soils at location 201368-15 to 2.2 metres at location 201368-16 approximately one week after the extended period of heavy rain ended.

4.5.5.2 Groundwater regime within Residual 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 shale hosted groundwater regime of the Study Area.

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.

4.5.6. Watercourses and dams

Watercourses associated with the Study Area are depicted on Figure 2 and described in Section 2 of this Study. The Study area also contains 4 dams.

For onsite effluent irrigation a 40 metre buffer distance is required between effluent irrigation areas and these features.

4.5.7. 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.

4.5.8. Environment and Health Protection (1998) guidelines site and soil assessment rating

4.5.8.1 Site assessment criteria

The site features of the Study Area were assessed against the site assessment criteria outlined in the Environment and Health Protection guidelines of 1998. .

The assessment rating for site features of the Study Area is indicated in broad terms by shading in Table 11.

Table 11: Site Assessment Rating for On-site Systems
(based Environment and Health Protection guidelines of 1998)

Site Feature	Relevant System	Minor Limitation	Moderate Limitation	Major Limitation
Flood Potential**	All land application systems	Rare. Above 20 year ARI	Occasional	Frequent. Below 20 year ARI
	All treatment systems	Vents, openings, and electrical components above 1 in 100yr flood contour		Vents, openings, and electrical components below 1 in 100yr flood contour
Exposure		High sun and wind exposure		Low sun and wind exposure
Slope (%)	Surface irrigation Sub-surface Absorption system	0 – 6 0-10 0-10	6-12 10-20 10-20	>12 >20 >20
Landform	All systems	Hill crests, convex side slopes and plains	Concave side slopes and footslopes	Drainage paths and incised channels
Run-on and upslope seepage	All land application systems	None- low	Moderate (to be restricted by soil and water management devices	High. Diversion not practical
Erosion Potential	All land application systems	No signs		Signs of erosion, eg. rills, mass movement and slope failure present
Site Drainage	All land application systems	No visible signs of surface dampness	Some indicators of poor drainage are present	Visible signs of surface dampness, such as moisture tolerant vegetation (sedges and ferns), and seepages, soaks and springs
Fill	All systems	No visible signs at the surface of fill material	Fill visibly present	
Buffer distance	*All systems* Surface irrigation Subsurface irrigation	*Horizontal distance of 250m to domestic groundwater well.* *100 metres from permanent surface waters (river, streams, lakes etc), 40 metres from farm dams, intermittent waterways and drainage channels.* - 6 metres if up-gradient and 3 metres if down-gradient of driveways, property boundaries, and buildings. 15m from the dwelling. 3 metres to paths & walkways. 6 metres to swimming pools. - 6 metres if up-gradient and 3 metres if down-gradient of swimming pools, property boundaries, driveways and buildings.		Buffer distances not available
Land Area	All systems	Sufficient & appropriate land available.		Sufficient & appropriate land not available
Rocks and rock outcrops (% of land surface containing rocks >200mm diameter)	All land application systems	< 10%	10 - 20%	> 20%
Geology / Regolith		No major discontinuity nor fractured subsoil present.		Major discontinuity & fractured subsoil present.

Based on the assessment rating outlined in Table 11 the following potential site constraints to onsite effluent irrigation were identified:

- Flood;
- Slope;
- Up-slope run-on waters;
- Mass movement (slope instability) and erosion; and
- Buffer distances to site features.

The above site constraints are to be ameliorated and managed by the site management recommendations outlined in this report.

4.5.8.2 Soil assessment criteria

The soil features of the Study Area were assessed against the site assessment criteria outlined in the Environment and Health Protection guidelines of 1998.

The assessment rating for soil features of the Study Area is indicated in broad terms by shading in Table 12.

Table 12: Soil Assessment Rating for On-site Effluent Irrigation (based Environment and Health Protection guidelines of 1998)

Soil Feature	Relevant System	Minor Limitation	Moderate Limitation	Major Limitation	Restrictive Feature
Depth to bedrock/shale or hardpan (m)*	Surface Irrigation Sub-surface Irrigation	> 1.0	0.5 - 1.0	< 0.5	Restricts plant growth (trees), excessive runoff, waterlogging
	Absorption	> 1.5	1.0 – 1.5	<1.0	Groundwater pollution hazard. Resurfacing hazard
Depth to high episodic/seasonal watertable (m)*	Surface Irrigation Sub-surface Irrigation	> 1.0	0.5 - 1.0	< 0.5	Groundwater pollution hazard. Resurfacing hazard
	Absorption	>1.5	1.0 - 1.5	<1.0	Potential for groundwater pollution
Soil permeability Category	Surface Irrigation Sub-surface Irrigation	2b, 3 & 4	2a, 5	1 & 6	Excessive runoff, water-logging, percolation
Coarse Fragments	All land Applications	0 - 20%	20 - 40%	> 40%	May restrict plant growth, affect trench installation
Bulk density	All land Applications	Not limiting		Limiting	Restricts plant growth, indicator of permeability
pH ($CaCl_2$)	All land Applications	> 6.0	4.5 - 6.0	<4.5	Reduces optimum plant growth
Electrical Conductivity (dS/m) ****	All land Applications	< 4	4 – 8	> 8	Excessive salt may restrict plant growth
Sodicity (Exchangeable Sodium Percentage ESP)*	Surface & Subsurface Irrigation (0-40cm) Absorption system (0-1.2m)	0-5	5-10	>10	Potential for structural degradation
Cation Exchange Capacity (CEC) (cmol/kg)*	Surface Irrigation Sub-surface Irrigation	> 15	5 – 15	< 5	Unable to hold plant nutrients
Phosphorous Sorption (kg/ha) for 0 – 100cm*	All land Applications	>6000	2000 - 6000	<2000	Unable to immobilise any excess P

Based on the assessment rating outlined in Table 12 the following potential site constraints to onsite effluent irrigation were identified:

- Soil depth;
- Depth to permanent or intermittent groundwater;
- Soil permeability;

- Sodium exchange capacity;
- Cation exchange capacity; and
- Phosphorus absorption capacity.

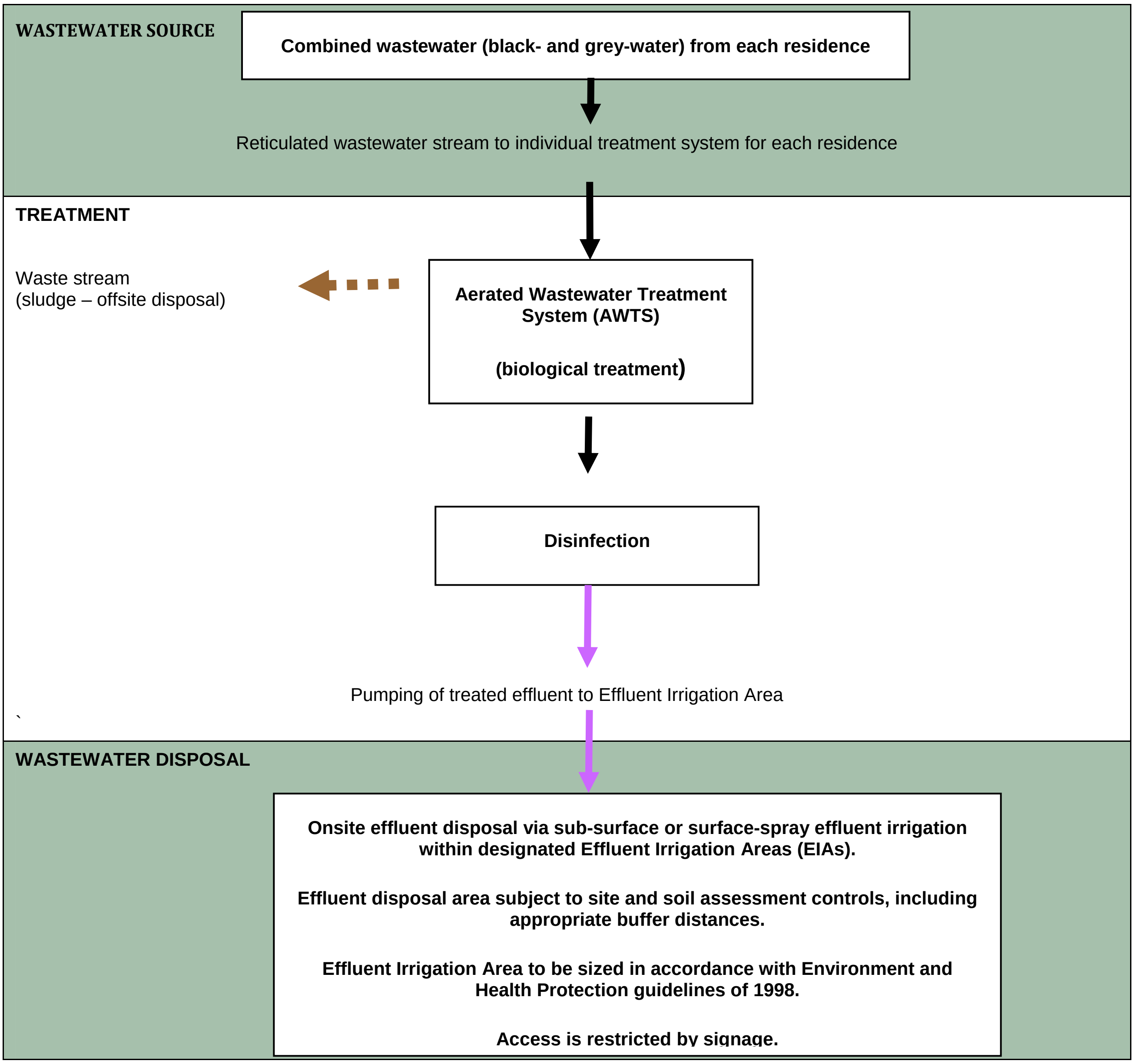
The above soil constraints are to be ameliorated and managed by the site management recommendations outlined in this report.

