LEGEND

1. Hunter Water supply
2. Potable water storage
3. Potable water distribution
4. Wyee Development (new)
5. Top-up to recycled water storage
6. Chlorine dosing

QUALITY CONTROL POINTS (QCP) FOR WATER QUALITY

POTABLE WATER STORAGE (2)
- Free chlorine
- pH

POTABLE WATER DISTRIBUTION (3)
- Turbidity
- Pressure

CRITICAL CONTROL POINTS (CCP) FOR WATER QUALITY

HUNTER WATER SUPPLY (1)
- Turbidity
- Ph
- Free chlorine

Location of QCP

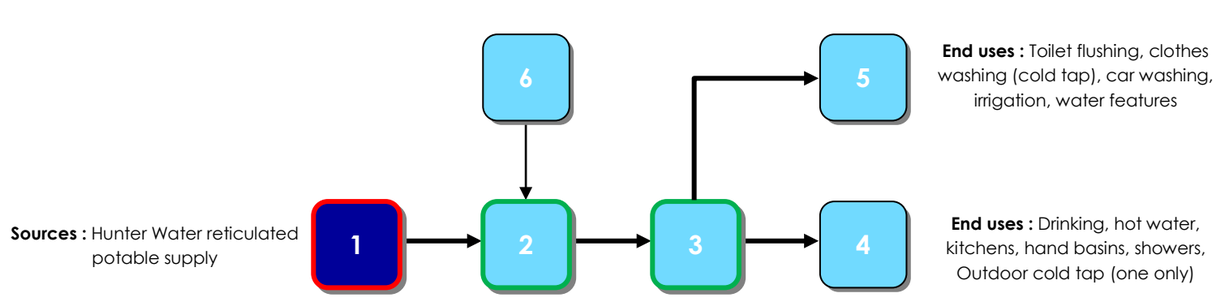
Location of CCP

New infrastructure

Existing infrastructure

Major flow

Minor flow



NOTE
The infrastructure detailed herein will be constructed in stages to match the needs of the development. More information on staging can be found on the layout drawings.

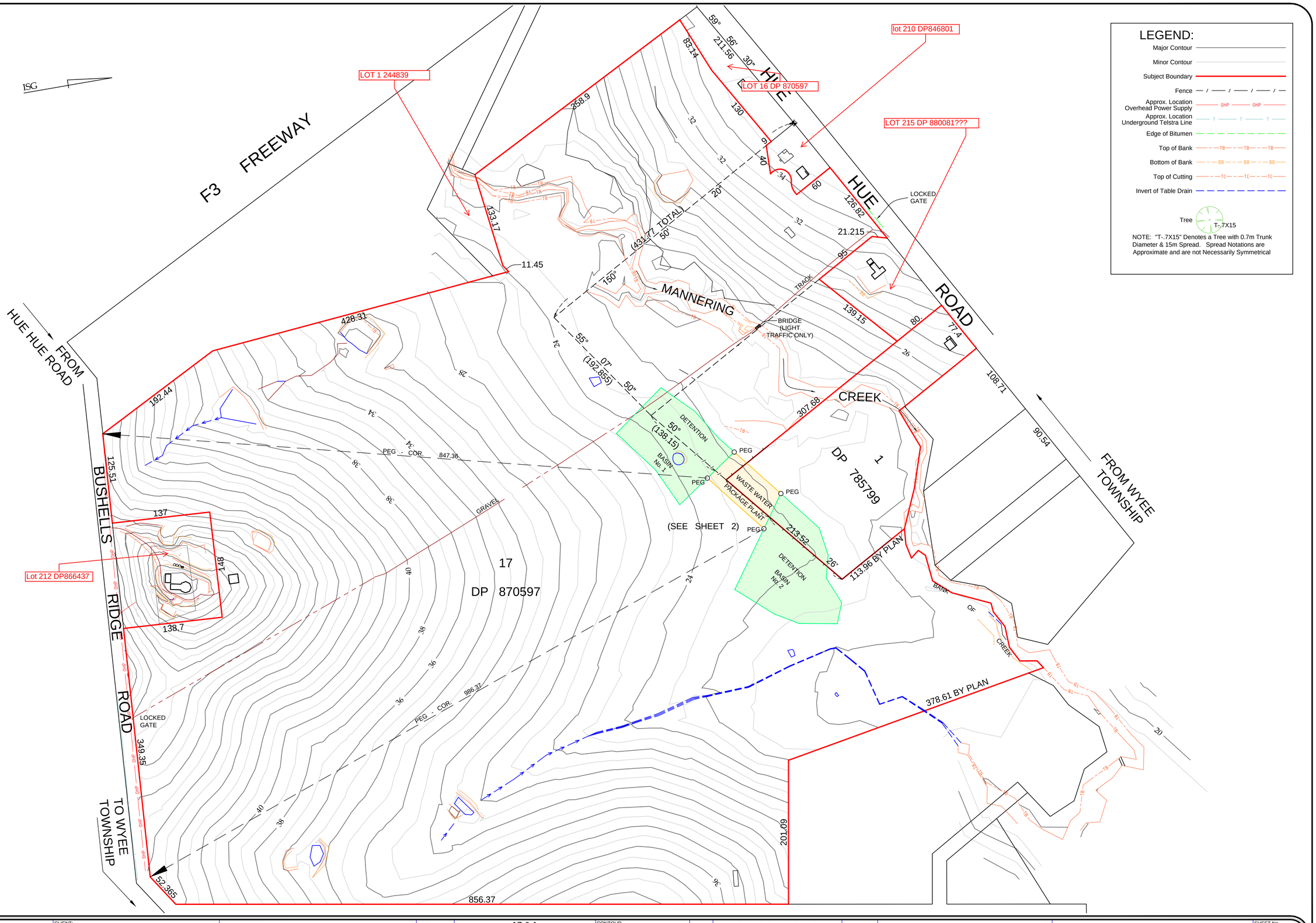
PERMEATE PARTNERS
E : info@permeate.com.au
SYDNEY : (02) 4368 6732
BRISBANE : (07) 3878 1536
W : www.permeate.com.au
MELBOURNE : (03) 8753 1317
PERTH : (08) 9404 8417

No.	Date	Drafter	Design	Mgmt	Amendment
B	260313	KRD			For information
A	220313	KRD			For information

CLIENT
Wyee Water
A local sustainable water utility

Name :	Wyee Water			
Project :	Wyee Development			
Design	Date	Drafting	Date	
KRD	260313			

Title :	Potable Water Process Flow Diagram	
Scale NTS	Permeate Project # C12079	Permeate Drawing # C12079-201
Sheet A3	Client Project # TBA	Client Drawing # TBA



AUTHORISED OFFICER

THIS PLAN TO BE READ IN CONJUNCTION WITH CBH REPORT WITH REFERENCE: 2012204

DRAWING No: DW12204

CLIENT: EG Property Group

DATE OF SURVEY: 30/10/2012

DATE DRAWN: 01/11/2012

REF: 2012204

SURVEY FILE: 12-204MG

0 25 50 100 150 200 250

REDUCTION RATIO 1:2500 @ A1 & 1:5000 @ A3

SURVEYED BY: P HUTCHEON & E HARVEY

DRAWN BY: I FEENEY

CHECKED BY: P HUTCHEON

LOT No.	17 & 1
SECTION	–
PLAN No.	DP 870597 & DP 785799
SUBURB	WYEE
LGA	WYONG
PARISH	–
COUNTY	NORTHUMBERLAND

CONTOUR INTERVAL: 2.0 m

DATUM: AHD
AUSTRALIAN HEIGHT DATUM

ORIGIN OF LEVELS: -

R.L.: -

REV.	REVISION DETAILS	DATE
-	-	-

SURVEYING & LAND DEVELOPMENT CONSULTANTS
12 WINANI ROAD
ERINA N.S.W. 2250
Ph: (02) 4367 7334
Fax: (02) 4365 2996
www.cbhsurvey.com.au

CHASE BURKE HARVEY

Plan Showing Features, Levels & Contours Over Sites of Proposed Wastewater Package Plant and Detention Basins 1 & 2 on Lot 17 DP 870597 and Lot 1 DP 785799 Hue Hue Road, WYEE

SHEET No. 1

No. of SHEETS: 2

DRAWING No: DW12204

REV: -

LEGEND:

- Major Contour
- Minor Contour
- Subject Boundary
- Fence
- Approx. Location Overhead Power Supply (OHP)
- Approx. Location Underground Telstra Line (T)
- Edge of Bitumen
- Top of Bank (TB)
- Bottom of Bank (BB)
- Top of Cutting (TC)
- Invert of Table Drain
- Tree — T-.7X15

NOTE: "T-.7X15" Denotes a Tree with 0.7m Trunk Diameter & 15m Spread. Spread Notations are Approximate and are not Necessarily Symmetrical

1

DP 785799

17

DP 870597

BRIDGE (LIGHT TRAFFIC ONLY)

TRACK

MANNERING CREEK

ISC

SURVEY RECOVERY RL 21.36

SURVEY RECOVERY RL 21.08

SURVEY RECOVERY RL 23.03

PEG RL 21.72

PEG RL 21.57

PEG RL 22.56

PEG RL 23.10

FENCE

WIRE

POST

GRAVEL

WASTEWATER PACKAGE PLANT

DETENTION BASIN No. 1

DETENTION BASIN No. 2

DAM

NS-STAKE

T-.4X8

T-.8X10

T-.5X10

T-.2X4

GIN Lid 4.75

28' 87.135 45"

51° 52.30 20"

47'

26' (79.97)

NS-STAKE (20.06)

50° 118.09

106.135 40' 10"

231° (15.225) 325°

235° 07' (192.855)

50"

125° 54.62

27 (18.065) 55"

00" (133.55)

SURVEYING & LAND DEVELOPMENT CONSULTANTS
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AUTHORISED OFFICER

THIS PLAN TO BE READ IN CONJUNCTION WITH CBH REPORT WITH REFERENCE: 2012204

DRAWING No: DW12204

CLIENT: EG Property Group

DATE OF SURVEY: 30/10/2012

DATE DRAWN: 01/11/2012

REF: 2012204

SURVEY FILE: 12-204MG

0 6 12 24 36 48 60

REDUCTION RATIO 1:600 @ A1 & 1:1200 @ A3

SURVEYED BY: P HUTCHEON & E HARVEY

DRAWN BY: I FEENEY

CHECKED BY: P HUTCHEON

LOT No.	17 & 1
SECTION	—
PLAN No.	DP 870597 & DP 785799
SUBURB	WYEE
LGA	WYONG
PARISH	—
COUNTY	NORTHUMBERLAND

CONTOUR INTERVAL: O.25 m

DATUM: AHD

AUSTRALIAN HEIGHT DATUM

ORIGIN OF LEVELS: -

R.L.: -

REV.	REVISION DETAILS	DATE
-	-	-

Plan Showing Features, Levels & Contours Over Sites of Proposed Wastewater Package Plant and Detention Basins 1 & 2 on Lot 17 DP 870597 and Lot 1 DP 785799 Hue Hue Road, WYEE

SHEET No. 2

No. of SHEETS: 2

DRAWING No: DW12204

REV: -

Water Futures
t-cAM Consulting

Independent Pricing and Regulatory Tribunal

Water Industry Competition Act 2006

Network Operator's Licence Audit Report
(initial (pre-commercial operation) stage audit)

Licence No. 10_014: Pitt Town Water Factory Pty Ltd, Pitt Town, Sydney, NSW
(also known as the Pitt Town Scheme)

Pitt Town Water Factory Pty Ltd (ACN 141 705660)

Final Report
30th May 2012

t-cAM Consulting. ABN 76559967228. 15 Kim Marie Mew, Moriac 3240. 0412 540 187. t-cam@bemail.com.au
Water Futures Pty Ltd. ABN 97109956961. PO Box 212, Killara 2071. 0409 283 737. dan@waterfutures.net.au

Table of Contents

1 Executive Summary

The purpose of this audit was to assess the adequacy of licence plans in meeting the requirements of the legislation. This infrastructure subject to audit was the Pitt Town Water Factory Pty Ltd (PTWF) Pitt Town Recycled Water Scheme (the Scheme). The scope of this audit was the operation and maintenance of the Scheme which is operated under a WICA Network Operator's Licence. Under the Licence, PTWF must have the licence plans audited by an auditor approved by IPART. The audit was an initial (pre-commercial operation) stage audit of the adequacy of the plans and not a compliance audit.

The auditors referenced the requirements of the audit deed poll and noted the *IPART Audit Guideline Water Industry Competition Act 2006 Water – Guidelines Revision 4 (February 2012)* in conducting the audit, determining audit findings and preparing the report. However, since the audit was started, and the field audit took place, during November 2011, this audit report does not fully reflect the 2012 guidance, even though the report has been issued post the issue of the later guidance. This report fully addresses the *IPART Audit Guideline Water Licence Audits Revision 2 (September 2009)* and partly addresses some aspects of the later guidance. This audit report should not be considered to constitute a document that complies with the later guidance and should not be used as a template or an example by other auditors or Licence Holders that are being audited against the more recent guidance.

The auditors were provided with sufficient and appropriate evidence, as described in *IPART Audit Guideline Water Industry Competition Act 2006 Water – Guidelines Revision 4 (February 2012)* on which to base their conclusions. The audit report findings accurately reflect the professional opinion of the auditors.

The audit report findings have not been unduly influenced by the licence holder nor any of its associates and expresses the auditors' opinions as to whether the licence holder has met the licence conditions and regulatory requirements as specified in the scope.

The audited infrastructure complied with the audited requirements of the Regulation and licence conditions, and was found to be capable of operating safely and in accordance with its Infrastructure Operating Plan (IOP), Water Quality Plan (WQP) and Sewage Management Plan (SMP) and other aspects of the licence and regulations. The licence holder audited (PTWF) was found to be operating the infrastructure in compliance with the audit criteria.

In the opinion of the auditors, the licence holder can commence commercial operation for the safe and reliable supply of fit-for-purpose water. There need be no hesitation in approving the commercial operation of the assets operated under this WICA licence.

The audit finding for a number of the assessed criteria was Adequate rather than Fully Adequate. In addition, some opportunities for improvement were identified against criteria that were assessed as Fully Adequate. However, there were no non-compliances or inadequacies that presented an immediate, significant risk to public health and safety, the environment, customer relations, operations, financial viability or scheme reliability.

The detailed audit findings are presented against the relevant criteria in five attachments, as follows:

- Attachment 1. Infrastructure Operating Plan
- Attachment 2. Water Quality Plan
- Attachment 3. Sewage Management Plan
- Attachment 4. Network Operator's Licence
- Attachment 5. Water Industry Competition (General) Regulation 2008

2 Introduction

2.1 Objectives

The purpose of this audit was to assess the adequacy of licence plans in meeting the requirements of the legislation.

2.2 Licensee's infrastructure, systems and procedures

This infrastructure subject to audit was the Pitt Town Water Factory Company Pty Ltd (PTWF) Pitt Town Recycled Water Scheme (the Scheme). There were three plans that were audited, as follows:

- The Infrastructure Operating Plan (IOP) (for both the Sewerage System and the Recycled Water Treatment Plant).
- The Water Quality Plan (WQP).
- The Sewage Management Plan (SMP).

2.3 Audit method

2.3.1 Audit scope

The scope of this audit was the operation and maintenance of the Scheme which is operated under a WICA Network Operator's Licence. Under the Licence, PTWF must have the licence plans audited by an auditor approved by IPART. The audit was an initial (pre-commercial operation) stage audit of the adequacy of the plans and not a compliance audit. The criteria for the audit for are defined under the *IPART Audit Guideline Water Licence Audits Revision 2 (September 2009)* and some aspects of the *IPART Audit Guideline Water Industry Competition Act 2006 Water – Guidelines Revision 4 (February 2012)*.

2.3.2 Audit standard

The audit approach followed standard audit guidance as set out in, for instance, ISO 19011:2011 Guidelines for auditing management systems.

The auditor and IPART recognise that some information (such as documented reactive maintenance events and performance history) was not be available as the plant and systems are not all operational. Where such exceptions to data availability exist, IPART have advised they will be practical and realistic and the auditor will be reviewing from a system, process and practice perspective. However, where there was no reasonable justification for such omissions (such as the licensee not having installed the asset concerned at the time of audit), then this would likely result in an adverse audit finding.

Audits are by necessity limited to sampling processes. It is not practicable, nor necessary, to inspect 100% of items within an audit scope. Auditing forms part of the broader risk management process by providing an independent check on the veracity of the processes and procedures in place to manage risk. Finding a balance between audit effort and practicality requires the exercise of experienced professional judgement. The amount of effort allocated to this audit has been kept to a reasonable minimum and is summarised in Table 1. More detailed sub-plans are given in following sections of this document.

2.3.3 Audit steps

The audit steps are indicated in Table 1. The field audit, involving interviews on site, took place on Wednesday 23rd November 2011. The detailed audit agenda are given in Tables 2 to 4.

The audit templates used during the audit are attached and form the audit report template. The focus was on substantiating claims and references in the plans and verifying that the plans can and are being operationalised. Where appropriate, the auditors randomly sampled examples sufficient to verify claims made by the licensee.

Quality was assured using a professional review process. Components of the audit report were reviewed by another Panel Member. Specifically, aspects of Dr Deere's work were reviewed and approved by Mr Carpenter, and vice versa.

2.3.3.1 Infrastructure Operating Plan audit

Purpose: Verify that the Infrastructure Operating Plan (IOP) was complete and capable of ensuring effective operation of the infrastructure to meet customer level of service and related regulatory compliance requirements.

Nature of Audit: Initial (pre-commercial operation) audit of the adequacy of the Infrastructure Operating Plan in accordance with the requirements of Schedule 1 clause 6 (1) and/or clause 13 (1) of the *Water Industry Competition (General) Regulation 2008*.

Category to be Assessed: Infrastructure Performance.

Audit activities: The site audit focused on assessing the degree of conformity between the as-built system and the descriptions of the system as given in the IOP. In order to test the IOP the auditor reviewed the following referenced systems, processes and practices (as appropriate to the Section of the Plan):

- Policies.
- Strategies.
- Plans.
- Life cycle analyses.
- Processes and Practices.
- Data and Knowledge Management Systems.
- Data and Knowledge.
- Maintenance and Operation Strategies and associated implementation via Work Instructions and Work Orders for Predictive and Preventive Maintenance and Condition Monitoring Activities.
- Contingency and Business Continuity Planning.
- Skills, Training and Resourcing Plans and Records linked to Asset Maintenance and Operational Strategies and Level of Service Specifications.

2.3.3.2 Water Quality Plan audit

Purpose: Verify that the Water Quality Plan (WQP) was complete and capable of ensuring that water quality objectives are consistently achieved so that water is fit-for-purpose, and that recycled water is not used for purposes other than those intended and for which it is fit.

Nature of Audit: Initial (pre-commercial operation) audit of the adequacy of the Water Quality Plan in accordance with the requirements of Schedule 1 clause 7 (1) of the *Water Industry Competition (General) Regulation 2008*.

Category to be Assessed: Water Quality.

Audit activities: The site audit focused on assessing the degree of conformity between the as-built system and the descriptions of the system as given in the WQP. In order to test the WQP the auditor reviewed the following referenced systems, processes and practices (as appropriate to the Section of the Plan):

- Recycled Water Quality Policy (or other policy/ies covering this aspect).
- System description, including water quality process flow diagram, water quality process description and review of historical water quality data.
- Water quality risk assessment – process adopted and results of assessment.

- Water quality risk management including preventive measures, critical control points, target criteria and critical limits.
- Process control procedures relevant to water quality management including operation, maintenance, calibration, monitoring and response.
- Verification of recycled water quality including laboratory analysis and response to customer complaints and enquiries.
- Recycled water quality incident response plans including notifying customers in the event of recycled water not necessarily being fit-for-purpose.
- Training, awareness and competency systems for operators related to water quality.
- Customer communication protocols related to recycled water quality and use.
- Validation of process controls and systems.
- Supporting documentation, reporting, review and audit, including audit of customers to ensure conformity to intended use restrictions.

2.3.3.3 Sewage Management Plan audit

Purpose: Verify that the Sewage Management Plan (SMP) was complete and capable of ensuring effective management of sewage, involving its conveyance, treatment and disposal, in a manner that meets health, ecological and waste disposal requirements.

Nature of Audit: Initial (pre-commercial operation) audit of the adequacy of the Sewage Management Plan in accordance with the requirements of Schedule 1 clause 14 of the *Water Industry Competition (General) Regulation 2008*.

Category to be Assessed: Sewage Management.

Audit activities: The site audits focused on assessing the degree of conformity between the as-built system and the descriptions of the system as given in the SMPs. In order to test the SMP the auditor reviewed the following referenced systems, processes and practices (as appropriate to the Section of the Plan):

Policy and context:

- Licence conditions issued under the POEO Act 1997 relevant to sewage management (Schedule 1, Clause 14(2)).
- Sewage Management policies and strategies.
- Programs of activities to fully implement the plan, including regular reviews for adequacy and proposed improvement.
- Contingency and Business Continuity Planning, including additional preventative measures where improvements are required.

Waste and site characterisation:

- Processes and Practices of waste characterisation of the sources, characterisation of receiving environment including precursor EIS commitments and approval conditions.
- Flow diagram of the sewage system.

Hazard and risk assessment/management:

- Health assessment including identification of hazardous sources and risk assessment (i.e. events for each component, probability of occurrence of events and measure to prevent occurrences or minimise impacts, and provision of alternate sewerage services, as well as complaints and bad debt recovery procedures).

- Ecological assessment and risk assessment characteristics and sensitivity of receive environment).

Data, monitoring and sampling:

- Data, sampling and knowledge of key characteristics (including performance history) of the sewerage system.

Communications and training:

- Communication strategies with government agencies and the community.
- Skills, Training and Resourcing Plans and Records linked to Asset Maintenance and Operational Strategies and Level of Service Specifications.

Table 1. Approximate time allocated to audit (days) – overall combined audit plan.

Task	Description	Infrastructure Operation Plan and related criteria	Water Quality Plan and related criteria	Sewage Management Plan and related criteria
1	Program and project management of the job in accordance with IPART WICA Auditing Guidelines	0.1	0.1	0.1
2	Plan review, questionnaire and audit preparation	1.5	0.5	0.5
3	Interviews and on site audit assessment against guidelines	1.5	1	0.5
4	Audit gap analysis	1.5	0.5	0.5
5	Prepare draft report	0.2	0.2	0.1
6	IPART/stakeholder/licensee liaison on draft	0.1	0.1	0.1
7	Final report	0.2	0.2	0.1
	Total days	5.1	2.6	1.9

Table 2. Desktop audit agenda of IOP and site visit. Wednesday 23rd November 2011.

Timing	Item	Location
08:00 to 08:15	On site inception meeting	Pitt Town
08:15 to 09:45	Site inspection	Pitt Town
09:45 to 10:45	Travel to Head Office	
10:45 to 11:00	Functional design/process briefing (contextualisation for following agenda items)	Sydney Head Office
11:00 to 11:15	Briefing on Corporate Quality Management and Knowledge Management Frameworks (contextualisation for following agenda items)	Sydney Head Office
11:15 to 11:30	Briefing and demonstration of asset hierarchy, data structures and data in asset management and maintenance management systems	Sydney Head Office
11:30 to 12:15	Provision of details of operational analysis including development of LoS specifications, performance criteria and performance monitoring framework.	Sydney Head Office
12:15 to 12:45	Lunch	Sydney Head Office
12:45 to 13:30	Provision of details of risk assessment processes and practices and application to the facility.	Sydney Head Office
13:30 to 13:45	Review of condition monitoring regime and monitoring and control systems.	Sydney Head Office
13:45 to 14:00	Review Contingency and Business Continuity Planning	Sydney Head Office
14:00 to 14:15	Life cycle planning and forecasting. Demonstration and review of application to the facility.	Sydney Head Office
14:15 to 14:45	Review of maintenance strategy, tactics, processes and practices and supporting systems.	Sydney Head Office
14:45 to 16:30	Review of operational structures, allocation of responsibilities, resourcing arrangements including contracted support services, provision of spare parts and logistics.	Sydney Head Office
16:30 to 17:00	Close out meeting including follow up of any issues identified and preliminary findings	Sydney Head Office

Table 3. Desktop audit agenda of WQP and site visit. Wednesday 23rd November 2011.

Timing	Item	Location
08:00 to 08:15	On site inception meeting	Pitt Town
08:15 to 09:45	Site inspection	Pitt Town
09:45 to 10:45	Travel to Head Office	
10:45 to 11:00	Desktop assessment of the risk assessment and CCP identification process.	Sydney head office
11:00 to 11:15	Review of validation	Sydney head office
11:15 to 11:30	Detailed assessment of nominated Critical Control Points including location of sampling lines for monitoring instruments, SCADA settings, calibration SOPs and records, operational SOPs, monitoring SOPs and corrective action SOPs.	Sydney head office
11:30 to 11:45	Desktop assessment of communication procedures and protocols for recycled water quality incidents including training and awareness of those procedures. Desktop assessment of communication and reporting both under routine and incident conditions.	Sydney head office
11:45 to 12:00	Desktop assessment of water quality monitoring and reporting systems including SCADA systems, quality assurance of data, both on line and laboratory acquired (e.g. laboratory test procedure accreditation and on line instrument calibration).	Sydney head office
12:00 to 12:15	Review of material and chemical receipt, storage and quality control facilities and procedures.	Sydney head office
12:15 to 12:45	Lunch	Sydney head office
12:45 to 16:30	No activity (auditor undertaking SMP audit)	
16:30 to 17:00	Close out meeting including follow up of any issues identified and preliminary findings	Sydney Head Office

Table 4. Desktop audit agenda and site audit of SMP. Wednesday 23rd November 2011.

Timing	Item	Location
08:00 to 08:15	On site inception meeting	Pitt Town
08:15 to 09:45	Site inspection	Pitt Town
09:45 to 10:45	Travel to Head Office	
10:45 to 12:45	No activity (auditor undertaking WQP audit)	
12:45 to 13:30	Policy and Context of the SMP: As detailed under Audit template: Sewage Management Plan (SMP): 'Policy and Context'.	Sydney head office
13:30 to 13:45	Waste and Site Characterisation As detailed under Audit template: Sewage Management Plan (SMP): Waste and Site Characterisation i.e. 2009 guidance paragraphs Number 1-4.	Sydney head office
13:45 to 14:00	Hazard and Risk Assessment/Management As detailed under Audit template: Sewage Management Plan (SMP): Hazard and Risk Assessment/Management i.e. 2009 guidance paragraphs Number 5-10 and 16.	Sydney head office
14:00 to 14:45	Data Monitoring and Sampling As detailed under Audit template: Sewage Management Plan (SMP): Data Monitoring and Sampling i.e. 2009 guidance paragraphs Number 11-15.	Sydney head office
14:45 to 16:30	Communications and Training: As detailed under Audit template: Sewage Management Plan (SMP): Communications and Training i.e. 2009 guidance paragraphs Number 17-18.	Sydney head office
16:30 to 17:00	Close out meeting including follow up of any issues identified and preliminary findings.	Sydney Head Office

2.3.4 Audit team

The Licence Holder (auditee) was Pitt Town Water Factory Pty Ltd (ACN 141 705660) (PTWF). For efficiency, all criteria were audited together using a combined auditing approach. This document sets out the detailed audit report against the audit criteria. The two auditors that conducted the audits were as follows:

- The Water Quality Plan and Sewage Management Plan auditor is Dr Dan Deere: Lead Auditor and Technical Professional, Water Quality and Sewage Management, Water Licensing and Technical Services Panel, Independent Pricing and Regulatory Tribunal, NSW Government.
- The Infrastructure Operating Plan Auditor is Tom Carpenter: Lead Auditor, Infrastructure Performance, Water Licensing and Technical Services Panel, Independent Pricing and Regulatory Tribunal, NSW Government.

2.3.5 Audit grades

The audit was graded as described in Table 2.3 of the IPART Audit Guideline Water Industry Competition Act 2006 Water – Guidelines Revision 4 (February 2012). Briefly, the audit grades are defined as shown in Table 5.

Table 5. Audit grades used in this audit.

Grades of adequacy or compliance	Description
Fully Adequate	Sufficient evidence to confirm that the requirements have been fully met.
Adequate	Sufficient evidence to confirm that the requirements have generally been met apart from a minor shortcoming which does not compromise the ability of the utility to achieve defined objectives or assure controlled processes, products or outcomes. For example: the inadequacy is administrative in nature; or the potential impact of the inadequacy is not likely to present a risk to public health, the environment and/or level of service if not rectified.
Inadequate	Sufficient evidence has **not** been provided to confirm that all major requirements are being met and the deficiency adversely impacts on the ability of the utility to achieve defined objectives or assure controlled processes, products or outcomes
No Requirement	The requirement to comply with the licence condition does not occur within the audit period or there is no requirement for the licensee to meet this assessment criterion.

2.4 Regulatory regime

The scheme operates under the *Water Industry Competition Act 2006* (WICA) which in turn calls up the following requirements:

- WICA Licence conditions of Network Operator's Licence No. 10_ 014 signed 11th November 2010.
- *Water Industry Competition (General) Regulation (2008).*
- Relevant aspects of the national *Australian Guidelines for Water Recycling (Phase 1) Managing Health and Environmental Risks (2006).*
- *IPART Audit Guideline Water Licence Audits Revision 2 (September 2009)* and latterly the *IPART Audit Guideline Water Industry Competition Act 2006 Water – Guidelines Revision 4 (February 2012).*

2.5 Reporting

The audit findings are presented against the relevant criteria in five attachments, as follows:

- Attachment 1. Infrastructure Operating Plan.
- Attachment 2. Water Quality Plan.
- Attachment 3. Sewage Management Plan.
- Attachment 4. Network Operator's Licence.
- Attachment 5. Water Industry Competition (General) Regulation 2008.

Attachment 1. Detailed Audit Findings: Infrastructure Operating Plan (IOP) WIC Reg Sched 1 cl.6(1) and cl.13(1)

Document reference	Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl.6(1)(a) and/or cl.13(1)(a)	The IOP indicates the arrangements in relation to the design, construction, operation and maintenance of the infrastructure, including particulars as to the life-span of the infrastructure, the system redundancy built into the infrastructure and the arrangements for renewal of the infrastructure.	The IOP includes a detailed asset register. As a minimum the asset register will include: ▾ A list of all assets ▾ Basic physical data (material, size, age) ▾ Relative locations of major infrastructure ▾ Capacities of infrastructure (eg, pumps, reservoirs, etc) – where applicable current and ultimate ▾ Location of secondary, alternative sources and/or infrastructure	**Comments:** PTWF has prepared asset registers in excel (as noted below) in anticipation of uploading it in to a suitable database/management program (MainPlan) within six months of operation. All assets are identified in P&ID's. Base data collected is sufficient to form the basis of a full asset register and management system. Collection and supply system registers are PTWF assets. The GE treatment plant asset register is mirrored in the PTWF register. Asset operation, location and operating characteristics documented. **Documentary evidence:** PTWF-MP-InfOP-0203-111004120308.pdf Section 2 SCH-004 Equipment Schedule Pitt Town Revl to Peter G.XLS SCH-003 Valve Schedule Pitt Town Revl to Peter G.XLS SCH-001 Instrument Schedule Pitt Town Revl to Peter G.XLS PTWF-MP-MAINPLAN Asset register-02-111128.xls Pitt Town_PIDs31MAR11-235528-P All.pdf	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • Demonstrate confirmation of acquisition and implementation of MainPlan as part of the operating audit.