4.6 Wastewater treatment and onsite effluent disposal

4.6.1. Overview

An overview of the proposed wastewater (black and grey-water) treatment and effluent disposal for each proposed residence is outlined schematically in Figure 11. The details of this system are described in more detail in the following sections.

Figure 11: Schematic overview of the wastewater treatment and disposal system.



4.6.2. Wastewater sources and generation rates

4.6.2.1 Water supply

The Study Area is serviced by a reticulated water source and this water source is proposed to be utilised in the waste stream.

4.6.2.2 Wastewater generation rates

Estimated daily wastewater (black- and grey-water) flow rates from each proposed residence are summarised in Table 13.

Table 13: Estimated daily wastewater (black- and grey-water) flow rates

Wastewater source	Number of bedrooms in residence	Estimated potential occupancy[1]	Estimated daily wastewater flow rate (L/person/day)[3]	Estimated daily wastewater flow rate (L / residence /day) [4]
Tank water	4	8	145	1160

Notes:

1. All values are based on a reticulated water supply with water saving fixtures installed.
2. Based on Wollondilly Shire Council's requirement that 'maximum potential occupancy = number of bedrooms x 2.
3. Based on Appendix 4.2D (page 141) of the AS/NZ 1547:2000 standard.
4. The daily wastewater flow rate was estimated by multiplying the potential occupancy by the estimated wastewater flow-rate per person.

4.6.3. Wastewater Treatment

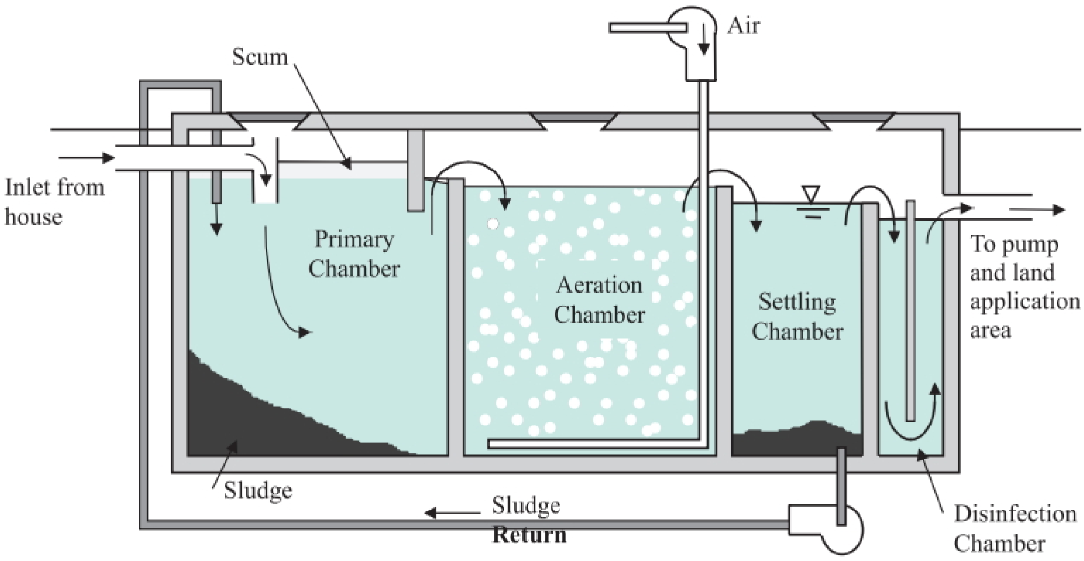
4.6.3.1 Proposed treatment system

It is proposed that wastewater (black- and grey-water) from each residence with up to 10 bedrooms is to be treated onsite via an Aerated Wastewater Treatment System (AWTS). This system uses aeration of wastewater as an integral part of the treatment process and AWTS treatment typically involves the following processes:

- settling of solids and flotation of scum in an anaerobic primary chamber (septic tank)
- oxidation and consumption of organic matter through aerobic biological processes
- clarification - secondary settling of solids
- disinfection using chlorination, or other approved means if surface land application of treated wastewater is to occur, and
- regular removal of sludge to maintain the process.

The above processes are illustrated in Figure 12.

Figure 12: Cross-section of a typical Suspended Growth AWTS (Source: Environment and Health Protection guidelines (1998).



AWTS rely on biological activity for proper system operation. Sudden changes to the hydraulic loading into a system (either a rapid increase or sudden decrease in load) can result in poor system performance. A period of a few weeks is typically required during commissioning of the system to achieve the expected treated wastewater quality. AWTS systems must be operated continuously and power to the system must not be turned off, if possible. If an AWTS is used at irregular intervals (such as for holiday homes) the system might need to be serviced at each start-up.

An AWTS typically produces effluent of a higher quality than that produced by septic tanks, with lower BOD, lower suspended solid levels, and much lower faecal coliform levels. However, a standard AWTS that is not explicitly designed to remove nutrients will generate high nutrient levels. Consequently, effluent irrigation areas need to be designed to cater for the nutrient load from the proposed AWTS.

4.6.3.2 Alternative wastewater treatment systems

All domestic wastewater treatment systems installed in NSW must be accredited by the NSW Department of Health pursuant to Clause 41(1) of the Local Government (General) Regulation 2005 (NSW). Providing a wastewater treatment system is accredited and the conditions of accreditation are capable of being met, particularly in relation to the disposal of effluent from the treatment system, then that system may be installed.

Some examples of alternative treatment systems to an AWTS include the following:

- Septic tank;
- Wet composting toilet, such as worm farm waste systems; and/or
- Waterless composting toilet.

Pump-out systems are generally not looked upon favourable by Council's as the pump-out costs often become prohibitively expensive to land owners.

4.7 Effluent disposal system

4.7.1. Proposed method of effluent disposal

Effluent is proposed to be disposed of onsite via either surface-spray or sub-surface effluent irrigation.

4.7.2. Minimum Effluent Management Area (EMA) required for a typical 4 bedroom residence

Nutrient loading and water balance calculations were undertaken based on the Environment & Health Protection Guidelines (Department of Local Government 1998) to determine the minimum Effluent Management Area (EMA) required to dispose of wastewater loads from typical wastewater treatment systems. These calculations in turn are based on a combination soil characteristics, vegetation, wastewater treatment quality for a standard AWTS and climatic features of the Study Area.

Table 14: Minimum Effluent Management Area (EMA) requirements for effluent disposal from a Standard AWTS

Assessment method	Estimated EMA[1, 2, 3] (m^2)	Reference
Nitrogen loadings	928	Appendix 4
Phosphorus loadings	1034	Appendix 4
Water balance	517	Appendix 5
Minimum EMA required for sub-surface effluent irrigation	**1034**	Maximum value of Appendix 4 and 5
Minimum EMA required for surface methods of effluent irrigation[4]	**1500**	**Maximum value of 1500m² or Appendix 4 and 5.**

Notes:

1. Based on daily wastewater flows from domestic sources only.
2. EMA sizes are based on wastewater generation rates outlined in Table 8;
3. Refer to Appendix 4 and 5 for nutrient loading and water balance calculations respectively; and
4. Wollondilly require a minimum of 1500m^2 for surface methods of effluent irrigation.

Based on Table 14, the minimum EMA required may be summarised as follows:

- Sub-surface effluent irrigation = 1034 m^2.
- Surface methods of effluent irrigation = 1500 m^2.

4.8 Recommended Development Controls

4.8.1. Development controls for the management of Site Constraints

Flooding

All EMAs are to be located above the 1 in 100 flood contour.

All vents, electrical components and opens of any proposed wastewater treatment system are to be located above the 1 in 100 flood contour.

Slope

Effluent Management Areas (EMAs) must **not** be located on slopes exceeding the following thresholds:

- Sub-surface effluent irrigation = 15%; and
- Surface-spray effluent irrigation = 10%.

Geotechnical instability

Effluent Management Areas (EMAs) must **not** be located within the areas delineated on Figure 2 as having a 'High' or 'Very High' geotechnical risk category.

Buffer distances

Unless otherwise approved by Wollondilly Shire Council, the positioning of all effluent disposal areas must comply with the following buffer distance requirements outlined in Table 15.

Table 15: Minimum buffer distance requirements for onsite effluent irrigation (adapted from Environmental the Health Protection guidelines of 1998).