Document reference	Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl.6(1)(a) and/or cl.13(1)(a) (continued…)	The IOP indicates the arrangements in relation to the design, construction, operation and maintenance of the infrastructure, including particulars as to the life-span of the infrastructure, the system redundancy built into the infrastructure and the arrangements for renewal of the infrastructure (continued…)	The IOP includes an operational analysis of the assets to meet present and future needs. Outputs from the operational analysis include a schedule of required capital works for asset renewal, replacement and development.	**Comments:** PTWF has fully documented the operational requirements and capacity needs for the sewage services, and recycled water treatment and distribution, including staged development and full development capacities and required assets. **Documentary evidence:** PTWF-MP-InfOP-0203-111004120308.pdf Section 2 PTWF - MP-RWSMP-0304-111129120308.pdf	☑ Fully Adequate
		The IOP includes details of the: ▾ System operating rules to operate the infrastructure in the most effective manner during normal and breakdown conditions ▾ Performance requirements for assets.	**Comments:** Operating rules are defined and performance requirements of assets documented. Also documents operation under failure conditions. **Documentary evidence:** PTWF-MP-InfOP-0203-111004120308.pdf Section 3 PTWF - MP-RWSMP-0304-111129120308.pdfPTWF-PR-Ancillary functional description-01-110803.pdf 45000002231-REP-001 Pitt Town MBR Control Philosophy RevB.pdf 3464814_OSC_Pitt Town_RevB.xls 3464814_CLSC_Pitt Town_RevB.xls	☑ Fully Adequate

Document reference	Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl.6(1)(b) and/or cl.13(1)(b)	The continued safe and reliable performance of the infrastructure	The IOP outlines the performance criteria and levels of service for the assets. These criteria are consistent with statutory obligations (if any) and there is a clearly defined process for documenting performance.	**Comments:** Performance of treatment plant and reticulation systems are monitored via instrumentation linked to SCADA/telemetry systems. Performance criteria are documented and monitored for critical control points and for operational performance management of equipment. Performance management of asset maintenance will be logged and reported via the MMS (MainPlan). **Documentary evidence:** PTWF-MP-InfOP-03-120308.pdf PTWF - MP-RWSMP-04-120308.pdf	☑ Fully Adequate

Document reference	Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl.6(1)(b) and/or cl.13(1)(b) (continued…)	The continued safe and reliable performance of the infrastructure (continued…)	The IOP includes an asset condition and risk assessment which is regularly updated and includes:: ▼ Asset condition; ▼ Asset criticality; and ▼ Asset assessment.	**Comments:** Asset criticality and assessment have been incorporated in to the initial risk assessment evaluation. Instrumentation and monitoring equipment are covered by a maintenance program. Their performance is specified in the IOP to be monitored every month and independent 3rd party calibration is proposed every 6 months. Pressure sewer units are telemetry monitored for fault or failure. Scheduling within the MMS could not be verified as the MMS is not yet operational. For the treatment plant itself, two manuals were provided, an early example from a similar plant at Gordon in the city's north and the full Pitt town manual as well. The manuals are comprehensive in particular with regard to the preventive maintenance tasks and inspections. The documentation includes reference to updating and maintenance of the risk register and definitionof a period for formal review of plans in the circumstance that an event trigger has not occurred. **Documentary evidence:** PTWF-MP-InfOP-03-120308.pdf Gordon Golf Course O&M Manual_0 (EXAMPLE).pdf Pitt Town WF RWTP O&M Manual_A.PDF	☑ Fully Adequate OFIs to further improve Fully Adequate findings: • Provide evidence of the scheduling and reporting applied against schedule as part of the first operational audit.

Document reference	Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl.6(1)(b) and/or cl.13(1)(b) (continued…)	The continued safe and reliable performance of the infrastructure (continued…)	The IOP documents, or includes reference to documents, that outline the operation and maintenance policies, procedures and schedules for all key infrastructure.	**Comments:** The IOP and RWSMP contain extensive cross-referencing to support documentation, though some of those related to asset management/maintenance are statements of intent with provision of examples. **Documentary evidence:** PTWF-MP-InfOP-03-120308.pdf PTWF - MP-RWSMP-04-120308PTWF.pdf GE Gordon Golf Course O&M Manual Pitt Town WF RWTP O&M Manual_A.PDF	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • As part of the first operational audit, demonstrate verification of the suite of required documentation and explain the final amendments made due to experience gained during commissioning.

Document reference	Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl.6(1)(b) and/or cl.13(1)(b) (continued…)	The continued safe and reliable performance of the infrastructure (continued…)	The relevant operation and maintenance policies and procedures are available at all facilities, personnel are trained in the procedures and training is kept current where appropriate.	**Comments:** List of SOP's to be developed/provided RWSMP Section 5. IOP documents monitoring and maintenance principles (Sections 3 & 4) Extensive suite of SOP's provided. Documented evidence was provided of training courses available and statements of training intention were made. **Documentary evidence:** PTWF-MP-InfOP-03-120308.pdf GE O&M Manual and training documentation WFC-PR-Rectic Response Procedure-01-111010.pdf PTWF - MP-RWSMP-03-111129.pdf Section 5. Pitt Town WF RWTP O&M Manual_A.PDF Training course details and support documentation.pdf FSR Training Courses 2011-10 (CG).pdf NSW Team Training Summary Report.pdf CV Kevin Loughran.pdf CV William Kennedy.pdf SOP's	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • Demonstrate ongoing maintenance of training for personnel. • Demonstrate completion of full suite of completed (and maintenance of) SOP's.

Document reference	Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl.6(1)(b) and/or cl.13(1)(b) (continued…)	The continued safe and reliable performance of the infrastructure (continued…)	The operation and maintenance procedures contain sufficient information to address the complexity, criticality, condition and age of the infrastructure.	**Comments:** Review of the IOP, RWSMP, O&M Manual, SOP's and emergency plans indicates that sufficient information will be in place. **Documentary evidence:** PTWF-MP-InfOP-03-120308.pdf GE O&M Manual and training documentation PTWF - MP-RWSMP-04-120308.pdf Section 5. SOP's PTWF-MP-IncER-04-120308.pdf	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • Demonstrate completion and ongoing maintenance of all important procedures.

Document reference	Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl.6(1)(b) and/or cl.13(1)(b) (continued…)	The continued safe and reliable performance of the infrastructure (continued…)	The maintenance procedures are linked to asset life cycle optimisation, safe and reliable performance of the infrastructure, service criticality and business risk and outline appropriate blends of: ▾ Reactive maintenance ▾ Preventive maintenance ▾ Predictive maintenance.	**Comments:** A review of the documentation provided indicated appropriate blends of reactive, preventive and predicative maintenance according to asset type and criticality. **Documentary evidence:** PTWF-MP-InfOP-03-120308.pdf GE O&M Manual and training documentation WFC-PR-Rectic Response Procedure-01-111010.pdf PTWF - MP-RWSMP-04-120308.pdf Section 5. Maintenance and Calibration Assessment form (303.APACWWPT.001.001).pdf Maintenance and Calibration Induction form (303.APACWWPT.001.002J.pdf Procedure on use of the Maintenance and Calibration Induction form (303 APACWWPT 001).pdf SERV-0001 Membrane Care, Handling and Storage Procedure _2553972.pdf SOP 0006 Ammonia testing procedure.pdf PTWF-MP-IncER-04-120308.pdf	☑ Fully Adequate

Document reference	Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl.6(1)(b) and/or cl.13(1)(b) (continued…)	The continued safe and reliable performance of the infrastructure (continued…)	The infrastructure investment/capital works requirements identified in the IOP are based on sound strategic service planning including: ▾ Required levels of service (including future growth in customer base and/or demand and documented performance targets). ▾ Security of supply or service provisions (including inherent reliability, redundancy, alternative sources of supply or service, emergency management and business continuity). ▾ Whole of life cycle cost evaluation.	**Comments:** The plans clearly link customer growth/demand and levels of service to capital requirements. Security of supply is adequately addressed. A whole of life cycle cost evaluation has been carried out and implemented. The estimated lives of assets, in particular elements of the buildings, are on the upper limit of an acceptable range and the auditor is of the opinion that there is no margin for error. However, it is possible that, with conscientious maintenance and renewal, they could be achieved. **Documentary evidence:** PTWF-MP-InfOP-03-120308.pdf PTWF - MP-RWSMP-04-120308.pdf Detailed life cycle costing sheets (Confidential)	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • Critically evaluate the estimated lives of assets, in particular elements of the buildings, against the proposed approach to maintenance and renewal.
		The IOP specifies future (life-cycle) expenditures based on forecast expenditure for: ▾ Capital (new and replacement) ▾ Operations ▾ Maintenance ▾ Management and Administration.	**Comments:** A detailed life cycle analysis has been prepared incorporating identified costs including renewal and replacement and leasing. The estimated effective lives are generous as noted in the previous audit element. **Documentary evidence:** PTWF-MP-InfOP-03-120308.pdf	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • Refer above audit element.

Document reference	Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl.6(1)(b) and/or cl.13(1)(b) (continued…)	The continued safe and reliable performance of the infrastructure (continued…)	The assignment of responsibility, to appropriate management and staff, is clearly articulated for the IOP implementation and on going management, (including prioritising and programming).	**Comments:** The senior and operations management are documented. Contracts exist for the operation and maintenance of the treatment plant and reticulation systems. Business contact list for service providers documented though contacts for day to day contract management are not nominated/specified in either GE or Mono-NOV contracts. The distribution system maintenance provider (Mono Pumps (Australia) Pty Ltd [Mono-NOV]) contract notes use of a sub-contractor for telemetry/SCADA maintenance. The performance requirements/scope are not attached to the contract. The GE contract refers to a Performance Guarantee to meet a specification 'the Proposal' that is not attached to the contract. **Documentary evidence:** PTWF-MP-InfOP-03-120308.pdf PTWF-MP-CLIST-03-111125.xlsx	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • Confirm that the GE Performance Guarantee explicitly relates to a specified, and not an implied, Proposal.
		A review process is in place to ensure that the IOP and associated procedures are kept current	**Comments:** Documented update procedures are in place, as is an ISO 9001 compliant management system. **Documentary evidence:** PTWF-MP-InfOP-03-120308 PTWF - MP-RWSMP-04-120308.pdf	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • Confirm that the reviews are conducted as scheduled or required in practice, not merely proposed.

Document reference	Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl.6(1)(c) and/or cl.13(1)(c)	The continuity of the water supply	Operational and maintenance procedures address both normal and abnormal (incident and emergency) conditions. The likelihood and consequences of asset failure are predicted. Other requirements included in the guidance above.	**Comments:** To the extent that the information available is incomplete (O&M Manual and SOP's) required operational and maintenance procedures are identified. Completed SOP's adequately address the conditions and failure events identified. The range of abnormal events identified is reflective of the operations of the business and the emergency plans adequate. **Documentary evidence:** PTWF-MP-InfOP-03-120308 PTWF - MP-RWSMP-04-120308.pdf PTWF-MP-IncER-04-120308.pdf PTWF-MP-RASMT-02-110917.pdf PTWF-MP-RVIEW-01-110707.pdf	☑ Fully Adequate OFIs to further improve Fully Adequate findings: • Provide evidence for confirmation of completeness and maintenance of SOP's as part of the first operational audit.

Document reference	Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl.6(1)(d) and/or cl.13(1)(d)	Alternative water supplies when the infrastructure is inoperable	Requirements included in the guidance above.	**Comments:** Alternative supplies of source water are identified and operable, including provision of potable water supplies. Telemetry and SCADA configuration is such that faster response to reticulation service failures are possible than with current public systems. **Documentary evidence:** PTWF-MP-InfOP-03-120308.pdf PTWF - MP-RWSMP-04-120308.pdf PTWF-MP-IncER-04-120308.pdf	☑ Fully Adequate

Document reference	Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl.6(1)(e) and/or cl.13(1)(e)	The IOP indicates the arrangements in relation to the maintenance, monitoring and reporting of standards of service	An appropriate quality/performance management system is outlined for monitoring and implementing the IOP, and the system is documented.	**Comments:** The RWSMP and IOP provide detailed documentation of the standards of service and monitoring for critical control. **Documentary evidence:** PTWF - MP-RWSMP-04-120308.pdf PTWF-MP-InfOP-03-120308.pdf	☑ Fully Adequate
		The sophistication of the monitoring and control systems is proportional to the complexity of the scheme. The monitoring and control systems, where relevant, provide information on: ▾ Leakage assessment and reduction ▾ Energy management ▾ Security of facilities ▾ Overflow events ▾ Flows and/or demands ▾ Warning of potential problems ▾ Internal performance indicators ▾ Regulatory performance indicators.	**Comments:** The monitoring systems are sophisticated and extensive, particularly in the distribution system. The level and detail is in excess of that currently provided to gravity sewerage service customers elsewhere. Future proofing has been ensured by the inclusion of electronic monitoring cable runs from the front yard meters to the house utility meter boxes. Not all performance (particularly internal) monitoring could be reviewed as many of the SCADA, telemetry and dashboard reporting screens and reports had not yet been developed. The process designs control narratives and descriptions do, however, document the requirements for internal and regulatory monitoring operation and reporting to a satisfactory level. **Documentary evidence:** PTWF - MP-RWSMP-04-120308.pdf PTWF-MP-InfOP-03-120308.pdf	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • Confirm full operational implementation of the intended monitoring and control systems and review as part of the first operational audit.

Document reference	Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl.6(1)(e) and/or cl.13(1)(e) (continued…)	The IOP indicates the arrangements in relation to the maintenance, monitoring and reporting of standards of service (continued…)	The IOP documents the process for keeping records and reporting on operational and maintenance matters.	**Comments:** These processes are documented in the IOP and in the RWSMP. The proposed recording of maintenance activities and performance via the MainPlan MMS and other records via the ISO 9001-compliant business systems. Evidence of ISO 9001 QA compliance certificate provided. **Recommendation:** Confirm reviews are conducted as scheduled, required. **Documentary evidence:** PTWF - MP-RWSMP-04-120308.pdf PTWF-MP-InfOP-03-120308.pdf	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • Confirm that the reviews are conducted as scheduled or required in practice, not merely proposed.

Attachment 2. Detailed Audit Findings: Water Quality Plan (non-potable water) (WQP (npw)) WIC Reg Sched 1 cl.7(1)(b)

Requirement to be evaluated	Guidance	Evidence / comments	Assessment Finding
Element one The WQP (npw) shows a commitment to responsible use and management of recycled water quality.	The organisation has a recycled water quality policy endorsed by the senior executive. The policy has been communicated in such a way that it is easily understood and implemented by employees.	Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 Appendix A provides a copy of PTWF's Recycled Water Policy (WFC-PO-Recycled Water-01-110930), highlighting the commitment to responsible, safe and sustainable use of recycled water. Awareness of the policy was evidence. The policy is Fully Adequate and fully compliant with good practice.	☑ Fully Adequate
Element one (continued…)	The organisation has identified and documented its regulatory and formal requirements. The responsibilities for managing regulatory requirements are allocated and communicated to the appropriate employees. The organisation has a documented process for reviewing and updating the regulatory and formal requirements.	The summary of regulatory and formal requirements given on page 11 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 is just Adequate. However, a table similar Table (2) should be produced to properly set out the details of the requirements and demonstrate how they are met. The information will be reviewed and updated as part of an annual audit, review and update process (Section 12.1).	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • Develop a table analogous to Table (2) for Regulatory and Formal requirements.

Requirement to be evaluated	Guidance	Evidence / comments	Assessment Finding
Element one (continued…)	The organisation has employed suitable expertise for the design, management and regulation of the recycled water system. The organisation has a documented process for identifying and involving governmental agencies with responsibilities and expertise in protection of public health and the environment. The organisation has a documented process for identifying relevant stakeholders (government and public). The organisation has appropriate processes and practices in place to ensure stakeholders are engaged and all stakeholder activities and outcomes are documented. The process ensures that stakeholder responsibilities are identified and understood. There is a process in place to ensure the stakeholder list is regularly updated.	The expertise engaged for the design, management and regulation of the recycled water system is adequate and of sufficient depth to be Fully Adequate. Section 2.1 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 provides a comprehensive summary of the project stakeholders and their roles. The summary includes governmental agencies. The summary is Fully Adequate and compliant with good practice. An OFI would be to include key contact details in Table (2). The information will be reviewed and updated as part of an annual audit, review and update process (Section 12.1).	☑ Fully Adequate OFIs to further improve Fully Adequate findings: • Include key contact details in Table (2) of the RWSMP.

Requirement to be evaluated	Guidance	Evidence / comments	Assessment Finding
Element two The WQP (npw) includes an analysis of the recycled water system	The WQP (npw) clearly identifies the source(s) of the water. The intended end uses, routes of exposure, receiving environments, endpoints and effects are identified in the WQP (npw). Unintended and unauthorised end uses are identified and considered in the WQP (npw). The WQP (npw) documents pertinent information and key characteristics of the recycled water system consistent with the complexity of the system. The organisation assembled a team of people with appropriate knowledge and expertise on the recycled water system (from source to end use) to undertake the analysis of the system. There a verified flow diagram of the recycled water system from source to the application or receiving environment. There is a documented process to periodically review the recycled water system analysis.	Section 3.5 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 clearly summarises pertinent information regarding the system from source to point and nature of use and is Fully Adequate. Section 3.1 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 summarises the system assessment team. The risk assessment team was Adequate but was not Fully Adequate since specific, independent public health expertise was lacking, either through using suitable consultants and/or government, e.g. NSW Health, involvement. However, subsequent to the initial assessment, NSW Health was involved in reviewing and commenting on the draft risk assessment, bringing up the compliance to Fully Adequate. Appendices C and D of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 show the process flow diagrams and P&IDs and these are Fully Adequate. The diagrams were consistent with what was observed during the site audit. The diagrams go down to the level of the single lot (e.g. Pitt Town Pressure Sewer Masterplan Rev A Drawing S101. Illustrated the sewerage system to the level of the lot). The Observant Monitor Map system shows each property on a map which links to the telemetry system. The above items will be reviewed and updated as part of an annual audit, review and update process (Section 12.1).	☑ Fully Adequate

Requirement to be evaluated	Guidance	Evidence / comments	Assessment Finding
Element two (continued…)	The organisation has defined and documented the processes for the collection and retention of historical data about sewage, greywater or stormwater quality, as well as data from treatment plants and/or recycled water supplied to users (over time and following specific events). For brownfield schemes this data was used in the risk assessment. The organisation has documented the process for identifying, listing and examining exceedances. The organisation has processes in place for assessing data to identify trends and potential problems in the recycled water system.	Section 3.6 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 explains that water quality data from similar schemes was used in this case since data from the current scheme is not yet available. This is acceptable and, in the context, is Fully Adequate. Going forward, Permeate Partners have been contracted to provide monthly provide reports evaluating the trends of the key process parameters, which is Fully Adequate.	☑ Fully Adequate
Element two (continued…)	The organisation has developed and documented the approach and methodology to be used for hazard identification and risk assessment, considering both public and ecological health. The organisation has a documented process to periodically review and update the hazard identification and risk assessment to incorporate any changes. The organisation has identified and documented hazards, sources and hazardous events for each component of the recycled water system. The organisation has estimated the level of risk for each identified hazard or hazardous event. The major sources of uncertainty associated with each hazard and hazardous event have been evaluated and actions have been considered to reduce uncertainty. The organisation has determined the significant risks and established documented priorities for risk management. The organisation has developed a process for periodically reviewing and updating the hazard identification and risk assessment to incorporate any changes to the system.	Section 3 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 and Appendix E provide the risk assessment. This is Fully Adequate. Actions for further reducing risks have been summarised and are set in context. Both maximum and residual risks have been assessed to health and environmental endpoints against likelihood and consequence criteria. However, uncertainties have not been explicitly assessed. The above items will be reviewed and updated as part of an annual audit, review and update process (Section 12.1).	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • When revising the risk assessment, explicitly capture and action relevant uncertainties.

Requirement to be evaluated	Guidance	Evidence / comments	Assessment Finding
Element three The WQP (npw) outlines the preventive measures for water quality management.	The organisation has identified existing preventive measures from source to customer for each significant hazard or hazardous event and estimated the residual risk. The organisation has completed an evaluation of alternative or additional preventive measures where improvement is required. The organisation has documented the preventive measures and strategies for addressing each significant risk in a plan. The organisation has assessed the preventive measures throughout the recycled water system to identify the critical control points. The organisation has established mechanisms for operational control at critical control points. The organisation has documented the critical control points, critical limits and target criteria.	Sections 3 and 4 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 and Appendices E provide the summary of preventive measures, control points, critical control points and relevant target criteria. This is Fully Adequate. The documented information was consistent with what was observed during the field audit. The scheme includes a number of best practice elements. For instance, the scheme is targeting a pressure differential between recycled and potable water although PTWF don't yet control the drinking water pressure – Sydney Water does. In addition, PTWF is planning to use its smart metering system to detect cross-connections. Currently however PTWF read the sewer and recycled water meters, not the potable meters. The Observant Monitor Map system shows each property and indicates sewer pump recycled water use via the telemetry system. This smart telemetry to the individual lot water and sewer meters should help detect cross-connections if so monitored.	☑ Fully Adequate OFIs to further improve Fully Adequate findings: • Press ahead with pioneering attempts to utilise smart metering and pressure differentials to help prevent and detect cross-connections.

Requirement to be evaluated	Guidance	Evidence / comments	Assessment Finding
Element four The WQP (npw) outlines the operational procedures and process control for the scheme.	The organisation has developed a process for identifying operational procedures required for processes and activities from source to end use. All the identified procedures have been documented and compiled into an operations manual. The organisation has developed monitoring protocols for operational performance of the system, including the selection of operational parameters and criteria, and the routine analysis of results. The monitoring protocols have been documented and compiled into an operational monitoring plan. The organisation has established and documented procedures for corrective action where operational parameters are not met. The organisation has established rapid communication systems to deal with unexpected events. There are processes in place to ensure that equipment performs adequately and provides sufficient flexibility and process control. The organisation has developed a program for regular inspection and maintenance of all equipment, including monitoring equipment. There are processes and procedures in place to ensure that only approved materials and chemicals are used. The organisation has documented procedures for evaluating chemicals, materials and suppliers.	Sections 5 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 and Appendices F and G provide the summary of operational procedures. These are Adequate and in an appropriately final draft stage, given the current state of implementation of the project, prior to full operation. The documented information was consistent with what was observed during the field audit. Gaps between current and desirable levels of development were fully understood and openly acknowledged and are planned for improvement. Chemical and material suppliers were not specifically identified, although chemicals used were listed and requirements to comply with plumbing regulations were clearly set out. Since this is a non-potable water scheme, this gap is not critical, but nor is the situation Fully Adequate. In order to be Fully Adequate, chemical and material suppliers and specific chemical and material products to be used for the scheme should be explicitly listed, along with the process for ensuring quality This item was assessed in more detail in the IOP audit, above.	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • Finalise the relevant O&M information, as discussed in the IOP audit, above. • Finalise the list of chemical/material suppliers and products to be used for the scheme and the procedures for ensuring adequate quality of chemicals/materials delivered/installed.

Requirement to be evaluated	Guidance	Evidence / comments	Assessment Finding
Element five The WQP (npw) outlines the process for verification of the water quality.	The organisation has determined the characteristics to be monitored in the recycled water system, the application site and the receiving environment (as appropriate). A sampling plan for each characteristic has been established and documented, including the location and frequency of sampling. The monitoring data is representative and reliable. The procedures for sampling and testing are fully documented and staff are appropriately trained (where relevant) The organisation has established an inquiry and response program for users of the recycled water. The program includes the appropriate training of employees. The organisation has developed procedures for the short term review of monitoring data and satisfaction of users of recycled water. Internal and external reporting mechanisms have been developed and documented by the organisation. The organisation has established and documented procedures for corrective action in response to non-conformances or feedback from users of recycled water. The organisation has in place rapid communication systems to deal with unexpected events.	Verification of water quality and user satisfaction, as designed, is Fully Adequate and is cross-referenced to specific process controls, for instance under Section 5 and Appendix U of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 and detailed in Section 6 and Appendices F, I and O. Verification is well-embedded within the document and is well integrated. Going forward, Permeate Partners have been contracted to provide monthly review and reporting including evaluating the trends of the key verification and process parameters. The corrective action responses would rapidly escalate to an incident response which may involve unnecessarily involving NSW Health, NOW and IPART. It would be more elegant to have more detailed internal procedures to prevent the need to adopt an 'incident' response in most readily controlled situations. There is a discrepancy between Tables (5) and (6) of Appendix O (no mention of pathogens) and Section 6.1 of the RWSMP (mentions pathogens and indicators). The point of truth was assumed to be Appendix O, and the schedule therein is Fully Adequate, but the discrepancy between the documents leads to an Adequate finding and needs to be resolved. There were a number of other similar minor discrepancies between documents. At the time of the field audit this aspect was Inadequate due to the absence of an agreed position with NSW Health. However, it is understood that at the time of writing this report, NSW Health is content with the verification in place.	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • Clarify the discrepancy between Tables (5) and (6) of Appendix O and Section 6.1 of the RWSMP and seek to eliminate other discrepancies between documents. OFIs to further improve Fully Adequate findings: • Develop corrective action procedures that encourage the control of excursions detected as part of verification monitoring in house rather than proceeding directly to incident response model

Requirement to be evaluated	Guidance	Evidence / comments	Assessment Finding
Element six The WQP (npw) includes details on the management of incidents and emergencies.	Communication protocols have been developed with the relevant (regulatory) agencies defined and a contact list of key people, agencies and businesses (both internal and external). The organisation has developed a public and media communications strategy. Potential incidents and emergencies have been identified and procedures and response plans documented, with the involvement of relevant agencies. The plans reflect the events identified in the risk assessment. Employees are trained in emergency response procedures and the plans are tested as appropriate. The organisation has developed procedures for the investigation of incidents or emergencies. The procedures outline the process for reviewing incidents or emergencies and making any necessary amendments to protocols.	Section 7 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 and Appendices J and K, and to some extent H and I, provide a Fully Adequate process for incident response. A number of foreseeable incidents are described and have protocols developed and agreed with relevant third parties. The above items, including Appendix K (contact list) will be reviewed and updated as part of an annual audit, review and update process (Section 12.1). At the time of the field audit this aspect was Inadequate due to the absence of an agreed position with NSW Health. However, it is understood that at the time of writing this report, NSW Health is content with the incident response plan that is now in place.	☑ Fully Adequate
Element seven The WQP (npw) outlines operator, contractor and end user awareness and training requirements	The organisation has developed mechanisms and communication procedures to increase operator contractor and end user awareness of, and participation in managing recycled water quality and environmental protection. The organisation has a process in place for ensuring that employees, including contractors, and end users maintain the appropriate experience and qualifications. The organisation has developed a process for identifying employee training needs and there are appropriate resources available to support any training programs. There are processes and procedures for documenting training and maintaining records of all employees training.	Section 8 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 and Appendices L and V provide a Fully Adequate process for training management from the perspective of recycled water quality management. This item is discussed more broadly and in more detail under the IOP audit, above.	☑ Fully Adequate

Requirement to be evaluated	Guidance	Evidence / comments	Assessment Finding
Element eight The WQP (npw) outlines the process for community awareness and involvement.	The organisation as assessed the requirements for effective involvement of users of recycled water and the community. The organisation has developed a comprehensive strategy for community consultation. The organisation's communication strategy includes an active two-way communication program to inform users of recycled water and promote awareness of recycled water quality issues. The organisation has developed a process for providing information on unauthorised use as well as the benefits of recycled water to users and the community.	Section 9 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 and Appendices N and V provide a Fully Adequate process for community engagement and involvement from the perspective of recycled water quality management.	☑ Fully Adequate

Requirement to be evaluated	Guidance	Evidence / comments	Assessment Finding
Element nine The WQP (npw) outlines the validation, research and development processes for the scheme.	The organisation has developed validation processes and procedures to ensure that the system is effective at controlling hazards. The organisation has established processes and practices for periodical revalidation of processes when changes in conditions occur. The organisation has a process for validating the selection and design of new equipment and infrastructure to ensure continuing reliability. The organisation able to demonstrate a commitment to increasing their understanding of the recycled water system and to improving their management of the system.	Validation is Fully Adequate and is cross-referenced to specific process controls, for instance under Section 3.7.2, Table (8), Section 10 and Appendix O of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12. Validation is well-embedded within the document and is well integrated. Pathogen log reduction values are demonstrably, conservatively sufficient. Going forward, Permeate Partners have been contracted to provide monthly review and reporting including evaluating the trends of the key validated process critical limit parameters. At the time of the field audit this aspect was Inadequate. Most inadequacies were minor in nature and were addressed through minor operational monitoring changes. However, a major gap was the failure of the UV disinfection system supplier to attest to the pathogen log reduction capability of the UV disinfection system. This unfortunate event caused delays of approximately six months in scheme review and approval and supports. The experience with this scheme, (and some other schemes that hit the same difficulty), demonstrates the wisdom of the new IPART requirement for an early-state Technology Assessment. It is understood that at the time of writing this report, the auditor, NSW Health and IPART are no fully content that validation has been demonstrated.	☑ Fully Adequate

Requirement to be evaluated	Guidance	Evidence / comments	Assessment Finding
Element ten The WQP (npw) outlines the process management of documentation and records as well as the reporting requirements.	The organisation has a process for documenting information pertinent to all aspects of recycled water quality management. The organisation has an appropriate document control system to ensure current versions of key documents are in use. The organisation has established a records management system and ensures that employees are trained to fill out records. The organisation has developed a procedure or process to periodically review documentation and revise as necessary. The organisation has established procedures for effective internal and external reporting. The organisation has established processes and procedures for the production of an annual report aimed at the users of the recycled water, regulatory authorise and stakeholders.	Documentation and records and reporting is Fully Adequate and is described under Section 11 and Table (14) of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12. Going forward, Permeate Partners have been contracted to provide monthly review and reporting in addition to the annual PTWF reporting processes.	☑ Fully Adequate
Element eleven The WQP (npw) outlines the process for long-term evaluation of results and the audit of the documentation.	The organisation has established processes and practices for the collection and evaluation of long-term data to assess performance and identify problems. The organisation has established processes and practices for documenting and reporting results. The organisation has established protocols for internal and external auditing to be conducted. The organisation has a process for documenting and communicating audit results to relevant stakeholders.	Auditing and evaluation is Fully Adequate and is described under Section 12 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12. Internal/external audits are scheduled annually/triennially, respectively. Detailed scheme evaluation, review and update is scheduled annually. On an ongoing (monthly) basis, Permeate Partners have been contracted to provide monthly review and reporting of data, including trends analysis.	☑ Fully Adequate

Requirement to be evaluated	Guidance	Evidence / comments	Assessment Finding
Element twelve The WQP (npw) outlines a process for review and continual improvement.	The organisation has developed a process for senior executive to review the effectiveness of the management system and evaluate the need for change. Has the organisation has developed processes and procedures for the continual improvement of the plans and processes. There is a process for communicating and implementing the continual improvement actions. The improvement process is monitored for effectiveness.	Review and continual improvement is Fully Adequate and is described under Section 13 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12. The information given within Section 13 is very brief, but refers back to the detailed information that drives review and improvement, as noted above. Detailed scheme evaluation, review and update is scheduled annually. On an ongoing (monthly) basis, Permeate Partners have been contracted to provide monthly review and reporting of data, including trends analysis.	☑ Fully Adequate

Attachment 3. Detailed Audit Findings: Sewage Management Plan (SMP) WIC Reg Sched 1 cl.14(1)

Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
Licence conditions issued under the POEO Act 1997 relevant to sewage management (Schedule 1, Clause 14(2))	**Policy and Context:** Advise if any POEO license was issued and, if so, the conditions that relate to sewage system. Based on the POEO and or WICA Licences outline how these conditions are reflected in: • The sewerage management policies and strategies applied to the site? • The programs of activities to be implemented the SMP including regular reviews for adequacy and proposed improvement? • Contingency and Business Continuity Planning, including additional preventative measures where improvements are required?	At the time of the field audit this aspect was Inadequate due to the absence of an agreed position with OEH. Consultation did take place with OEH who indicated that an EPL was not required for this system (letter dated 28/8/11). However, in the opinion of the auditors, that correspondence required additional information from PTWF and closure was not achieved by the time of the field audit. However, it is understood that at the time of writing this report, OEH is content that there is no need for an EPL for this scheme (letter from OEH to PTWF dated 1st March 2012) so that this aspect is Fully Adequate. Spills of sewerage and recycled water, from any assets that carry these grades of water, are unlikely by design. OEH did not require an agreement in relation to these matters. At the time of the field audit, response procedures for such eventualities, rare as they may be, were Inadequate. However, at the time of writing, these revised procedures are Fully Adequate (Section 7 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 and Appendices J and K, and to some extent H and I).	☑ Fully Adequate

Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
The manner in which the health and ecological assessments will be undertaken and any concerns arising from any such assessment.	The organisation has developed and documented the approach and methodology to be used for the ecological and health assessment incorporating hazard identification and risk assessment. **Waste and Site Characterisation:** At a minimum the process includes: 1 The development of a verified flow diagram of the sewage system from source to the receiving environment (including reticulation, treatment, disposal and by-product streams). 2 The process for waste characterisation of the source of the sewage 3 Identification and characterisation of the proposed site and the receiving environment (i.e. the sensitivity of the receiving environment) both for intended and unintended discharges. 4 Identification of pertinent information and key characteristics of the sewerage system consistent with the complexity of the system.	Section 3.5 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 clearly summarises pertinent information regarding the system from source to point and nature of use and is Fully Adequate. Section 3.6 explains how a conservative approach was adopted in estimating source water characteristics. Since the scheme is not yet operational, it is quite appropriate to estimate, rather than measure, source water characteristics, and this approach is and is Fully Adequate. This approach is appropriate given that the source is likely to be fairly 'typical' sewage effluent. Sections 3.5 and 3.8, as well as the risk assessment, adequately discuss environmental risks associated with the use of the water. There is no detailed land capability assessment but the nature of this scheme (nature of the water quality and the receiving environment) is considered too low risk to require such an assessment. In the opinion of this auditor, the level of assessment is Fully Adequate for this context but an opportunity for improvement exists to review receiving environment capability in more depth. Appendices C and D of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 show the process flow diagrams and P&IDs and these are Fully Adequate. The diagrams were consistent with what was observed during the site audit. The diagrams go down to the level of the single lot (e.g. Pitt Town Pressure Sewer Masterplan Rev A Drawing S101. Illustrated the sewerage system to the level of the lot). The Observant Monitor Map system shows each property on a map which links to the telemetry system.	☑ Fully Adequate OFIs to further improve Fully Adequate findings: • Consider undertaking a basic receiving environment capability assessment for the use of recycled water.

Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
The manner in which the health and ecological assessments will be undertaken and any concerns arising from any such assessment (continued…)	**Hazard and Risk Assessment/Management** 5 The identification and documentation of hazards (both Health and Ecological impacts) sources and hazardous events for each component of the sewerage system. 6 The methodology for estimating the level of risk for each identified hazard or hazardous event. 7 The identification of existing preventive measures from source to disposal for each significant hazard or hazardous event and estimates of the residual risk. 8 An evaluation of alternative or additional preventive measures where improvement is required. 9 The assessment of preventive measures throughout the sewage system to identify the critical control points. 10 The establishment of mechanisms for operational control at critical control points. 11 A documented process to periodically review and update the hazard identification and risk assessment to incorporate any changes.	Section 3 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 and Appendix E provide the risk assessment. This is Fully Adequate. Actions for further reducing risks have been summarised and are set in context. Both maximum and residual risks have been assessed to health and environmental endpoints against likelihood and consequence criteria. The above items will be reviewed and updated as part of an annual audit, review and update process (Section 12.1). The system includes a number of best practice preventive measures for which the scheme should be commended. These include pressure sewer design such as PN16 PE welded sewerage assets which mitigate tree root intrusion and wet weather ingress as well as environmental egress. The blockage risks within the sewer are mitigated by a macerating pump at each property connection, and both the macerators and pumps are telemetered. There are pressure monitoring points on line within the sewerage system as well as flushing points to enable detection and response to blockages. There is a 900 L tanks on each lot with a flush out point. Flushing can be to tanker. An aggressive substance would possibly damage the pump seals which would trigger a pump problem alarm and in turn help to mitigate risks from some extreme contaminants. The sewerage catchment is only residential and so the risks as a whole are limited. The plant is built at a level that matches the existing nearby council sewerage plant with critical assets raised 300 mm above that 1/100 year flood level. The flow balance tank on site covers 110,000 L and can take in surge inflows. The pressure network can readily handle any surge. If required, waste can be sent to the nearby council sewage treatment plant on a temporary basis through an existing Access Agreement. An eductor truck could be used to manage the transfer.	☑ Fully Adequate

Requirement to be evaluated	Guidance	Evidence/comments	Assessment Finding
The manner in which the health and ecological assessments will be undertaken and any concerns arising from any such assessment (continued…)	**Data Monitoring and Sampling:** 12 The process for collecting baseline monitoring data for the site and the receiving environment to confirm the risk assessment. 13 A process for determining the characteristics to be monitored in the sewage system and the receiving environment (as appropriate). 14 The development of a sampling plan for each characteristic that encourages the collection of representative and reliable monitoring data. 15 The procedure for the collection and retention of historical data about influent sewage as well as data from the effluent disposed of from the treatment plants and the receiving environment (over time and following specific events). 16 Documented process for identifying, listing and examining exceedances.	Data sampling and monitoring, as designed, progressing from start up through to long term, is Fully Adequate and is described under the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 Appendix O. Going forward, Permeate Partners have been contracted to provide monthly review and reporting including evaluating the trends of the key verification and process parameters in addition to the annual reporting provided by PTWF.	☑ Fully Adequate
The manner in which the health and ecological assessments will be undertaken and any concerns arising from any such assessment (continued…)	**Communication and Training:** 17 The process for consulting with relevant Government Agencies and the community concerning the proposed scheme. 18 The organisation has identified a team of people with appropriate knowledge and expertise on the sewerage system (from source to end use) to undertake the assessment of the system.	Section 3.1 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 summarises the system assessment team. The risk assessment team was Adequate but was not Fully Adequate since specific independent environmental expertise was lacking, either through using suitable consultants and/or government, e.g. OEH, involvement. Section 2.1 provides a comprehensive summary of the project stakeholders and their roles. The summary includes governmental agencies and how they were consulted. The summary is Fully Adequate and compliant with good practice.	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • Ensure specific, independent environmental expertise in the update of the system and risk assessment.

Attachment 4. Detailed Audit Findings: Network Operator's Licence No. 10_014 11th November 2010

Clause	Requirements [and guidance]	Evidence/comments	Assessment Finding
A1 Activities Authorised - non-potable water supply	This Licence authorises the Licence Holder and the persons specified in Table 1.1 to construct, operate and maintain the water industry infrastructure specified in Table 1.2 for the purposes as specified in Table 1.3 within the area specified in Table 1.4, subject to the conditions imposed by or under the Act, the Regulation and this Licence.	See below	See below
1. Authorised persons	A network operator and specified authorised persons may construct, operate and maintain specified infrastructure for specified purposes within specified areas. Permeate Partners Pty Ltd (ACN 130 112 257) [The organisation and the authorised third parties have constructed, operated and/or maintained the water industry infrastructure for the authorised purposes and within the area of operations only].	Permeate Partners was identified as an authorised person for key aspects of operation and maintenance. Other contractors were identified in them main body of the documentation supplied but did not appear to have management roles of a nature that would require them to be nominated as authorised persons.	☑ Fully Adequate
2. Specified water industry infrastructure	Infrastructure for the production, treatment, filtration, storage, conveyance or reticulation of non-potable water	Described in the WQP and IOP and subordinate documents and assessed as part of those more detailed audit reports, above.	☑ Fully Adequate
3. Authorised purposes	1. Irrigation 2. Toilet flushing 3. Car washing 4. Wash down of hard surfaces 5. Supply of cold water to washing machine The infrastructure is not used for an unauthorised purpose.	Described in Section 1.1 and Section 3.5 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12. The descriptions in the plan match the licence. The descriptions are not identical to those in the licence which may lead to confusion in future and could be amended as an opportunity for improvement. The field inspection revealed signage stating "NOT TO BE USE FOR FIRE FIGHTING PURPOSES" on the accessible recycled water hydrant plugs. Recycled water hydrant on the locked site is intended to be used for hosing down of hard surfaces. There is a separate potable water fire hydrant connection on the site. Recycled water hydrants were lilac and potable ones were yellow.	☑ Fully Adequate OFIs to further improve Fully Adequate findings: • Literally match the descriptions of the *intended use* and *authorised purposes* between the management plan and licence, respectively.
4. Specified area of operations	The area bordered by Old Stock Route Road, Railway Road, Hawkesbury Valley Way, Macquarie Street and the Hawkesbury River in Pitt Town, Hawkesbury, NSW. [The water industry infrastructure constructed, operated and/or maintained by the organisation or an authorised third party does not extend outside the area of operations].	The area was visited, located on a map and described in the supplied documents and matched the licence specifications.	☑ Fully Adequate

Clause	Requirements [and guidance]	Evidence/comments	Assessment Finding
A2 Activities Authorised - sewerage services	This Licence authorises the Licence Holder and the persons specified in Table 2.1 to construct, operate and maintain the water industry infrastructure specified in Table 2.2 for the purposes as specified in Table 2.3 within the area specified in Table 2.4, subject to the conditions imposed by or under the Act, the Regulation and this Licence.	See below	See below
1. Authorised persons	A network operator and specified authorised persons may construct, operate and maintain specified infrastructure for specified purposes within specified areas. Permeate Partners Pty Ltd (ACN 130 112 257) [The organisation and the authorised third parties have constructed, operated and/or maintained the water industry infrastructure for the authorised purposes and within the area of operations only].	Permeate Partners was identified as an authorised person for key aspects of operation and maintenance. Other contractors were identified in them main body of the documentation supplied but did not appear to have management roles of a nature that would require them to be nominated as authorised persons.	☑ Fully Adequate
2. Specified water industry infrastructure	Infrastructure for the treatment, storage, conveyance or reticulation of sewage, including any outfall pipe or other work that stores or conveys water leaving the infrastructure	Described in the WQP and IOP and subordinate documents and assessed as part of those more detailed audit reports, above.	☑ Fully Adequate
3. Authorised purposes	Treat, store, conveyor reticulate sewage The infrastructure is not used for an unauthorised purpose.	Described in Section Section 3 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12. The descriptions in the plan match the licence.	☑ Fully Adequate
5. Specified area of operations	The area bordered by Old Stock Route 'Road, Railway Road, Hawkesbury Valley Way, MacQuarie Street and the Hawkesbury River in Pitt Town, Hawkesbury, NSW. [The water industry infrastructure constructed, operated and/or maintained by the organisation or an authorised third party does not extend outside the area of operations].	The area was visited, located on a map and described in the supplied documents and matched the licence specifications.	☑ Fully Adequate
A3 Environmental requirements	A 3.1 Before commencing construction of the water industry infrastructure [A1 or A2] under this licence, the Licence Holder must: (a) prepare and provide IPART with a construction environmental management plan (CEMP). The CEMP must outline the proposed actions and mitigation measures to manage the environmental risks for undertaking construction of the water industry infrastructure. (b) provide IPART with a report, prepared by an approved auditor, in such manner and form as IPART may direct as to the adequacy of the CEMP.	A Review of Environmental Factors was completed March 2010 by DBL Property and a CEMP was developed based on matters identified by IPART and in the original application from the Licence Holder (Section F). The organisation complied with the supplied CEMP and has been independently audited against that CEMP with a compliant finding provided.	☑ Fully Adequate

Clause	Requirements [and guidance]	Evidence/comments	Assessment Finding
	A3.2 The Licence Holder must implement all actions and mitigation measures in accordance with the 'Response to the DECCW submission to IPART regarding the Pitt Town Water Factory' prepared by Parsons Brinkerhoff Australia Pty Ltd (2010).	Paul Rossington of Parsons Brinkerhoff prepared the response to OEH and he will be signing off that all actions are complete. At the time of writing work is continuing, e.g. landscaping. This action will need to be assessed as part of the next audit.	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • Review this as part of the operational audit.
B1. Ongoing capacity to operate. WIC Act 10.4 (a) & 13.2 (a)	The Licence Holder must have the technical, financial and organisational capacity to carry out the activities authorised by this Licence. If the Licence Holder ceases to have this capacity, it must report this to IPART immediately. [The organisation can demonstrate the level of technical and organisational resourcing and the capacity of those resources have not diminished since the licence was awarded. The organisation has developed and implemented appropriate resource plans which identify personnel requirements for safe operation of the infrastructure. Personnel requirements would include skill sets and appropriate levels of staffing. The organisation undertakes financial audits of the licensed activities at a frequency appropriate for the organisation's exposure to financial risk. The organisation has a procedure to identify if there is insufficient capacity to carry out the licensed activity and the procedure includes notification of IPART. The organisation has a procedure to ensure IPART is informed immediately if the capacity is not retained].	At the time of the audit, in the opinion of the auditors, and in the opinion of IPART (*Application for a Network Operator's Licence and a Retail Supplier's Licence from Pitt Town Water Factory Pty Ltd IPART's report to the Minister Water — Ministerial report September 2010*) the Licence Holder satisfactorily met these criteria IPART considered that the Licence Holder satisfactorily met these criteria subject to the naming of Permeate Partners as an authorised third party (which has occurred) and adoption of the CEMP (which has occurred, as noted above).	☑ Fully Adequate

Clause	Requirements [and guidance]	Evidence/comments	Assessment Finding
B2 Obtaining appropriate insurance	B2.1 Before commencing to operate water industry infrastructure under this Licence, the Licence Holder must: (a) obtain appropriate insurance sufficient for the size and nature of the activities authorised under this Licence, (b) demonstrate that the insurance obtained is appropriate by providing a report to IPART from an Insurance Expert certifying that in the Insurance Expert's opinion the type and level of insurance obtained by the Licence Holder is appropriate for the size and nature of the activities authorised under this Licence, and (c) provide a copy of each certificate of currency of insurance obtained to IPART. B2.2 The report from the Insurance Expert must: (a) identify the key risks of undertaking the activities authorised under this Licence, (b) set out the types and levels of insurance obtained by the Licence Holder in the relation to the activities being undertaken, (c) provide reasons as to why the types and levels of insurance are appropriate for the size and nature of the activities being undertaken, and (d) if any risks arising from undertaking the activities remain uninsured, provide reasons as to why.	In the opinion of IPART (*Application for a Network Operator's Licence and a Retail Supplier's Licence from Pitt Town Water Factory Pty Ltd IPART's report to the Minister Water — Ministerial report September 2010*) the Licence Holder satisfactorily met these criteria. IPART reviewed these insurances and provided advise that they were adequate (email from IPART to the auditor, dated 8th December 2011).	☑ Fully Adequate

Clause	Requirements [and guidance]	Evidence/comments	Assessment Finding
B3 Maintaining appropriate insurance	B3.1 The Licence Holder must maintain appropriate insurance sufficient for the size and nature of the activities authorised under this Licence. [The licensee has obtained/maintained appropriate insurance.] B3.2 From time to time when requested in writing by IPART, the Licence Holder must provide a report to IPART, in the manner, form and time specified by IPART, from an Insurance Expert certifying that in the Insurance Expert's opinion the type and level of insurance obtained by the Licence Holder is appropriate for the size and nature of the activities authorised under this Licence. [The licensee provided a report to IPART from an Insurance Expert certifying the level of insurance is appropriate]. B3.3 Whenever there is a change in the type, level or period of insurance held by the Licence Holder in relation to the activities authorised under this Licence, the Licence Holder must provide a copy of the certificate of currency to IPARTwithin 10 days of the change being made. [The organisation has evidence to demonstrate it provided such a certificate when required.] [The organisation has provided a report from an independent insurance broker that holds an Australian financial services licence (AFSL) under Part 7.6 of the Corporations Act 2001 (Cth), and the report includes providing the ABN and AFSL number. the letter or report should state: • that the insurance obtained is appropriate for the size and nature of the activities authorised under the licence, • attach a copy of each certificate of currency of insurance in relation to the licensed entity & licensed activities • identify the key risks of undertaking the activities authorised under the licence • set out the types and levels of insurance obtained • provides reasons as to why the types and levels of insurance are appropriate • for the size and nature of the activities being undertaken, and • if any risks arising from undertaking the activities remain uninsured, provide reasons as to why. The auditor is to check with IPART whether IPART has received a report that meets the requirements of the licence obligation].	In the opinion of IPART (*Application for a Network Operator's Licence and a Retail Supplier's Licence from Pitt Town Water Factory Pty Ltd IPART's report to the Minister Water — Ministerial report September 2010*) the Licence Holder satisfactorily met these criteria. IPART reviewed these insurances and provided advise that they were adequate (email from IPART to the auditor, dated 8th December 2011).	☑ Fully Adequate