System	Buffer Distance
All land application systems	- 100 metres to permanent surface waters (e.g. river, streams, lakes etc) - 250 metres to domestic groundwater well - 40 metres to other waters (e.g. farm dams, intermittent waterways and drainage channels, etc)
Surface spray irrigation	- 6 metres if area up-gradient and 3 metres if area down-gradient of driveways and property boundaries. - 15 metres to dwellings. - 3 metres to paths and walkways. - 6 metres to swimming pools.
Surface drip and trickle irrigation	- 6 metres if area up-gradient and 3 metres if area down-gradient of swimming pools, property boundaries, driveways and buildings.
Subsurface irrigation	- 6 metres if area up-gradient and 3 metres if area down-gradient of swimming pools, property boundaries, driveways and buildings.
Absorption Systems	- 6 metres if area up-gradient and 3 metres if area down-gradient of swimming pools, driveways and buildings. - 12 metres if area up-gradient and 6 metres if area down-gradient of property boundaries.

Groundwater

A detailed groundwater assessment is to be undertaken for the Study Area at the Development Application Stage of development. The objective of the detailed groundwater assessment is to delineate portions of the Study Area where groundwater (permanent or intermittent) is within 1 metre of the soil surface.

No effluent disposal is to occur in areas where groundwater (permanent or intermittent) is within 1 metre of the soil surface.

Note: Preliminary groundwater investigations undertaken as part of this assessment identified that groundwater may be within 1 metre of the grounds surface at some locations within the Study Area. These investigations were insufficient in detail to delineate the groundwater constraints of the entire

Study Area. Furthermore, groundwater constraints should be considered in the context of development detail that will not be known until the Development Application stage of development.

Surface water controls

Cut-off drains or bunding (a mound) are to be installed upslope of the proposed EMA to divert surface water around the EMA.

4.8.2. Development controls for the management of soil constraints

Soil sodicity

All sub-soils exposed during earthworks associated with the proposed development are to be capped with at least 300mm of non-sodic, non-saline topsoil.

Cation Exchange Capacity and Phosphorus Retention Index

This constraint is to be managed by appropriately sizing EMAs in accordance with Wollondilly Shire Council's requirements.

Nutrient management

EMAs should contain a well maintained lawn that is regularly mown with the grass clipping removed. Removal of grass clippings reduces nutrient accumulations within the EMA.

4.8.3. Development controls for the management of Effluent Management Areas (EMAs)

General

All Effluent Management Areas (EMAs) must:

- not be used for the production of any edible food crops or plants;
- have stock and vehicles (with the exception of a lawn mover) excluded;
- be managed in accordance with the requirements of the Environment and Health Protection guidelines (1998); and
- be designed by a suitably qualified and experience wastewater consultant in accordance with the requirements Wollondilly Shire Council's On-site Sewerage Management System and Greywater re-use (2011). Indicative sizings for a typical 4-bedroom residence with wastewater treated via an Aerated Wastewater Treatment System (AWTS) are:
  - ➢ Sub-surface methods of effluent irrigation = 1034m^2; and
  - ➢ Surface methods of effluent irrigation = 1500m^2.

Surface-spray effluent irrigation

If surface spray effluent irrigation is installed, it must include:

- an appropriate filter on the effluent supply line;
- spray drift controls, including low throw sprinklers; and
- sign-posting and/or fencing to exclude public access.

Sub-surface effluent irrigation

If sub-surface effluent irrigation is to be installed, it must include:

- a flush valve at the lowest point of the EIA;
- a vacuum breaker at the highest point of the EIA;
- root guard on irrigation lines; and
- an appropriate filter on the effluent supply line.

Plumbing

All plumbing works:

- must be undertaken in accordance with the NSW Code of Practice for Plumbing and Drainage 3rd Edition 2006;
- including below-ground pipes must have an identification tape (marked in accordance with the AS/NZ 3500.1 Clause 9.5.4.1) installed on top of the pipeline, running longitudinally, and fastened to the pipe at not more than 3m intervals;
- must ensure that all irrigation lines be marked and labelled in accordance with the NSW Code of Practice for Plumbing and Drainage 3rd Edition 2006; and
- all pipes or pipe sleeves and identification tapes must be coloured purple as per the AS 2700 and marked with the following in accordance with the AS 1345 'WARNING RECYCLED/RECLAIMED WATER - DO NOT DRINK" at intervals not exceeding 0.5m.

4.9 Conclusions

Providing the recommended Development Controls outlined in this OWFS are implemented, domestic wastewater (black and grey-water) from the proposed residences are considered to be capable of being managed by onsite treatment with a domestic AWTS with onsite disposal via either surface-spray of sub-surface effluent irrigation.

With regard to the four objectives of the Specialist Study Requirements that are of relevance to onsite wastewater treatment and disposal, the following is noted:

- The onsite wastewater feasibility of the Study Area was assessed in Section 4 of this Study;
- Recommendations for the management of Effluent Management Areas (EMAs) was provided in Section 4.8 of this Study;
- The most suitable wastewater treatment system for the treatment of domestic wastewater from each proposed residence was found to be an Aerated Wastewater Treatment System (AWTS). Alternative wastewater treatment systems were discussed and these are included in Section 4.6.3.2 of this Study; and
- Nutrient loading and water balance calculations were undertaken and based on these calculations, the minimum areas required for onsite effluent irrigation to dispose of the effluent load from a standard AWTS for a standard four bedroom residence are as follows:
    - Sub-surface effluent irrigation = 1034 m^2; and
    - Surface methods of effluent irrigation = 1500 m^2.

5.0 INTEGRATED WATER QUALITY MANAGEMENT PLAN (IWQMP)

5.1 Introduction

The precise definition of an '*Integrated Water Quality Management Plan (IWQMP)*' has not been provided in the tender documentation for this Study. The view of this Study is that water quality management is one part of an integrated water management plan, where there are many interactive components as depicted on Figure 13.

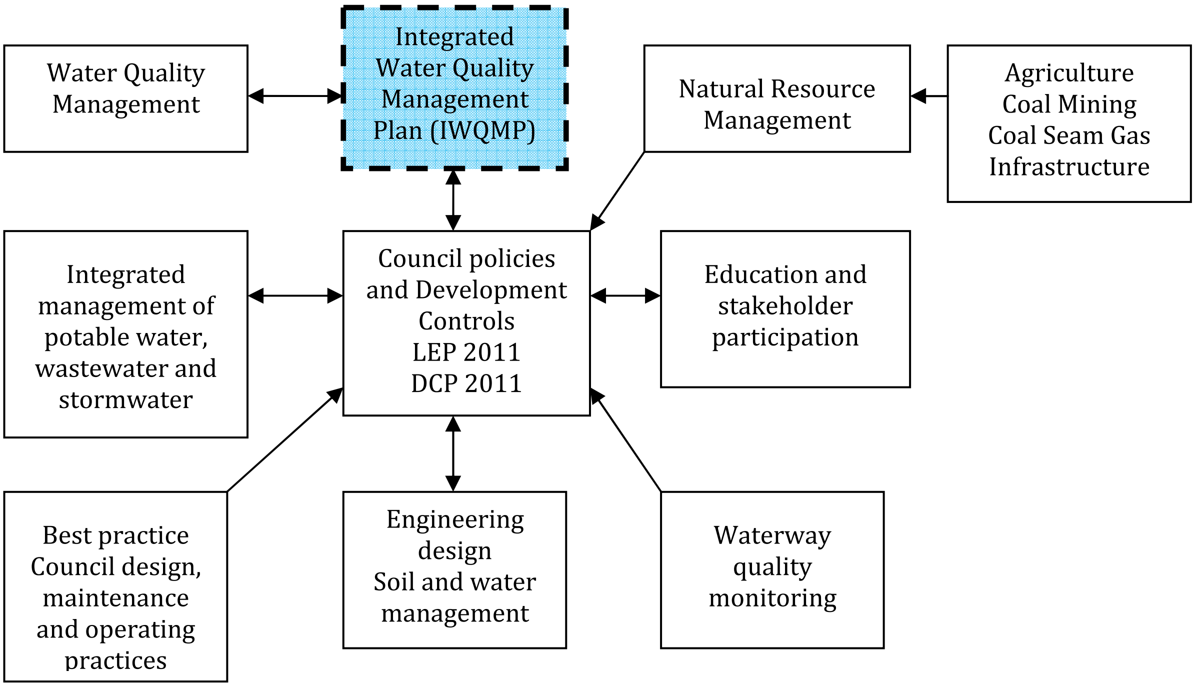


Figure 13: Flow chart of a typical Integrated Water Quality Management Plan (IWQMP) in relation to other water quality aspects Council functions (Flow chart adapted from **Mackay City Council, 2006**).

As the principal consent authority, Wollondilly Shire Council will need to consider water quality policy aspects in the context of other Council functions as outlined in Figure 13 and needs to ensure that Development Controls for the Study Area are consistent with the objectives of the IQWMP.

Hence, whilst this Study only considers water quality issues relevant to the Study Area, the IWQMP described in the following sections must by necessity, be integrated with other Council functions, Policies and Development Controls.