Clause	Requirements [and guidance]	Evidence/comments	Assessment Finding
B4 Complying with NSW Health requirements	The Licence Holder must carry out the activities authorised by this Licence in compliance with any requirements of NSW Health that IPART has agreed to and are notified from time to time to the Licence Holder by IPART in writing.	The Licence Holder has held discussions with NSW Health and come to agreement through an Operating Protocol Supply of Recycled Water dated 25/11/2011 between the Licence Holder and NSW Health (Nepean Blue Mountains & Western Sydney, Local Health Districts, Public Health Unit). The Licence Holder has replaced the UV disinfection system with an alternative unit to the satisfaction of NSW Health (email from NSW Health to the auditor dated 3rd February 2012).	☑ Fully Adequate
B5 Reporting in accordance with the reporting manual	The Licence Holder must prepare and submit reports in accordance with the applicable Reporting Manual issued by IPART and available from IPART's website www.ipart.nsw.gov.au.	The reporting process in place is as required by IPART's Reporting Manual.	☑ Fully Adequate
B6 Reporting information in relation to the register of licences	Whenever any of the following information changes, the Licence Holder must provide the updated information to IPART within 14 days of the change: (a) each source from which the water handled by the infrastructure is derived, (b) the identity of each licensed retail supplier or public water utility that has access to the infrastructure services provided by the infrastructure for the purpose of supplying water to its customers, (c) a description of any other water infrastructure to which the infrastructure is connected. [In the case of any of these changes, the organisation has provided the relevant information to IPART within 14 days of the change].	Not yet assessable but no inadequacies identified in this audit. This should be reviewed under future audits.	☑ Fully Adequate
B7 Monitoring	B7.1 Any monitoring required to be undertaken by the Licence Holder for the purposes of this Licence or any Plans required under the Regulation must be undertaken in accordance with the requirements set out below. B7.2 The following records must be kept of any samples collected: (a) The date(s) on which the sample was taken, (b) The time(s) at which the sample was collected, (c) The point or location at which the sample was taken, and (d) The name of the person who collected the sample. B7.3 A laboratory accredited for the specified tests by an independent body acceptable to NSW Health, such as the National Association of Testing Authorities (NATA) or equivalent, shall carry out all analyses of samples.	To the extent that this could be assessed, monitoring plans and accreditation requirements were adequate. However, monitoring records will need to be gathered in future following scheme start up and this was not assessed under this audit. NATA accreditation is required for water quality testing (as noted under the WQP component of this audit).	☑ Fully Adequate

Clause	Requirements [and guidance]		Evidence/comments	Assessment Finding
B8 Provision of copy of plans	B8.1	Whenever the Licence Holder makes a significant change to its Plans, the Licence Holder must provide a copy of the amended Plan to IPART at the same time it provides a copy to the approved auditor engaged to provide a report as to the adequacy of the changed Plan as required under the Regulation.	Towards the end of the audit period, plans were updated and provided to the auditors but were not simultaneously provided to IPART. However, plans were supplied to IPART by the time the audit report was finalised.	☑ Adequate Actions to upgrade Adequate findings to Fully Adequate: • Ensure that in future updated plans are supplied to IPART at the same time as to the auditors.

Clause	Requirements [and guidance]	Evidence/comments	Assessment Finding
B9 delineating responsibilities – interconnections	B9.1 Where a water industry code of conduct under clause 25 of the Regulation has not been established by order published in the Gazette and the water industry infrastructure specified in Schedule A, clause A1, Table 1.2 and clause A2, Table 2.2 of this Licence is connected to any other water industry infrastructure, the Licence Holder must establish a code of conduct in relation to the respective responsibilities of the Licence Holder and each licensed network operator, licensed retail supplier and/or public water utility that is responsible for the other water industry infrastructure. B9.2 The arrangements are to be agreed in writing between the Licence Holder and the other licensed network operators, licensed retail suppliers and/or public water utilities prior to commencing commercial operation of the water industry infrastructure specified in Schedule A, clause A1, Table 1.2 and clause A2, Table 2.2 of the Licence. B9.3 The arrangements must address the following matters: (a) responsibility for the repair, replacement or maintenance of any pipes, pumps, valves, storages or other infrastructure connecting the water industry infrastructure specified in Schedule A, clause A1, Table 1.2 and clause A2, Table 2.2 of this Licence to any other water industry infrastructure, (b) responsibility for water quality, (c) liability in the event of the unavailability of water, (d) liability in the event of infrastructure failure, (e) responsibility for handling customer complaints. [The organisation has identified whether a code of conduct needs to be established. Where relevant, the arrangements have been established, documented and various responsibilities undertaken by the relevant parties. The arrangements address the relevant matters. In the absence of the Water Industry Code of Conduct, the licensee must have relationships established with the relevant parties to deal with issues such as customer complaints. This relationship should be confirmed in a written document such as a Memorandum of Understanding or written agreement. In the case of handling customer complaints, the arrangements need to be consistent with the notifiable events identified in an incident and emergency response plan agreed to with NSW Health.]	There is no connection between this and others' water industry infrastructure.	No Requirement

Clause	Requirements [and guidance]	Evidence/comments	Assessment Finding
B10 Notification of changes to Authorised Person	If an Authorised Person ceases, proposes to cease or receives notification to cease providing any of the services relating to the activities authorised by this Licence, the Licence Holder must provide IPART with written notice as soon as practicable and in any event no later than 28 days prior to the date of cessation of the services. Such written notice must include details of how the services previously undertaken by the Authorised Person will continue to be undertaken.	Not yet assessable but no inadequacies identified in this audit. This should be reviewed under future audits.	☑ Fully Adequate

Attachment 5. Detailed Audit Findings: Paraphrased aspects of the Water Industry Competition (General) Regulation 2008

Clause	Requirements [and guidance]	Evidence/comments	Assessment Finding
General requirements			
WIC Act section 14 (3)	A network operator must pay the annual licence fee determined by the Minister.	IPART has confirmed to the auditors that these fees have been paid (email from IPART to the auditor, 30th May 2012 – fees are paid from 30th September 2011).	☑ Fully Adequate
WIC Reg Sched 1 cl. 1 (1)	A network operator must provide the Minister or IPART with information as directed by the Minister or IPART in relation to licensee's activities under licence and must provide it in the time specified in the direction.	Not yet assessable but no inadequacies identified in this audit. This should be reviewed under future audits.	☑ Fully Adequate
WIC Reg Sched 1 cl. 5	A network operator must comply with any water industry code of conduct, marketing code of conduct and transfer code of conduct.	The marketing code of conduct and the transfer code of conduct are currently only draft – so compliance is not yet required. The Water Industry code of conduct was written in as licence condition B9, delineating responsibilities and interconnections, which was considered No Requirement.	☑ Fully Adequate
WIC Reg Sched 1 cl 2.1	The licensee must not bring any new water or sewage infrastructure into commercial operation without the written approval of the Minister. [The organisation can demonstrate that all new infrastructure commenced commercial operation after receiving written approval of the Minister].	Not yet assessable but no inadequacies identified in this audit. This should be reviewed under future audits.	☑ Fully Adequate
WIC Reg Sched 1 cl 2.2 (b)	The infrastructure is capable of operating safely. [The organisation can demonstrate that the infrastructure can operate without causing harm to public health and the environment and complies with the requirements of other relevant legislation such as the Occupational Health and Safety Act].	This was assessed as part of the IOP audit. During the site audit a number of minor gaps were identified but these were subsequently rectified. The site has three Safety showers, a HAZCHEM register and PTWF has notified WorkCover of chemical storage (although there are no Dangerous Goods). PTWR has a compliance certificate for BCA.	☑ Fully Adequate

Clause	Requirements [and guidance]	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl 2.2 (b)	The infrastructure is capable of operating in accordance with its infrastructure operating plan and its water quality plan or sewage management plan, as the case requires. [The organisation can demonstrate that the plans are being implemented, for example, the procedures referenced in the plans are being used by the operators and the operators are trained in the procedures. The organisation can show that the practices adopted on site are covered by the plans and the on-site practices are not contradictory to the documented procedures].	This was assessed as part of the IOP, WQP and SMP audits, above.	☑ Fully Adequate
Health requirements			
WIC Act section 18	A network operator must comply with any direction of the Minister to take specified action to reduce or eliminate a risk to public health or public safety arising from certain activities.	Not yet assessable but no inadequacies identified in this audit. This should be reviewed under future audits.	☑ Fully Adequate
WIC Reg Sched 1 cl. 1(2)	A network operator must immediately notify certain persons of any incident in the conduct of its activities that threatens, or could threaten, water quality, public health or safety.	Not yet assessable but no inadequacies identified in this audit. This should be reviewed under future audits.	☑ Fully Adequate
Netw. Op. Licence cl. B4	The licensee must comply with any requirements of NSW Health which IPART has notified the licensee of in writing. [The organisation can show they have developed a relationship with NSW Health. This can be in the form of an MOU or communications protocol. The organisation has a register to record NSW Health/IPART requirements if they come in, and there is evidence of compliance with the requirements. NSW Health, with the agreement of IPART, has required that notifiable events and response protocols (in a document such as an incident and emergency response plan) are agreed with NSW Health before a scheme commences commercial operation]	Under Section 7.3 of the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12, NSW Health and IPART are noted as organisations to be notified in the event of notifiable events. The Licence Holder has involved NSW Health in review of its risk assessment and has held discussions with NSW Health and come to agreement through an Operating Protocol Supply of Recycled Water dated 25/11/2011 between the Licence Holder and NSW Health (Nepean Blue Mountains & Western Sydney, Local Health Districts, Public Health Unit). This document includes discussion of notifiable events. The Licence Holder has replaced the UV disinfection system with an alternative unit to the satisfaction of NSW Health (email from NSW Health to the auditor dated 3rd February 2012).	☑ Fully Adequate
Environmental requirements			
WIC Reg Sched 1 cl. 4	In relation to the protection of the environment, there has been compliance with the requirements of: (a) the Environmental Planning and Assessment Act 1979 and any environmental planning instruments under that Act, and (b) the Protection of the Environment Operations Act 1997 and any regulations under that Act.	These requirements were considered under the audit of the SMP.	☑ Fully Adequate

Clause	Requirements [and guidance]	Evidence/comments	Assessment Finding
Infrastructure Operating Plan			
WIC Reg Sched 1 cl. 3(a), (b)	The water or sewerage infrastructure is properly designed and constructed, operated in a safe and reliable manner and maintained in a proper condition, having regard to: (a) the purposes for which it is licensed, and (b) the licence conditions.	These requirements were considered under the audit of the IOP.	☑ Fully Adequate
WIC Reg Sched 1 cl. 3(c)	The water or sewerage infrastructure is properly designed and constructed, operated in a safe and reliable manner and maintained in a proper condition, having regard to any publicly available standards or codes relating to its design, construction, operation and maintenance. [The organisation has established a procedure for identifying and keeping up to date with any publicly available standards and codes. These may include documents produced by Standards Australia, Water Services Association Australia, regulatory agencies such as the EPA and Health, a relevant public utility, product manufacturers and suppliers. The organisation has established procedures to consider the requirements of all identified standards and codes and to determine if the requirements are relevant for the safe and reliable design, construction and operation of the specific water industry infrastructure. The organisation has established procedures to comply with the standards and codes which are deemed relevant to the specific water industry infrastructure].	These requirements were considered under the audit of the IOP.	☑ Fully Adequate
WIC Reg Sched 1 cl. 6(2) (a) and WIC Reg Sched 1 cl. 13(2) (a)	The infrastructure operating plan is fully implemented and kept under regular review and all of the licensee's activities are carried out in accordance with that plan. [The relevant staff members are aware of the requirements of the plan and have evidence of implementation, such as up to date checklists and registers for maintenance, training, inductions, monitoring, incidents and emergencies. The organisation has a procedure for reviewing the plan on a regular basis].	These requirements were considered under the audit of the IOP.	☑ Fully Adequate
WIC Reg Sched 1 cl. 6(2) (b) and WIC Reg Sched 1 cl. 13(2) (b)	If the Minister has directed, amendments to the licensee's infrastructure operating plan, such amendments were completed in accordance with the Minister's direction.	Not yet assessable but no inadequacies identified in this audit. This should be reviewed under future audits.	☑ Fully Adequate

Clause	Requirements [and guidance]	Evidence/comments	Assessment Finding
WIC Reg Sched 1 cl. 6(3) And WIC Reg Sched 1 cl. 13(3) And Netw. Op. Licence cl. B8	If any significant change is made to its infrastructure operating plan (or the Minister or IPART demands it), the licensee provides the Minister or IPART with a report, prepared by an approved auditor regarding the adequacy of the plan and the condition of its infrastructure.	Not yet assessable but no inadequacies identified in this audit. This should be reviewed under future audits.	☑ Fully Adequate
WIC Reg Sched 1 cl. 8	The water meters connected to a licensee's water main comply with the requirements of the Plumbing and Drainage Code of Practice. The licensee has ensured the water meter is properly maintained and periodically tested, and the water meter is read at least every 4 months, and written notice of each meter reading is sent to the relevant licensed retail supplier. [The organisation has a procedure to check all water meters (both customer's and the licensee's water meters) comply with the requirements and have ongoing maintenance and meter readings].	The Licence Holder is using the same water meters as Sydney Water use, which is the "Elster V100" unit. These comply with the requirements.	☑ Fully Adequate
WIC Reg Sched 1 cl. 11 And WIC Reg Sched 1 cl. 15	Customer's installations are not connected to the licensee's water main or sewer main unless the installation complies with the Plumbing and Drainage Code of Practice. [The organisation has a procedure for obtaining a plumbing certificate of compliance from Office of Fair Trade through customers regarding compliance of their internal plumbing].	Extensive documentation was provided to demonstrate compliance with the plumbing requirements, both Licence Holder and local council inspections and reports (noted at many points within the Pitt Town Water Factory Company Recycled Water System Management Plan Revision D dated 08/03/12 and in particular at Appendix U).	☑ Fully Adequate
Water Quality Plan			
WIC Reg Sched 1 cl. 7(4)(a)	The water quality plan is fully implemented and kept under regular review and the licensee's activities are carried out in accordance with that plan.	This was audited under the WQP audit.	☑ Fully Adequate
WIC Reg Sched 1 cl. 7(4)(b)	If the Minister so directs, amendments to the licensee's water quality plan are made in accordance with the Minister's direction.	Not yet assessable but no inadequacies identified in this audit. This should be reviewed under future audits.	☑ Fully Adequate
WIC Reg Sched 1 cl. 7(5) and Netw. Op. Licence cl. B8	If any significant change is made to its water quality plan (or the Minister or IPART demands it), the licensee provides the Minister or IPART with a report, prepared by an approved auditor regarding the adequacy of the plan	Not yet assessable but no inadequacies identified in this audit. This should be reviewed under future audits.	☑ Fully Adequate
WIC Reg Sched 1 cl. 10	The licensee under a licence for water infrastructure to supply non-potable water for a particular purpose must ensure that the water supplied is fit for that purpose.	This was verified under Element 9 of the WQP.	☑ Fully Adequate

New South Wales

Water Industry Competition Act 2006

Notice of approval to bring new infrastructure into commercial operation

I, Greg Pearce MLC, Minister for Finance and Services, have considered the request by Pitt Town Water Factory Pty Ltd (ACN 141 705 660) (**PTWF**) for approval to bring new infrastructure into commercial operation under the *Water Industry Competition Act* 2006. The new infrastructure is described in Schedule A, Table 1 and 2 of PTWF's network operator licence (10_014) (**Licence**).