5.2 IWQMP objectives

The objective of the IWQMP is to outline Development Controls that should be imposed upon development within the Study Area to ensure that the objectives of the relevant legislation, policy and guidelines in relation to water quality are met. These objectives are best met by adopting Riparian Enhancement Activities (REA), Water Sensitive Urban Design (WSUD) and applying appropriate Development Controls as discussed in the following sections.

5.3 Riparian Enhancement Activities (REA) and Water Sensitive Urban Design (WSUD) – An Overview

5.3.1. Overview

Specialist Study Requirements in relation to Riparian Enhancement Activities (REA) and Water Sensitive Urban Design (WSUD) for the Study Area are as follows:

> ***Objectives….***
>
> *'…To incorporate the principles of Water Sensitive Urban Design and Managing Urban Stormwater as outlined in DECCW's General Guidelines for Strategic Planning'.*
>
> ***Tasks….***
>
> '…*Identify Riparian Enhancement Activities and their role in stormwater treatment and design in this regard the principles contain in the publication, Water Sensitive Urban Design should be incorporated into the report..'.*

Despite extensive enquiries of the Office of Environment and Heritage together with a search of their website (*http://www.environment.nsw.gov.au/*) it was not possible to retrieve a copy of the referenced document and accordingly this Study has assumed that the document is no longer available. However, this Study acknowledges the intent of the comment by the DG and the following sections generally outline the principles of REA and WSUD in the context of water quality management.

The general relationship between REA and WSUD is depicted schematically on Figure 14 and each of these activities is described further in the following sections.

Residential Development Area:

- Including residence, yard area, effluent irrigation area, roads and any areas containing WSUD features.

Riparian corridor:

- Area containing Core Riparian Zone and Vegetated Buffer.

Water Sensitive Urban Design (WSUD):

- WSUD activities are located outside of the riparian corridor (**Figure 5**) and incorporated into the residential development area;
- Include water quality management activities to improve water quality, such as installation of grass swales, biorention swales, sedimentation ponds, stormwater detention ponds, rainwater tanks, etc;
- Model the proposed WSUD features in a program such as MUSIC™. Modelling in the program MUSIC includes a water balance equation for the Study Area;
- The objective of WSUD is to treat stormwater to a suitable standard before the water enters the riparian corridor; and
- The actual features installed are determined by stormwater modelling in a program such as MUSIC™.

Riparian Enhancement Activities (REA):

- REAs occur only within the riparian corridor (**Figure 6**);
- Include activities such as weed removal, replanting native vegetation and fencing to exclude stock; and
- Objective is to return riparian corridor to as close a possible to natural state for bed and bank stability and water quality benefits.

Legend

Blue arrow = direction of stormwater flow.

Figure 14: Schematic representation of the relationship between REA and WSUD.

5.4 Water Sensitive Urban Design (WSUD)

Since the late 1990s there have been an increasing number of initiatives to manage the urban water cycle in a more sustainable way. These initiatives are underpinned by key sustainability principles of water consumption, water recycling, waste minimisation and environmental protection.

The integration of management of the urban water cycle with urban planning and design is known as '*Urban Sensitive Urban Design (WSUD)'* (Melbourne Water, 2005).

Under the WSUD principles, urban stormwater is managed as both a resource and for the protection of receiving water ecosystems. The practise of WSUD espouses the innovative integration of urban water management technologies into the urban environment and that strategic planning and concept designs are under-pinned by sound engineering practices in design and construction.

Various WSUD guidelines are available, such as the Melbourne Water (2005) guidelines entitled '*Water Sensitive Urban Design*' or '*Urban Stormwater: Best Practice Environmental Management Guidelines*' by Victorian Stormwater Committee (1999) and others. These guidelines provide details on the various WSUD options available for treatment of stormwater runoff and are not exhaustive.

Some typical WSUD features that may be included into a residential development are as follows:

- Sediment basins and ponds;
- Biorention basins and swales;
- Grass swales;
- Sand filters;
- Constructed wetlands;
- Lakes and stormwater detention basins; and
- Rainwater tanks.

Not all WSUD options are required for all sites and the actual treatment options required are determined based upon the outcomes of stormwater modeling. The stormwater modeling approach allows for flexibility in both the site layout and WSUD features that are to be installed.

5.5 Riparian Enhancement Activities (REA)

5.5.1. Importance of native riparian vegetation

Wollondilly Shire Council DCP (2011) outline the importance of native riparian vegetation as follows:

> *'As rainfall moves through the drainage lines of a catchment the water picks up "eroding soil, nutrients, salt or other contaminants and moves them into the river system. It also transports food – nutrients, leaf litter, fine particles of organic matter and other dissolved substances – for aquatic plants and animals" (LWRRDC 4 1998).*
>
> *Riparian zones exert a powerful influence on the type of food and nutrients in the stream, on in-stream energy production and on where the river is located in the landscape. Riparian vegetation often has a higher plant diversity than adjacent upland areas with taller, more dense and structurally more complex vegetation.*
>
> *The positive impacts that healthy riparian vegetation offers to the river ecosystem are outlined below:*
>
> ***Shading:***
>
> *Most river shade comes from healthy, intact riparian vegetation and it:*
>
> - *acts to maintain lower water temperatures assisting many native animals and plants to survive. It evens out extremes of temperature and humidity providing more balanced conditions for plants and animals;*
> - *may act as a trigger for egg hatching, larval development and other components of animal life cycles as they are temperature dependent;*
> - *may affect the growth and development of most aquatic organisms (such as algae, invertebrates, fish, reptiles and amphibians) as they are in part dependent on temperature;*
> - *decreases the amount of available light and reduces excessive growth of algae or nuisance plants; and*
> - *creates dim or dappled light which provides habitat and shelter for many prey animals.*

Food source for aquatic plants and animals:

- *Native streamside vegetation is a vital source of food for aquatic plants or animals in the form of leaf litter, insects and other organic debris, especially large woody debris.*

- *These food sources "are essential elements of the food web which supports predatory invertebrates, fish and other aquatic vertebrates and terrestrial and semiaquatic consumers" (Bunn et. al. 1999).*

Woody debris

- *As branches, large limbs and sometimes entire trees fall into a river they may slow water flow, protect the bed of the stream and trap sediment up stream. They can significantly reduce bed erosion and may create deeper pools, which supply vital habitat to aquatic animals and plants during dry times. This is particularly important in up-land smaller streams. Removal of large woody debris can have a big impact on bed and bank erosion of the stream.*

- *Tree branches and trunks provide niches and habitats for microbes including fungi, bacteria and algae and small invertebrates such as freshwater hydra, blackfly larvae and net-spinning caddis. They filter feed, shred or consume leaves and fine litter and, in turn, become food for larger animals such as platypus and fish.*

- Large snags are vital to the growth and survival of our native fish species. They provide shelter, habitat and refuge from predators. These logs are an essential spawning habitat for some native fish. "Snags provide habitat for other aquatic and terrestrial species. Birds, reptiles, amphibians and mammals use woody debris for resting and foraging and as lookout sites" (Treadwell et. al. 1999).

Bank stability

- *Healthy riparian vegetation helps stabilise and protect stream banks mainly through their root systems, which reinforce the soil and safeguard the bank against collapse.*

- *It may also decrease the velocity of water flow in the channel thus reducing scouring of the bank and thereby undercutting and collapse. Riparian vegetation can also stabilise undercut banks which provide shaded habitat for fish and other aquatic species.*

Filtering nutrients and sediment

- *Riparian zones act as a buffer between overland flow and the river. They slow down overland flows and cause sediments and nutrients to be deposited on land and take up some of the transported nutrients. This is particularly important as it can improve water quality and prevent excessive aquatic plant growth. Trapping the sediment before it reaches the river system helps to reduce habitat loss, scouring, turbidity and excessive nutrient inputs.*

- *Habitat loss occurs when sediment settles out and blankets streambeds and logs.*

- *The sediment smothers habitat, spawning sites and food sources for aquatic species such as fish and can reduce dissolved oxygen levels.*

- *Coarse, suspended sediment particles, moving at high velocity, can scour or "dislodge benthic (bottom dwelling) animals and reduce the biomass of algal food resources for invertebrate consumers. Passive filter feeders, such as blackfly larvae and net-spinning caddis larvae, can be killed as their guts fill with indigestible silt"(Prosser et. al. 1999).*

- *Increased turbidity interferes with light penetration and thus directly affects photosynthesis and the feeding efficiency of visual predators such as water birds and fish. It may also inhibit fish growth and reproduction and the establishment, survival and growth of periphyton (algal communities). It should be noted however that Australian rivers and streams tend to be naturally turbid. Turbidity may reduce blooms of toxic blue-green algae species.*

Scenic and cultural values of water

- *Water can have importance for scenic and cultural reasons. The scenic importance of surface water features relate to the water body itself and its context and setting in the landscape and may include the adjoining riparian lands and land uses or built elements which have a relationship with a water body such as bridges, land uses which use water (such as irrigated farmland) and recreational areas.*

- *The cultural importance of water may be related to the significance of watercourses and ground water systems in Aboriginal and European Heritage as well as modern day cultural affinity such as leisure and recreation places, places with iconic or landmark significance and water which contributes to the general character and setting of a locality that is important to the current community.'*

5.5.2. Riparian Zone management

Management of riparian zones is generally divided into three accepted categories based upon function, whereby the categories define the core functions and current and predicted environmental significance.

The three general categories are as follows:

- **Category 1.** Environmental Corridors;
- **Category 2.** Terrestrial and Aquatic Habitats; and
- **Category 3.** Bed and Bank Stability and Water Quality.

These classifications follow from a Study undertaken by the Department of Infrastructure, Planning and Natural Resources (DIPNR) for the Wollongong and parts of the Shellharbour local government areas (DIPNR 2004) and also adopted by other local government areas, such as Ku-ring-gai Council and also for the document entitled '*Draft Riparian Objectives and Principles for Structure and Planning in North West and South West Sectors*'.

Category 1 Environmental Corridors provide linkages for wildlife. This category provides the greatest minimum width of riparian and buffer zone and typically includes the most intact riparian zones in remnant bushland areas. These areas would have the greatest value for (aquatic and terrestrial) habitat, wildlife movement and conservation, water quality maintenance, fluvial/geomorphic processes and stream stability. A critical role for this category is to provide as much habitat complexity and continuity as possible so that movement of genetic material, via pollinators (insects, birds and animals) and seed and plant material dispersal. This will minimise the risk of isolating plant and animal populations and hence their decline through reduced fitness and inbreeding depression, and is fundamental to conserving biodiversity.

Category 2 Terrestrial and Aquatic Habitat riparian zones contain useful basic habitat and preserves the natural features of a watercourse. The size and condition of these riparian zones and buffers is less than Category 1 but fluvial geomorphic processes can still occur, they have good habitat quality (but lesser wildlife movement value) and will be useful for water quality maintenance.

Category 3 Bed and Bank Stability and Water Quality riparian zones would provide limited habitat value but provide an important contribution to the overall health of the catchment. Typically these would be narrow zones along highly modified streams that may have no indigenous vegetation.

The generally recommended Core Riparian Zones and Vegetated Buffers associated with each of these Riparian Categories are summarised in Table 16**.**

TABLE 16: Minimum Environmental Objectives for Riparian Zones

Minimum environmental objectives for riparian zones	**Category 1 Environmental corridor (Red)**	**Category 2 Terrestrial and aquatic habitat (Green)**	**Category 3 Bank stability and water quality (Blue)**
Identify whether or not there is a 'watercourse' present	Not applicable	yes	yes
Delineate riparian zone on a map and zone appropriately for environmental protection	yes	yes	not required
Provide a core riparian zone width **greater** than (not to be considered as part of the fire protection zones)	40 m from top of both banks	20 m from top of both banks	**10m** from top of both banks
Provide additional width to counter edge effects on the urban interface (can be part of the fire protection zone)	10 m	10 m	generally not required
Provide continuity for movement of terrestrial and aquatic habitat	yes (including piered crossings and elevated pathways)	yes (piered crossings preferred and elevated pathways)	where appropriate
Rehabilitate/re-establish local provenance native vegetation	yes	yes	where appropriate
Locate new services outside the core riparian zone wherever possible (sewer, water, electricity, gas, communication, transport etc…)	yes	yes	
Locate playing fields and recreational activities outside core riparian zone	yes	yes	
Treat stormwater runoff before discharge into riparian zone or the watercourse	yes	yes	yes
Detain stormwater runoff before discharge into CRZ or watercourse	yes	yes	yes

Source: Draft Riparian Objectives and Principles for Structure and Planning in North West and South West Sectors.

5.6 Stormwater quality run-off objectives and water quality modeling

Development controls in relation to stormwater management within the Study Area are to be governed by specific Government endorsed policies and guidelines. These have been outlined in detail in Section 3 of this Study, specific water quality objectives are summarized as follows:

- **SREP 20 – Hawkesbury-Nepean River No 2:**

  '…must not prejudice the achievement of the goals of use of the river for primary contact recreation (being recreational activities involving direct water contact, such as swimming) and aquatic ecosystem protection in the river system. If the quality of the receiving waters does not currently allow these uses, the current water quality must be maintained, or improved'

- **Wollondilly Shire Council LEP (2011):**

  '*Before determining a development application for development on land to which this clause applies, the consent authority must consider any adverse impact of the proposed development on the following:*

  (a) the water quality of receiving waters,….'

- **Wollondilly Shire Councils DCP (2011):**

  'All stormwater generated from any development shall be treated to an acceptable standard. In determining the "acceptable standard" the consent authority shall be mindful of the relevant guidelines of the State and Federal Governments.

- Water Management Act (2000)

  '*(c) the water quality of all water sources should be protected and, wherever possible, enhanced, and*

  (d) the cumulative impacts of water management licences and approvals and other activities on water sources and their dependent ecosystems, should be considered and minimised,…''

- **Fisheries Management Act (1994)**

  '*f) Pollution of waterways should be a voided by:*

  – identification of point-source and diffuse pollutant discharges

  – prevention or minimisation of such discharges

  – effective treatment of any continuing discharges

  – disposal of wastes to alternative land sites, or to processing facilities….'

  '…The cumulative impact of new developments upon water quality should be assessed and evaluated.

  NSW Fisheries supports efforts to reduce pollution of waterways and achieve an overall improvement in water quality - including the fitting of gross-pollutant traps to stormwater drains, construction of artificial wetlands at creek outfalls, fitting of multi-level offtakes on weirs and dams, control of catchment erosion and reestablishment of riparian vegetation communities.'

- **Habitat Protection Plan – Hawkesbury Nepean River System**

  'v) systems for treating stormwater (such as gross pollutant traps, sedimentation ponds and artificial wetlands);

  vi) measures that minimise sediment escape during clearing and construction….'

SREP 20, the WMA 2000 and the FMA 1994 are all generally driven by the objective to maintain or improve the water quality in the receiving waters, a concept that has generally become known by the term 'Neutral or Beneficial Effect' (NorBE).

DCP 2011 considers that all stormwater from a development should be treated to an "acceptable standard" and should be considered in the context of the relevant guidelines of the State and Federal Governments. In this context, the NSW Office of Water (NOW) and NSW Department of Fisheries and Aquaculture (DOFA) are the appropriate agencies for consultation when determining what is an '*acceptable standard'.*

Therefore, for NorBE to be demonstrated, stormwater modelling must indicate that stormwater quality values or outcomes must be less than or equal to the Government endorsed targets for the Study Area, which are to be determined in consultation with NOW and NSW DOFA.

In the absence of instruction from either NOW or NSW DOFA to the contrary, the concept of NorBE has been adopted as the water quality objective of this IWQMP. Accordingly, future development in the Study Area is required to include:

- Stormwater modelling of pre and post-development scenarios in a program such as Music™; and
- Integration of practical WSUD features into the sub-division layout to demonstrate NorBE.

As part of the development assessment process for future sub-division applications within the Study Area, stormwater modeling will then be required to demonstrate compliance with pre-determined government endorsed water quality objectives. In the absence of advice to the contrary, NorBE is considered to be met when:

- The post-development scenario has demonstrated an improvement in water quality for Total Suspended Solids (TSS), Total Nitrogen (TN) and Total Phosphorus (TP); and
- The proposed WSUD Water Quality Infrastructure is practical and capable of being managed long-term.

Stormwater modeling at the Development Application stage will enable the development of water balance equation for the sub-division allowing the optimization of water reuse thus minimising the use of potable water.

5.7 Actions and strategies to ameliorate potential negative impacts on receiving waters

5.7.1. Introduction

This section outlines the recommended actions and strategies to ameliorate potential impacts on the receiving water of Stonequarry Creek and the broader Hawkesbury-Nepean catchment. Recommended Development Controls for the Study Area are presented in the following sections including Table 16.

5.7.2. General WSUD Development Controls for the Study Area

Development Controls for the Study Area with regard to stormwater quality need to be flexible to allow for various WSUD options that available and for the tailoring of the best options for an individual site to be determined.

It is anticipated that a typical sub-division will include one or more of the following WSUD options:

- collection of roof water in a stormwater tank and using this water for toilet flushing;
- treatment of stormwater run-off from all hardstand areas and effluent disposal areas with a grass buffer, grass swale and/or a bio-retention swale;
- diversion of surface waters collected from one or more allotments to a sediment pond that is located in the lowest point in the sub-division catchment and outside of any CRZs; and
- Grass swales and/or bioretention swales on either side of all constructed public roads.

Other than grass swales and/or bioretention swales associated with road reserves, there will be no need for any public Water Quality Infrastructure as all Water Quality Infrastructure will be capable of being managed on private land.

Stormwater quality modelling in the program MUSIC™ will include a water balance equation for the Study Area. The treatment chain is to be modeled in a manner to incorporate stormwater runoff from the developed site and including effluent irrigation areas.

WSUD features are to be configured in a manner to optimise re-use of water and minimises potable use. These features will include rainwater tanks on residences and re-use of this water for toilet flushing.

5.7.3. WSUD Development Controls and onsite effluent disposal

Wollondilly Shire Council's Policy for onsite wastewater management requires specific buffer distances to certain site features. For example a 40 metre buffer distance is required to a dam or intermittent drainage line. The purpose of these buffer distances is to protect public health and the environment.