I have considered a report prepared by approved auditors within the meaning of the Water Industry Competition (General) Regulation 2008 (**Regulation**), which is included as Attachment A. I am satisfied that the report indicates the new infrastructure:

1. complies with the requirements of the Regulation and the conditions of the Licence; and
2. is capable of operating safely and in accordance with PTWF's infrastructure operating plan and water quality plan.

I therefore give my approval under Schedule 1, clause 2 of the Regulation for PTWF to commence commercial operation of the new infrastructure.

.....

Hon. Greg Pearce MLC
Minister for Finance and Services

Dated this 15th day of June 2012

LEGEND

1. Wyee Development (new)
2. Inlet screen
3. Flow balance tank
4. Pre-Anoxic zone
5. Aerobic zone
6. Post-Anoxic zone
7. Membrane filtration
8. UV Disinfection
9. Chlorine contact tank
10. Recycled water storage
11. Recycled water distribution pumps
12. Residential non-potable uses
13. Irrigation to Public Open Space
14. Odour scrubbing
15. Alum dosing
16. Carbon dosing
17. Citric acid dosing
18. Caustic dosing
19. Chlorine dosing
20. General site sump
21. Belt press
22. Polymer dosing

A. Screenings and grit
B. Foul air (untreated)
C. Foul air (treated)
D. Internal recycle
E. Return Activated Sludge (RAS)
F. Dewatered Waste Activated Sludge (WAS)
G. Chlorine for membrane cleaning
H. Chlorine for disinfection
I. Chlorine for residual dosing

QUALITY CONTROL POINTS (QCP) FOR WATER QUALITY

BIOREACTOR (5, 6, 7 & 8)
- pH
- Dissolved oxygen
- Temperature
- Flow

CHLORINE RESIDUAL (11)
- Chlorine residual

CRITICAL CONTROL POINTS (CCP) FOR WATER QUALITY

MEMBRANES (8)
- Permeate turbidity

UV (9)
- UV Transmissivity
- UV Intensity
- Flow

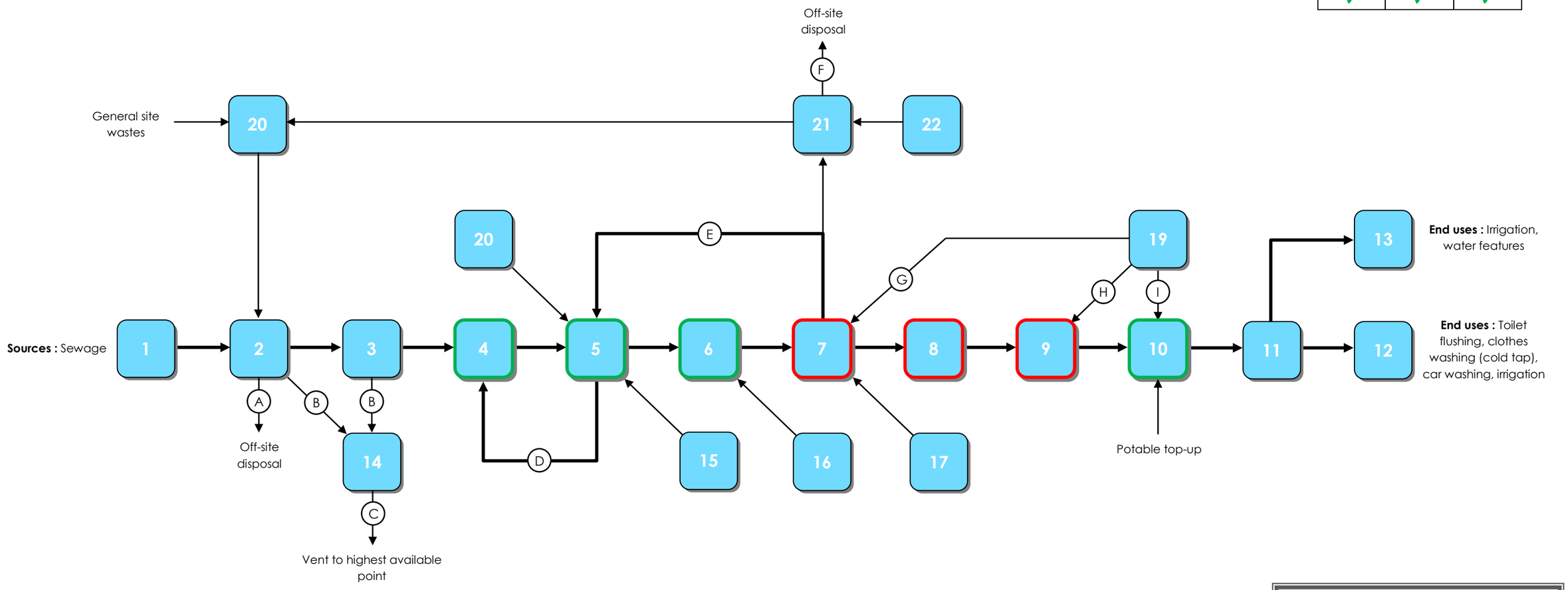
CHLORINE CONTACT (10)
- Chlorine residual
- Flow

Location of QCP — Major flow

Location of CCP — Minor flow

New infrastructure — Existing infrastructure

	Log removal		
Unit operation	**Virus**	**Protozoa**	**Bacteria**
MBR	≥2.5	≥4.0	≥4.0
UV	≥1.0	≥1.5	≥3.0
Chlorine	≥3.0	-	≥4.0
Design	**≥6.5**	**≥5.5**	**≥11.0**
Required	**≥6.0**	**≥5.0**	**≥5.0**
	✓	✓	✓



NOTE
The infrastructure detailed herein will be constructed in stages to match the needs of the development. More information on staging can be found on the layout drawings.

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No.	Date	Drafter	Design	Mgmt	Amendment
C	260313	KRD			For information
B	220313	KRD			For information
A	151112	KRD			For information

CLIENT
Wyee Water
A local sustainable water utility

Name :	Wyee Water			
Project :	Wyee Development			
Design	Date	Drafting	Date	
KRD	260313			

Title :	Sewerage and Recycled Water Process Flow Diagram	
Scale NTS	Permeate Project # C12079	Permeate Drawing # C12079-200
Sheet A3	Client Project # TBA	Client Drawing # TBA

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Land Capability Assessment for Recycled Water Management Scheme, Wyee

FINAL REPORT

March 2013

Prepared for: Water Factory Company Pty Ltd

Prepared by: Whitehead & Associates Environmental Consultants Pty Ltd
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Document Control Sheet

Document and Project Details	
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Author:	Jasmin Kable and Shann Mitchell
Project Manager:	Mark Saunders
Date of Issue:	28 February 2013
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Synopsis:	This Land Capability Assessment Report has been prepared to provide recommendations for surface irrigation of recycled water associated with the staged residential subdivision at Wyee.
Client Details	
Client:	Water Factory Company Pty Ltd
Contacts:	Brendan Seage (DBL Property- Project Manager) (02) 9267 4267

Document Distribution

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Document Verification

Checked by:  **Mark Saunders**	***Issued by:***  **Shann Mitchell**

Contents

Appendices

Executive Summary

Whitehead & Associates ("W&A") were engaged by Water Factory Company Pty Ltd ("the Client") to undertake a Land Capability Assessment (LCA) for the proposed staged subdivision bounded by Hue Hue Road and Bushells Ridge Road, Wyee ("the Site"). Based on plans provided by Water Factory Company, it is proposed to subdivide the existing ~105 ha Site in multiple release stages for residential community development, comprising, in total, approximately 778 lots. It is proposed to develop a Recycled Water Irrigation (RWI) scheme in the land set aside for the second stage of the subdivision. The proposed Recycled Water Supply (RWS) scheme would supply the subdivision with a reticulated recycled water supply, with 'excess' recycled water being irrigated on managed pasture in the second stage of subdivision.

A site and soil assessment was conducted on 7th February 2013, in accordance with the Australian Guidelines for Water Recycling (2006) under the requirements of the Water Industry Competition Act (WICA, 2006), to determine the limitations (if any) for RWI at the Site. Site and soil investigations were also compared with previous investigations including the Preliminary (Phase 1) Contamination and Geotechnical Assessment conducted by Douglas Partners (2009), for verification. Overall, the Site constraints for RWI were generally moderate, due to the presence of isolated regions with clay subsoils and the presence of a high seasonal watertable with localised waterlogging adjacent to drainage lines.

Design household (ET) water demands and wastewater generation rates were determined in accordance with the Building Sustainability (BASIX) and Water Efficiency Labelling Scheme) WELS requirements. The household water demands have been conservatively estimated as 741 L/ET/day based on the determined occupancy data and 'pre BASIX' benchmark home condition.

Both water and nutrient balances have been undertaken to determine sustainable irrigation rates for community land in the subdivision and ultimate irrigation capacity to determine the maximum development potential of the subdivision before an alternative end-use must be found for the recycled water. The Site has been divided into three zones identified for irrigation purposes and each of these zones (RWIZs 1 – 3) has been allocated corresponding development release stages for irrigation purposes. The three zones include public open space surrounding the subdivision, proposed recreation area within the subdivision and some reuse in the land designated for the latter stages of the subdivision. The capacity of the lots to manage the predicted hydraulic loads for seasonal variations, described as Low season, Peak season and Shoulder season has been assessed to determine the sustainable irrigation potential of the Site.

The assessment demonstrates that the hydraulic load is limiting across the Site and wet weather storage or an alternative off-site reuse option would be required once maximum subdivision development potential has been reached. The internal (per household) reuse potential based on the Peak scenario is 348 L/ET/day with 126 L/ET/day excess requiring community irrigation. The internal reuse potential based on the Shoulder scenario is 289 L/ET/day with 185 L/ET/day excess requiring community irrigation. The internal reuse potential based on the Low scenario is 230 L/ET/day with 245 L/ET/day excess requiring community irrigation. Therefore, each household has a potential to offset between 31% (Low) and 47% (Peak) of the total potable water demand using recycled water. These proposed irrigation volumes can be sustainably managed within the proposed RWIZs of the recreation zone 29, clear open space areas and Stages 27 and 28. W&A consider that on-site surface irrigation is achievable up to, and including, the Stage 26 residential release if internal reuse of recycled water is provided to each new property (via dual-reticulation).

1 Introduction

Whitehead & Associates Environmental Consultants Pty Ltd ("W&A") were engaged by Water Factory Company Pty Ltd ("the Client") to undertake a Land Capability Assessment (LCA) for the proposed staged subdivision bounded by Hue Hue Road and Bushells Ridge Road, Wyee ("the Site"). The LCA primarily focuses on the region located on the southern side of Mannering Creek, but also includes selected assessment of the region proposed for the first stage of subdivision located on the northern side of Mannering Creek. The Site is located on the existing parcels: Lot 17, DP 870597 and Lot 1, DP 785709, within the Lake Macquarie City Council ("Council") local government area.

The fieldwork was undertaken by Jasmin Kable and Shann Mitchell of W&A on the 7th February 2013. This LCA report provides the results of our investigations along with recommendations for the preferred Recycled Water Irrigation Zones (RWIZs) to protect nearby sensitive lands and waterways.

2 Site Description

The Site occupies an area of approximately 105 ha and is bound by Hue Hue Road to the north, Bushells Ridge Road to the south, Dillabirra Road (un-sealed access road adjacent to the "Paper" subdivision) to the east and further rural land to the west.

Mannering Creek traverses the northern region of the Site; extending southwest to northeast. An un-named creek, referred to in this report as the south-east tributary, which flows into Mannering Creek, extends in a north/south orientation within the eastern portion of the Site. Numerous constructed dams are located throughout the Site; predominantly within the south-western and north-western corners. Wyee Dam is located approximately 800 m to the east of the Site along Mannering Creek.

The Site currently consists of partially cleared rural land and riparian vegetation that is zoned for agriculture and environmental conservation. There are also isolated regions of partially cleared stands of mature trees (typically various species of Eucalyptus) to the east of the Site and along the southern Site boundary. An existing residential dwelling is located on the crest of a hill along the southern Site boundary. A former small scale quarry is located adjacent to the existing dwelling and a former poultry farm is located within the north-western corner of the Site. Some large-lot residential properties are located adjacent to Hue Hue Road.

According to topographical information provided by LMCC (LIDAR, 2012), the Site is located between approximately 20 m and 62 m AHD (Australian Height Datum). The topography of the Site is generally comprised of rolling hills, grading between 0% and 15%, with slopes falling gently to the northeast. Figure 1 shows the location and associated features and topography of the Site.

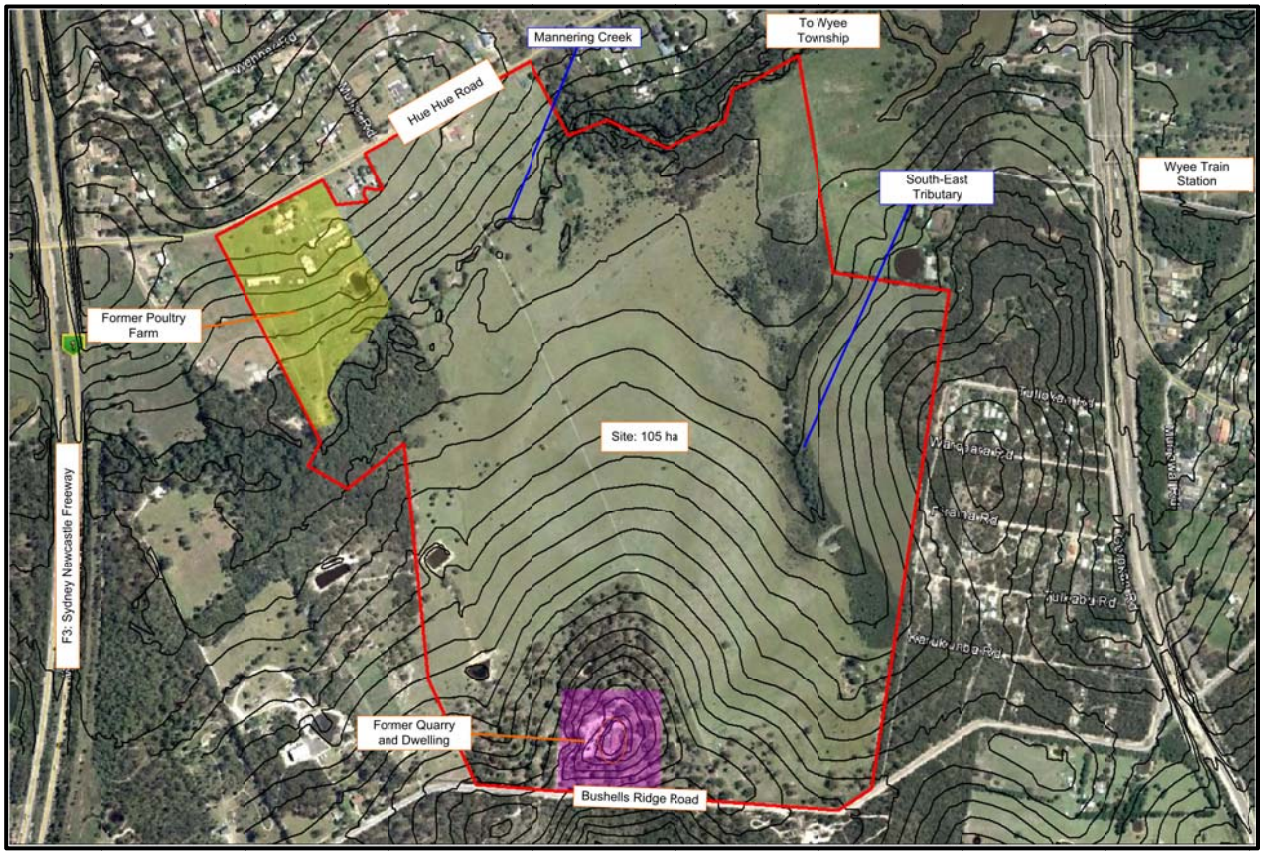


Figure 1: Site Location, Features and Topography

3 Proposed Development

Based on plans provided by Water Factory Company (Ref: Concept Plan and Master Plan, Wyee), W&A understands that it is proposed to subdivide the existing ~105 ha Site in multiple release stages for residential community development, comprising of approximately 778 lots. The proposed zoning comprises of a combination of residential, conservation, environmental living and open space zones.