In the case of a dam, wastewater may pollute the dam water and pose a risk to the health of stock and/or humans if contact occurs. Therefore a 40 metre buffer distance for onsite effluent disposal is appropriate for such features if they are to be installed as part of the Water Quality Infrastructure for the WSUD of the development.

In the case of a natural Watercourse, a 40 metre buffer distance to this feature is applied to manage the risk of effluent being incorporated into the drainage waters of the Watercourse. Due to the connectivity of the natural Watercourse to the natural drainage environment effluent will move offsite rapidly and pose an unacceptable environmental and public health risk. A 40 metre buffer distance is therefore appropriate for onsite effluent irrigation to these features, as per Wollondilly Shire Council's onsite wastewater management policy.

A 40 metre buffer distance between an effluent disposal area and a Grass Swale and/or Bioretention Swale that is installed with the explicit purpose of treating stormwater runoff from a designated effluent irrigation area or residential development area as part of the WSUD is not appropriate. The reasons for this are as follows:

- these features are most effective nearest to the source of pollution;
- these features are located outside of the riparian zone (Figure 8) are therefore not directly connected to the natural drainage system and therefore are not a direct conduit to transport pollutants as part of the natural drainage system; and
- these features are extremely effective at reducing nutrient and water borne contamination and are readily maintainable.

A specific exclusion should therefore be included in the WSUD Development Controls for the Study Area in relation to buffer distance requirements between Grass Swales, Biorention Swales and onsite effluent irrigation areas.

5.7.4. Water quality and quantity

Stormwater quality impacts should be modelled as part of the Development Application stage for any future sub-divisions within the Study Area. Modelling should be undertaken in a computer program such as Music™ and should include the following features as a minimum:

- The proposed lot layout;
- The location of any building envelopes;
- The location of the proposed any related effluent irrigation area/s;
- The incorporation of Water Sensitive Urban Design principles;
- The location of any required Water Quality Infrastructure; and
- Consideration for the error in the stormwater model.

Stormwater modelling should demonstrate NorBE in relation to the water quality of the receiving waters of the Stonequarry Creek and more generally the Hawkesbury-Nepean catchment. It must also demonstrate that the amount of stormwater run-off from a site '*does not significantly increase as a result of the development*'. The latter requirement in relation to quantity is made with reference to SREP 20.

Stormwater modelling at the Development Application Stage should include a water balance equation incorporating wastewater and stormwater that optimises re-use and minimises potable use.

5.7.5. Core Riparian Zones (CRZs) and Vegetated Buffers (VBs)

Based upon the Wollondilly Shire Council DCP, LEP and the NOW guidelines in relation to Controlled Activity approvals, suggested Core Riparian Zones (CRZs) and Vegetated Buffer (VBs) for the Study Area are outlined in Table 17.

Table 17: Summary of recommended CRZs and VBs for the Study Area

Sensitive Riparian Land Category	Number of features	Mapped Strahler Order	Name(s) of features	Adopted recommended Core Riparian Zone (m)	Adopted vegetated buffer to counter edge effects with urban interface
Category 1 – Environmental corridor	1	5	Stonequarry Creek	40	10
Category 2 - Terrestrial and aquatic habitat	1	3 or 4	Un-named	20	10
Category 3 – Bank stability and water quality	4	1 and 2	Un-named	10	Nil

Notes:

1. Mapped Strahler Order refers to the Watercourse Order as depicted on Figure 2.
2. Sensitive riparian land categories are based on function as interpreted in Wollondilly Shire Council's LEP 2011 and DCP 2011.

5.7.6. General

Recommended Development Controls for the Study Area are presented in Table 18.

Table 18: Recommended Development Controls for the Study Area

Aspect	Recommended Development Control/s	Basis for recommendation	Comments
Water quality	• All future sub-division Development Applications should be subject to water quality modelling to demonstrate a 'Neutral or Beneficial Effect' (NorBE) on the water quality in the receiving waters of Stonequarry Creek. • If NorBE cannot be met the sub-division Development Application should be reconfigured to achieve NorBE. • If the development cannot be re-configured to achieve NorBE then it should be refused. • Consideration should be given to including either grass swales or bio-swales into the proposal.	• To demonstrate compliance with requirements of Section 6(3) of SREP 20. • To demonstrate compliance with Section 7.3 of the Wollondilly Local Environmental Plan (LEP) 2011. • To comply with the principles of the WMA 2000. • To demonstrate compliance with Sections 2.6.2, 2.6.5 and 2.6.6 of the Wollondilly Development Control Plan (DCP) 2011.	Stormwater modeling targets for the related development control/s should be determined in consultation with the NSW Office of Water (NOW). The stormwater modeling targets determined by NOW should be included in the Development Control/s for the Study Area.
Water quantity	• All future sub-division Development Applications should be subject to Stormwater modeling to demonstrate that the quantity of stormwater run-off does not significantly increase post development.	• To demonstrate compliance with requirements of Section 6(4) of SREP 20. • To demonstrate compliance with Section 7.3 of the Wollondilly Local Environmental Plan (LEP) 2011. • To comply with the principles of the WMA 2000. • To demonstrate compliance with Sections 2.6.2, 2.6.5 and 2.6.6 of the Wollondilly DCP 2011.	
Onsite Effluent Disposal	All future Development Applications should be accompanied by a site-specific 'Onsite Wastewater Feasibility Study' (or equivalent study) conducted in accordance with the following documents:	• To demonstrate compliance with requirements of Section 6(3) of SREP 20. • To demonstrate compliance with Section 7.3 of the Wollondilly	Wollondilly Shire Council's Environmental Health branch in relation to exclusions for Grass Swales and/or Biorention Swales for the treatment of Stormwater

Aspect	Recommended Development Control/s	Basis for recommendation	Comments
	• Wollondilly Shire Council's policy and strategy onsite wastewater management. Development Controls for the Study Area should also include the following: • Exclusion of Grass Swales and/or Biorention Swales that are designed to treat stormwater runoff from effluent irrigation areas from the buffer distance requirements of Wollondilly Shire Council's policy and strategy for onsite wastewater management. The basis for this recommendation is that these devices may be required treat stormwater runoff and form part of the treatment chain to treat stormwater runoff from effluent disposal areas. • All permanent ponds and dams installed as part of the Water Quality Infrastructure should be located at least 40 metres from the proposed effluent irrigation area – as Wollondilly Shire Council's current requirements; and • A surface water diversion device should be installed up-slope of all effluent disposal areas and designed to divert surface waters around effluent disposal area/s.	Local Environmental Plan (LEP) 2011. • To comply with the principles of the WMA 2000. • To demonstrate compliance with Sections 2.6.2, 2.6.5 and 2.6.6 of the Wollondilly Development Control Plan (DCP) 2011.	runoff from effluent irrigation areas.
Core Riparian Zones and Vegetative Buffers.	Unless otherwise directed as part of consultation with NOW and the NSW DOFA all CRZs and VBZs should be as per Table 15.	• To demonstrate compliance with the requirement of Wollondilly Local Environmental Plan (LEP) 2011. • To demonstrate compliance with the requirements of the Wollondilly	The NSW Office of Water (NOW) and the NSW Department of Fisheries and Aquaculture (DOFA) should be consulted as part of the re-zoning process with regard to the proposed Core Riparian Zones (CRZs) and Vegetated Buffer

Aspect	Recommended Development Control/s	Basis for recommendation	Comments
		Development Control Plan (DCP) 2011. • To demonstrate compliance with the requirements of the Fisheries Management Act (1994). • To demonstrate compliance with the requirements of the Fisheries Management Act (1994). • To demonstrate compliance with the requirements of the Water Management Act (2000).	Zones (VBZs).
Stream Crossings and works within 40 metres of the high bank of a Watercourse.	Unless otherwise directed as part of the consultation process with NOW and NDoF&A, all stream crossings are to undertaken in accordance with the documents entitled: • 'Policy and guidelines. Aquatic Management and Fish Conservation guidelines' dated 1999; and • 'Policy and guidelines for fish friendly water crossings' (undated). Prior to undertaking any works a 'Controlled Activities Approval' is to be sought under the *Water Management Act 2000* and if necessary, the relevant Fisheries Permit/s.	• To demonstrate compliance with the requirements of the Fisheries Management Act (1994). • To demonstrate compliance with the requirements of the Water Management Act (2000).	The NSW Office of Water and the NSW Department of Fisheries and Aquaculture should be consulted as part of the re-zoning process. It is noted that NOW may issue an exemption under Section 400 of the Water Management Act to the requirement of seeking CAA's for future Development Applications.
Wollondilly LEP (2011) and DCP (2011)	N/A	N/A	The Wollondilly LEP (2011) and DCP (2011) should be reviewed in the context of this Study. It is noted that the existing plans in the Wollondilly LEP and DCP (2011) are do not depict 1st Order watercourses within the Study Area.
Developer Contributions	Life Cycle Analysis should be undertaken on any Water Quality Infrastructure that is	The location of Water Quality Infrastructure cannot be determined at the	

Aspect	Recommended Development Control/s	Basis for recommendation	Comments
	proposed for land that is to be transferred to Council's ownership post sub-division. Developer contributions should then be paid based upon the results.	re-zoning stage for the Study Area.	

5.8 Water Quality Management Needs that Development Contributions should address

Council would reasonably seek developer contributions for any infrastructure that was installed on public lands as a consequence of any proposed development. Developer contributions would typically be required for the following WSUD infrastructure located on Public land, viz:

- Stormwater detention/retention basins;
- Systems of stormwater quality management, such as trash racks etc; and
- A reticulated stormwater collection system.

In the case of the Study Area however, it is not known if the above features will be installed on public land (within the Study Area) as the detailed development features are not currently known.

Should development contributions be sought for developments located within the Study Area, such contributions would need to be determined by undertaking a life cycle analysis of the proposed infrastructure that is proposed. Such infrastructure requirements would be limited to grass swales and/or biorention swales associated with the drainage systems on adjacent public roads as most of the other WSUD infrastructure will capable of being including on private land.

However, it is the view of this Study that determining what these contributions might be at the rezoning stage is not practicable or feasible. Issues regarding developer contributions should be determined at the time of a subdivision proposal and treated on its merits.

6.0 LIMITATIONS OF THIS STUDY

This Study has been prepared subject to a number of limitations. These include:

- The application of conditions of approval or impacts of unanticipated future events could modify the outcomes described in this document. In particular, the occurrence of earthquakes of any magnitude, extreme rainfall events or the effects of climate change 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;
- The findings contained in this Study 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;
- In preparing this Study, Harvest Scientific Services Pty Ltd has relied upon certain verbal information and documentation provided by the client and/or third parties. Harvest Scientific Services Pty Ltd did not attempt to independently verify the accuracy or completeness of that information. To the extent that the conclusions and recommendations in this Study are based in whole or in part on such information, they are contingent on its validity. Harvest Scientific Services Pty Ltd 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 Pty Ltd; and

- This Study is not to be relied upon for any purpose other than that defined in this Study.

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.

7.0 SPECIALIST STUDY REQUIREMENTS AND LOCATION WHERE REQUIREMENT IS ADDRESSED

Tables 19A, 19B and 19C provides a summary of the Study and identifies how each of the guidelines have been met.

Table 19A: Satisfaction of Guidelines - Output

Output	**How and Where Guidelines addressed**
A report prepared by a suitably qualified and experienced consultant incorporating the onsite wastewater feasibility of the development site in terms of land capability and an integrated water quality management plan that details measures to be adopted for the waste water management systems and future stormwater management systems. This assessment must include:	This document.
A description and analysis of the potential effluent management and treatment units to be used on site.	Section 4.
A description of the management requirements necessary for the use of an effluent disposal area.'	Section 4.

Table 19B: Satisfaction of Guidelines - Objectives

Objectives	**How and Where Guidelines addressed**
To assess the onsite wastewater feasibility of the site based on soils and geotechnical constraints;	Section 4.
To provide information on the management requirements of an effluent disposal area, with the appropriate guideline and any additional requirements;	Section 4.
To prepare an integrated water quality management plan for the Study Area.	Section 5.
To recommend the most suitable effluent treatment system to be used on the site, as well as including information about other possible units.	Section 4.
To provide information regarding nutrient loading and water balance calculations based on the Environment and Health Protection Guidelines 1998.	Section 4.

To recommended actions and strategies to ameliorate potential negative impacts on the receiving waters.'	Section 5.
To identify water quality management needs that developer contributions and/or development works may address.	Section 5.
To incorporate the principles of Water Sensitive Urban Design and Managing Urban Stormwater as outlined in OEH's General Guidelines for Strategic Planning.	Section 5.

Table 19C: Satisfaction of Guidelines - Objectives

Tasks/Methodology	**How and Where Guidelines addressed**
'Desk top' review of available information including soil profile mapping;	Section 2.
Conduct a site assessment including sampling of soils in locations suitable for wastewater irrigation;	Section 4.
Obtain water samples from study site drainage and samples from the nearby Stonequarry Creek as well as sample stormwater runoff from an adjoining site that has been developed with R5 large lots;	Section 2.5.4.
Laboratory assessment of samples;	Section 2.5.4 Section 4.
Recommend minimum subsurface and surface spray irrigation area requirements;	Section 4.7.2.
Recommend maximum slopes, minimum setbacks for dwellings, residential infrastructure and other sensitive land uses and natural features to irrigation areas;	Section 4.8.1
Document and map the nature of the existing catchments identifying natural drainage systems (permanent and intermittent) and man-made drainage systems from existing topographic mapping supplied by the proponent.	Section 2.5
Summarise Government endorsed objectives and strategies for water quality and catchment management pertaining to the proposed development.	Section 3.
Identify riparian enhancement activities and their role in stormwater treatment and design in this regard the principles contain in the publication, Water Sensitive Urban Design should be incorporated into the report.	Section 5.
Develop a water balance equation for the Study Area incorporating wastewater, stormwater that optimises reuse and minimises potable use.'	Section 5.6

8.0 STUDY CONCLUSIONS

Based on the findings of this Study it was found that in the context of the existing legislative framework that applies to the Study Area, the re-zoning of the Study Area for the proposed rural/residential land-use will not result adversely on stormwater quality within Stonequarry Creek and/or more generally the broader Hawkesbury-Nepean river system.

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

Prepared by:

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Principal Environmental Scientist

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PLATES

PLATE 1 Relatively flat grazing land

PLATE 2 Side-slope grazing land

PLATE 3 Steep side-slope grazing land

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 View of 1st Order Watercourse located centrally within the Study Area

PLATE 13 View of 3rd Order Watercourse at sampling location 201368-SW02 – Figure 4

PLATE 14 View of Stonequarry Creek at sampling location 201368-SW01 – Figure 4

PLATE 15 View of Stonequarry Creek at sampling location 201368-SW03 – Figure 4

APPENDIX 1

ALS Group

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES1303670**	Page	: 1 of 3
Client	: **HARVEST SCIENTIFIC SERVICES**	Laboratory	: Environmental Division Sydney
Contact	: MR JIM CUPITT	Contact	: Client Services
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Project	: WATER SAMPLES-COC-201368-SW-180213	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 18-FEB-2013
Sampler	: JC	Issue Date	: 25-FEB-2013
Site	: ABBOTSFORD		
		No. of samples received	: 4
Quote number	: SY/050/05 V2	No. of samples analysed	: 4

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Hoa Nguyen	Senior Inorganic Chemist	Sydney Inorganics
Tony De Souza	Senior Microbiologist	Sydney Microbiology

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **Microbiological Comment: Membrane filtration (MF) results for MW006 and MW023 are reported as approximate (~) when the growth of bacteria on the filter membrane is counted <10cfu and/or >100cfu.**
- **Microbiological Comment: Membrane filtration results for MW006 for No. 1 are reported as approximate (~) due to the presence of many non-target organism colonies that may have inhibited the growth of the target organisms on the filter membrane. It may be informative to record this fact.**
- **MW006 is ALS's internal code and is equivalent to AS4276.7.**
- **MW023 is ALS's internal code and is equivalent to AS4276.9.**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	201368-SW01	201368-SW02	201368-SW03	201368-SW4	----
			Client sampling date / time	15-FEB-2013 15:00	15-FEB-2013 15:00	15-FEB-2013 15:00	15-FEB-2013 15:00	----
Compound	CAS Number	LOR	Unit	ES1303670-001	ES1303670-002	ES1303670-003	ES1303670-004	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.36	7.56	7.76	7.23	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	453	800	596	205	----
EA025: Suspended Solids								
Suspended Solids (SS)	----	5	mg/L	<5	5	<5	29	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.02	0.06	0.11	0.10	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	0.06	3.66	5.47	5.61	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.4	1.8	2.8	3.6	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	0.5	5.5	8.3	9.2	----
EK067FG: Filtered Total Phosphorus as P by Discrete Analyser								
Filtered Total Phosphorus as P	----	0.01	mg/L	0.02	0.02	0.03	0.59	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	0.04	0.46	0.21	0.70	----
Microbiological parameters								
Enterococci	----	1	CFU/100mL	34	32	140	~10	----
MW006: Faecal Coliforms & E.coli by MF								
Faecal Coliforms	----	1	CFU/100mL	~88	~200	~200	~400	----

APPENDIX 2

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.	Digga ✓	Logged
		15	Gemco	S.W.
PROJECT			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	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			F ✓ M ✓ 35%			

MINOR MATERIAL	1 Some	1 Trace	2 Some	2 Trace	3 Some	3 Trace	4 Some	4 Trace	5 Some	5 Trace	6 Some	6 Trace
Gravel												
Sand												
Silt												
Clay												

COLOUR	1	2	3	4	5	6
Brown			✓			
Red-Brown						
Yellow-Brown						
Grey	✓	light	✓			
White						
Black						
Other						

	1	2	3	4	5	6
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 Primary (F - M - C)	F, M	F, M				
Grain Size Second (F - M - C)			F, M	F, 13.30%		

MINOR MATERIAL	1 Some	1 Trace	2 Some	2 Trace	3 Some	3 Trace	4 Some	4 Trace	5 Some	5 Trace	6 Some	6 Trace
Gravel												
Sand												
Silt												
Clay												

COLOUR	1	2	3	4	5	6
Brown	light ✓	✓	✓ DARK			
Red-Brown						
Yellow-Brown				✓		
Grey				✓		
White						
Black						
Other						

	1	2	3	4	5	6
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	LARGE					
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																														

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

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	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 Second		✓ ✓ 20%	✓ 25%			
MINOR MATERIAL Gravel (Some / Trace)			IRON ✓			
Sand			STONE			
Silt						
Clay						
COLOUR Brown	✓	✓				
Red-Brown			✓			
Yellow-Brown			✓			
Grey			light ✓			
White						
Black						
Other						
MOISTURE CONTENT (W < pl > D)	D ✓	✓	✓			
RELATIVE DENSITY (VL L MD D VD)						
CONSISTENCY (VS S F St Vst)		Vst ✓	Vst ✓ ✓			
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.	Digga	✓	Logged
		18	Gemco		S.F.W.
PROJECT			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	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				
PLASTICITY (L - M - H)		M ✓				
GRANULAR MATERIAL Grading (Poor Gap Well)						
Grain Size (F - M - C) Primary	F ✓ M ✓					
Grain Size Second		✓ ✓ 325%				
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 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																														

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CLIENT		Job No.	Borehole No. 19	Digga ✓	Logged S.F.L.W
PROJECT				Gemco	
				Fox	Date
		Lot No. —	R.L. E/S	Hand Auger	22/04/13

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 (F - M - C) Primary	F, M	F, M				
Grain Size Second			F - M, 3-25%			
MINOR MATERIAL Some			IRON STONE GRAVEL			
MINOR MATERIAL Trace						
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)		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	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

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**

Effluent Subdivison Profile

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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

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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

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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	**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

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Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
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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	**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

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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	**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

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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	**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

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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		
Approx. Clay Content (%):	25 - 35%		
Potential infiltration rate:	Moderate		
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

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Effluent Subdivison Profile

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	**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

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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
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 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

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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

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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 meq%	SOLUBLE Comment	EXCHANGEABLE meq%	EXCHANGEABLE % of ECEC	EXCHANGEABLE 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	**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 (%):	20 - 30%	> 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

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Effluent Subdivison Profile

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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

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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

Effluent Subdivison Profile

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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		
Approx. Clay Content (%):	40 - 55%		
Potential infiltration rate:	Very 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

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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

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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

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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	**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 (%):	35 - 40%	> 2mm	Gravel
Potential infiltration rate:	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

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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		EXCHANGEABLE		
	meq%	Comment	meq%	% of ECEC	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

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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 meq%	SOLUBLE Comment	EXCHANGEABLE meq%	EXCHANGEABLE % of ECEC	EXCHANGEABLE 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

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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	**Particle Size Analysis (PSA)**	
Approx. Clay Content (%):	40 - 50%	> 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

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Effluent Subdivison Profile

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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	**Particle Size Analysis (PSA)**	
Approx. Clay Content (%):	35 - 40%	> 2mm	Gravel
Potential infiltration rate:	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

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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

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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	**Particle Size Analysis (PSA)**	
Approx. Clay Content (%):	35 - 40%	> 2mm	Gravel
Potential infiltration rate:	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

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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	**Particle Size Analysis (PSA)**	
Approx. Clay Content (%):	35 - 45%	> 2mm	Gravel
Potential infiltration rate:	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

Corrosion & Scaling Assessment:
Soil Reporting Profile

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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.m	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

Corrosion & Scaling Assessment:
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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**	Description:	**Soil**
	NARELLAN NSW 2567	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

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Corrosion & Scaling Assessment:

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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.m	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

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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

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Corrosion & Scaling Assessment:

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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

Corrosion & Scaling Assessment:
Soil Reporting Profile

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

Client Name: **Harvest Scientific Services**
Client Contact: **Jim Cupitt**
Client Job N°:
Client Order N°:
Address: **PO Box 427 NARELLAN NSW 2567**

Project Name: **REF: 201368**
Location:
SESL Quote N°:
Sample Name: **201368-09 (1000-1200)**
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.[illegible]	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:

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Corrosion & Scaling Assessment:
Soil Reporting Profile

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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:
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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:
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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.m	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:
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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.	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

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Corrosion & Scaling Assessment:
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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

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Corrosion & Scaling Assessment:

Soil Reporting Profile

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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

Corrosion & Scaling Assessment:
Soil Reporting Profile

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

Client Name: **Harvest Scientific Services**
Client Contact: **Jim Cupitt**
Client Job N°:
Client Order N°:
Address: **PO Box 427 NARELLAN NSW 2567**

Project Name: **REF: 201368**
Location:
SESL Quote N°:
Sample Name: **201368-13 (0-300)**
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.m	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

Corrosion & Scaling Assessment:
Soil Reporting Profile

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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.m	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

Corrosion & Scaling Assessment:

Soil Reporting Profile

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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

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Corrosion & Scaling Assessment:
Soil Reporting Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
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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; **Resistivity,** AS1289.4.4.1:1997,

Consultant:
Chris Fraser

Authorised Signatory:
Ryan Jacka

Date of Report:
08/02/2013

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Corrosion & Scaling Assessment:
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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.m	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:
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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.m	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

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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

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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.

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:
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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.□	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

Corrosion & Scaling Assessment:
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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

Corrosion & Scaling Assessment:

Soil Reporting Profile

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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.m	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:
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Corrosion & Scaling Assessment:
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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

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Corrosion & Scaling Assessment:
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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,

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Date of Report: 08/02/2013

APPENDIX 4

Determination of minimum effluent irrigation area required based on nutrient loadings
Location : PICTON

Nitrogen loadings

*Parameters

Q (wastewater flow rate L/day)	=	1160
Lx (critical loading rate mg/m^2/d)	=	25
C (conc. Of N in treated wastewater mg/L)	=	20

EIA required based on nitrogen loadings is **928** square metres.

Phosphorous loadings

*Parameters

Phosphate Retention Index (PRI) (g P/kg)	=	0.382
Critical loading rate of phosphate (mg/m^2/day)	=	3
Conc. of phosphate in treated wastewater (mg/L)	=	12
Wastewater flow rate L/day	=	1160

Results

Phosphorous sorption capacity=	5730	kg/ha
Phosphate adsorbed	0.1909809	kg/m^2
Phosphate uptake	0.055	kg/m^2
Phosphate generated	254.04	kg

EIA required based on phosphorous loadings is **1034** square metres.

* Calculations based on formula detailed in the Environment and Health Protection Guidelines 1998.

APPENDIX 5

WATER BALANCE

IRRIGATION AREA DETERMINATION BASED ON THE NOMINATED AREA METHOD

(formula derived from the Environment & Health Protection Guidelines 1998)

Location : Picton

Rainfall Station	Picton Council Depot	50th Percentile	(BOM, 2008)
Evaporation Station	Camden Airport	Mean	(QDPI, 1999)

Design Wastewater Flow	Q	l/day	1160
Design percolation	R	mm/wk	15
Land Area	L	m^2	**517**

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Totals
Days in Month	D	-	days	31	28	31	30	31	30	31	31	30	31	30	31	365
Precipitation*	P	-	mm/month	68.8	66.4	68.3	47.3	31.8	34.8	26	25.1	37.1	49.8	55.5	53.2	564.1
Evaporation~	E	-	mm/month	217	176.4	151.9	114	86.8	75	80.6	96.1	120	145.7	180	232.5	1676
Crop Factor	C	ET/E		0.78	0.75	0.78	0.67	0.56	0.50	0.49	0.58	0.66	0.85	0.81	0.68	

Inputs

Precipitation	P	-	mm/month	68.8	66.4	68.3	47.3	31.8	34.8	26	25.1	37.1	49.8	55.5	53.2	564.1
Effluent Irrigation	W	(Q x D)/L	mm/month	69.5	62.8	69.5	67.3	69.5	67.3	69.5	69.5	67.3	69.5	67.3	69.5	818.6
Inputs	I	P + W	mm/month	138.3	129.2	137.8	114.6	101.3	102.1	95.5	94.6	104.4	119.3	122.8	122.7	1382.7

Outputs

Evapotranspiration (APET)^	ET	-	mm/month	169.6	131.6	118.6	75.9	48.5	37.8	39.5	55.5	78.8	123.2	145.8	158.6	1183.4
Percolation	B	R/7 x D	mm/month	66.4	60.0	66.4	64.3	66.4	64.3	66.4	66.4	64.3	66.4	64.3	66.4	782.1
Outputs	O	ET + B	mm/month	236.0	191.6	185.0	140.2	114.9	102.1	105.9	121.9	143.1	189.6	210.1	225.0	1965.5

Storage	S	I - O	mm/month	-97.7	-62.4	-47.2	-25.6	-13.6	0.0	-10.4	-27.3	-38.7	-70.3	-87.3	-102.3	**-**
				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Cum Storage	M	-	mm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-

STORAGE	V	M(max)		0.0

* Precipitation and evaporation data was obtained from the BOM website and QDPIs Rainman program, respectively

^ Areal potential evapotranspiration (APET) data was obtained from the Climatic Atlas of Australia: Evapotranspiration 2003 CD-ROM