Figure 2 outlines the proposed staging plan for the housing development areas and associated surrounding development. The Stage One housing release is proposed to be comprised of five (5) housing release portions, containing approximately 140 residential lots, to be constructed in the north-eastern portion of the Site, which is bordered by Hue Hue Road to the north and Mannering Creek to the south. The Stage One development area consists of a crest that runs parallel along Hue Hue Road at an elevation of approximately 35 m AHD grading southeast towards Mannering Creek (20 m AHD).

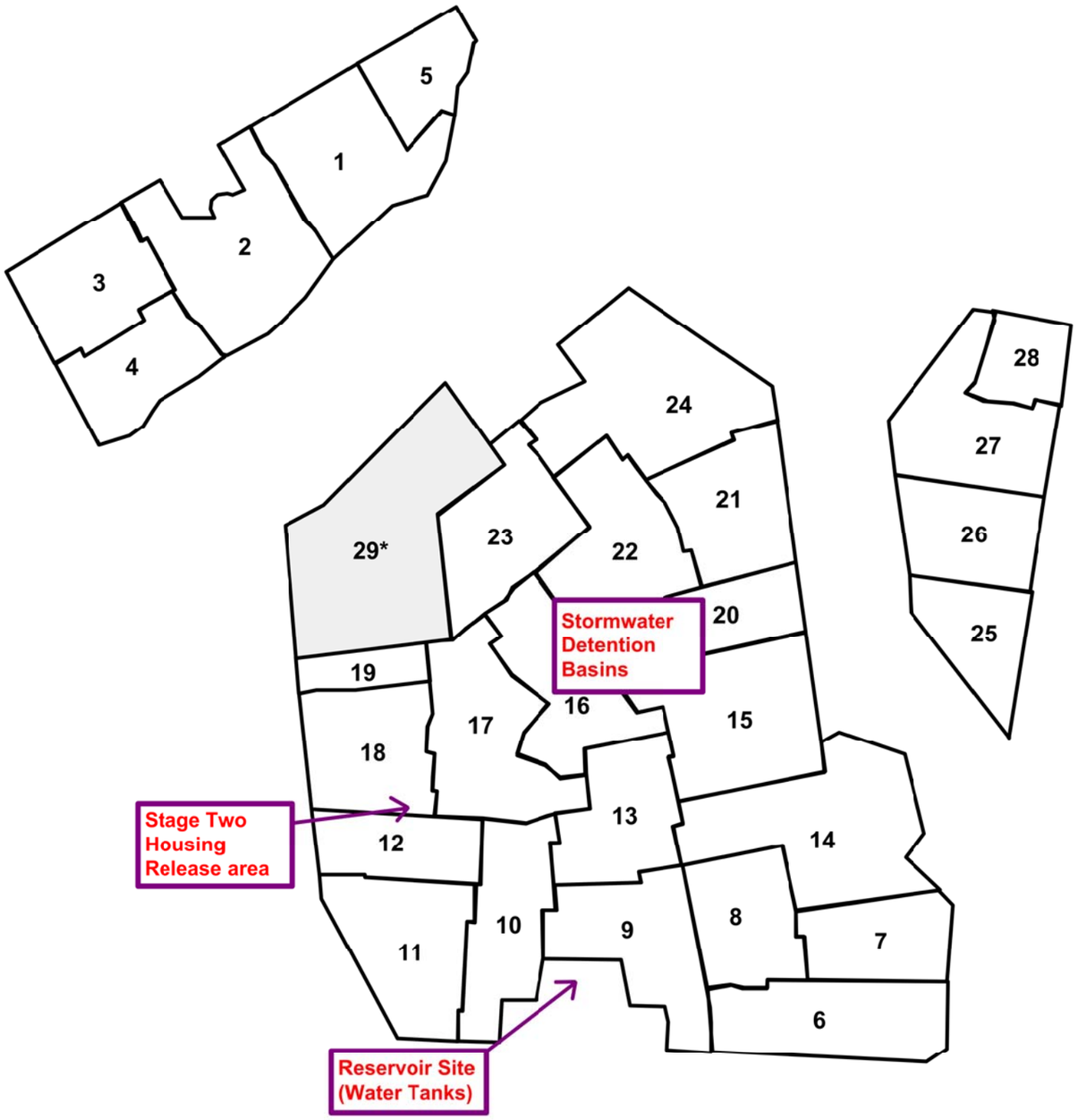
Potable water for the development will be supplied by a Hunter Water service via transfer main from outside the Site to storage tanks located on the proposed Recycled Water Plant (RWP) site (Refer to Figure 2). After a certain number of lots, yet to be determined, are developed the potable water storage will be moved to the southern boundary of the Site at the proposed water reservoir site. Wastewater generated from the Stage One development will be treated in the dedicated RWP to be located on-site (0.5 ha compound) adjacent and to the south of Mannering Creek.

It is expected that the ultimate build-out of the Stage One release may take 5-7 years; during which time a Recycled Water Supply (RWS) scheme, comprising reticulated third-pipe supply will be progressively made available to each new residence. While recycled water will be available from the beginning of Stage One, it may be necessary to use potable water top-up in the early stages of development as there may not be sufficient recycled water supply to meet demand. While, in the longer-term it is expected

that the RWS scheme will be able to meet a proportion of household water demand, it is likely that wastewater generation will exceed recycled water demand during portions of each year (winter months) for the majority of the built-out period. Therefore, alternative reuse opportunities are needed.

It is proposed to develop a Recycled Water Irrigation (RWI) scheme in the land set aside for Stage Two of the subdivision. The proposed irrigation scheme would take 'excess' recycled water from the RWP for irrigation of managed pasture in the Stage Two development area, which is bordered by Bushells Ridge Road to the south and Mannering Creek to the north. The Stage Two development area is separated in the east of the Site by the south-east tributary. The Stage Two development will comprise of a further 638 residential lots constructed over the remainder of the property. Whilst the release areas have been numbered in Figure 2, there is no confirmed sequence of their roll-out, especially in the Stage Two development. It is envisaged that the irrigation area would continue to be used until such a time that the land is required for development. At that time, excess recycled water from the combined Stage One and Stage Two releases would be supplied for other end-uses or discharged to sewer under license.

Other areas of the development have been proposed for infrastructure improvements as per the proposed development plan shown in Figure 2. Two stormwater detention basins, located either side of the RWP compound on the southern side of Mannering Creek, will operate to moderate the stormwater runoff generated by development. Additionally, there are two distinct regions set aside as conservation areas, one on the southern border adjacent to the water reservoir site and the other in the northeast region of the Site, adjacent to the southern side of Mannering Creek. There is a region of public open space set aside in central region adjacent to the western border for sporting facilities. There are also regions, which were identified as areas of high ecological constraint in the biodiversity study conducted by Eco Logical Australia (2010), which are highlighted in the proposed development plans as endangered ecological communities (EECs). There are also regions where the existing vegetation is to be maintained and cleared regions to be revegetated.



* Public Open Space- Recreation Ovals

FIGURE 2: CONCEPTUAL PLAN OF PROPOSED STAGED SUBDIVISION OF THE SITE AND RELEASE AREAS

- Existing Vegetation to be Retained
- Open Space Area
- Cleared Area to be Revegetated
- Endangered Ecological Community (EEC)- Vegetation to be Retained
- Conservation Area
- Reservoir Site
- Development Footprint
- Public Open Space
- Site Boundary
- 1% ARI flood level
- Release Areas

Project: LCA for Recycled Water Management Scheme, Wyee
Drawn: Jasmin Kable
Date: 11 February 2013
Scale: 1:4680 (approx) @A3

N

Whitehead & Associates Environmental Consultants Pty Ltd

4 Scope of Work

The scope of work undertaken was to provide advice for the preferred reuse site(s) with particular respect to their ability to receive irrigated recycled water in a sustainable and reliable manner over the expected lifespan of the scheme.

The study methodology included:

- a review of background information on the project area including any previous investigations completed.
- visiting the Site (once) to undertake a detailed site investigation to:
    - assess a range of site constraints including landform, slope, aspect, drainage, flooding and proximity to sensitive environments;
    - undertake a preliminary soil survey to assess soil physical characteristics such as texture, structure, depth, colour, drainage and presence of watertables;
    - undertake in-house laboratory analysis of pH, electrical conductivity and Emerson Aggregate Class;
    - provide (10) representative soil samples for independent lab analysis of phosphorus sorption and cation exchange capacity (nutrient modelling) and exchangeable sodium percentage (soil dispersion potential);
    - identify an appropriate location and configuration for the recycled water irrigation zones(s) including all recommended/required setbacks (buffers);
    - identify any land improvement works or mitigation measures required to address particular site constraints (e.g. terracing, soil importation, vegetation improvement, landscaping, stormwater diversion); and
    - site investigations were undertaken with specific reference to the requirements of relevant standards and guidelines including the *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) (AGWR) (2006)*.
- using the results of the preliminary site assessment to direct the water and nutrient balance assessment for the preferred RWIZs and also to identify any additional studies or investigations required to adequately assess the irrigation potential of the preferred RWIZs.
- prepare a written LCA Report for the Site, including a detailed site plan (showing available RWIZs, describing the results and recommendations from our investigations.

5 Regulatory Requirements and Guidelines

The Independent Pricing and Regulatory Tribunal (IPART, NSW) regulate the licensing of private water schemes under the *Water Industry Competition Act (WICA) 2006*. Under the Act, a corporation must obtain a licence to construct, maintain or operate any water industry infrastructure (network operators' licence), or to supply potable or non-potable water, or provide sewerage services by means of any water industry infrastructure (retail suppliers licence). Both the network operators' and retail suppliers' licences are applicable for the development of the RWS/RWI schemes at the Site.

Under the *Water Industry Competition (General) Regulation (WICR) 2008*, network operator licensees for sewerage schemes are required to produce a Sewage Management Plan (SMP) and subsequent audit reports on the SMP before commercial operation of the scheme. The sustainability assessment is an audit of a portion of the SMP with the aim of helping to determine whether the proposed infrastructure will

provide sewerage services which are sustainable and do not present a risk to the environment.

This report will address the 'sustainability assessment' requirements set out by *WICR (2008)*, including: water balance calculations for the scheme, covering all disposal paths, including the production of the recycled water and disposal to land and water; and a Land Capability Assessment (LCA), as there will be application of recycled water to land and the sustainable rate of application of the recycled water will be determined. General storage capacity requirements will also be outlined for the RWS/RWI schemes based on the water balance calculations. The remaining sections of the sustainability assessment will be completed by the licensee. The outstanding SMP audit components can be completed after commencement of construction.

The Australian Guidelines for Water Recycling: Managing health and environmental risks (Phase 1) (AGWR, 2006), were developed to provide guidance on the supply, use and regulation of recycled water schemes. The guidelines use a risk management framework comprising of twelve (12) elements with multiple barriers to control hazards. The framework is summarised by four (4) main categories: commitment to responsible use and management of recycled water; system analysis and management; supporting requirements; and review.

The principles of sustainable use of recycled water are based on three main principles:

1) protection of public and environmental health is of paramount importance and should never be compromised;
2) protection of public and environmental health depends on implementing a preventative risk management approach; and
3) application of preventative measures and requirements for water quality should be commensurate with the source of recycled water and the intended uses.

In regards to public health, relatively few restrictions need to be placed on non-drinking water uses of tertiary treated and disinfected recycled water. End use controls and onsite constraints can also be used to minimise both human exposure to hazards and the impact on receiving environments; such as signage, use of buffer zones, and control of plumbing and distribution systems.

The licensed network operator must submit to IPART an Infrastructure Operating Plan and a Water Quality Plan which is consistent with the AGWR (2006) and address the Framework for Management of Recycled Water Quality and Use.

6 Previous Investigations

There have been various previous investigations on the Site and these findings have been incorporated into our analyses and recommendations.

Wyee Local Environmental Study (RPS, 2010)

A Local Environmental Study (LES) was prepared for the Site to assess a potential rezoning of land within Wyee, Lake Macquarie. The Site falls within Precinct Four of the four proposed Township precincts proposed for Wyee. The LES identified that the Site has environmental constraints which need to be managed in an appropriate manner if the proposed development is to take place.

Preliminary (Phase 1) Contamination and Geotechnical Assessment (Douglas Partners, 2009)

A preliminary (Phase 1) contamination and geotechnical assessment, which included site investigations and a site history review for the study Site and adjacent paper subdivision to the east of the Site.

Twenty-four (24) soil bore holes were examined throughout the Site and adjacent areas. The soils generally consisted of 200-400 mm clayey silty sand to silty sand overlying sandy clays that ranged from 800-2300 mm depth. The soils were underlain by sandstone or claystone bedrock. The soils were consistent with residual soils derived from the parent rock. The soils (subsoils in particular) were found to be slightly susceptible to dispersion in the more elevated portions of the Site. The soils were also generally non-saline and it is unlikely that there is a presence of acid sulphate soils on the Site. There was no evidence of hill slope instability (landslip) and only a localised, low degree of slumping (erosion triggered) occurred along the creek banks.

The study inferred that the permanent groundwater table is likely to be present at a significant depth below the ground surface, based on the Site's topography. A shallow permanent water table may be encountered within the central, lower areas of the Site and along the creeks. This was inferred from waterlogged soils (significant gleying in the subsoil) observed in a number of the bore holes in these regions and groundwater encountered in bore hole 8 at a depth of 700 mm. Areas of surface soil moisture and weak near surface soils may be as a result of natural springs along the western side of the south-east tributary. Discussions that Douglas Partners (2009) had with a neighbour indicated that this region never entirely dries out and may be continuously recharged from springs redirecting to the surface.

No regulatory notices were issued for the Site under either the *Contaminated Land Management (CLM) Act 1997* or Section 55 of the *Protection of the Environment Operations (POEO) Act 1997*. Soil contamination risks across the Site are generally quite low. The Site had been used primarily for rural, intensive agricultural and residential purposes, although extractive land uses (small-scale quarrying) were identified in two regions of the Site. Uses that may have resulted in contamination included orchards, poultry farming and market gardening, with localised areas of potential contamination from illegal dumping, workshop facilities, refuelling infrastructure and the presence of fill. There was an assumed potential for asbestos contamination from fibre boards used in the buildings. The Mine Subsidence Board indicates that the Site is outside a prescribed subsidence district.

This study concluded that the Site is generally suitable for development, however further investigations and testing of the identified areas of concern will be required to determine the level of contamination (if any).

Biodiversity Study (Eco Logical Australia, 2010)

The biodiversity study found that there were several threatened flora and fauna species that occurred at the Site, or were considered probable to occur or located in the surrounding region. Therefore, adequate conservation of the habitats for these species is critical in order to maintain population viability and ecosystem function.

There were six vegetation communities that were identified, including two endangered ecological communities (EECs): freshwater wetland on coastal floodplains and swamp sclerophyll forest on coastal floodplain. Development planning of the Site needed to take into account the buffers required to conserve the identified EECs. Council will manage the EECs to which the developer will need to follow the LMCC Biodiversity Planning Policy and Guidelines for LEP Rezoning Proposals (LMCC, 2009). A number of important corridors were also identified on the Site: Mannering Creek Riparian Corridor, Regional Wildlife Pathway, remnant native vegetation corridor and partially cleared native vegetation.

There were 153 flora species and 68 fauna species identified on the Site. There were two threatened flora species identified: *Tetratheca juncea* and *Angophora inopina*, and six threatened fauna species identified: Glossy Black Cockatoo, Squirrel Glider, Eastern

Free-tail Bat, Grey-headed Flying Fox, Little Bent-wing Bat and Large Eared Pied Bat. There were an additional twenty-seven (27) fauna species considered likely to occur on the Site based on local occurrence and known habitat requirements.

Water Management Study (Cardno, 2010)

A flood study was conducted by Cardno (2010) to determine if the Site was affected by the 1 in 100 year annual recurrence interval (1% ARI) flood level. The Site, for the existing catchment, is affected by the 1% ARI flood level which is shown on the site plan provided as Figure 3.

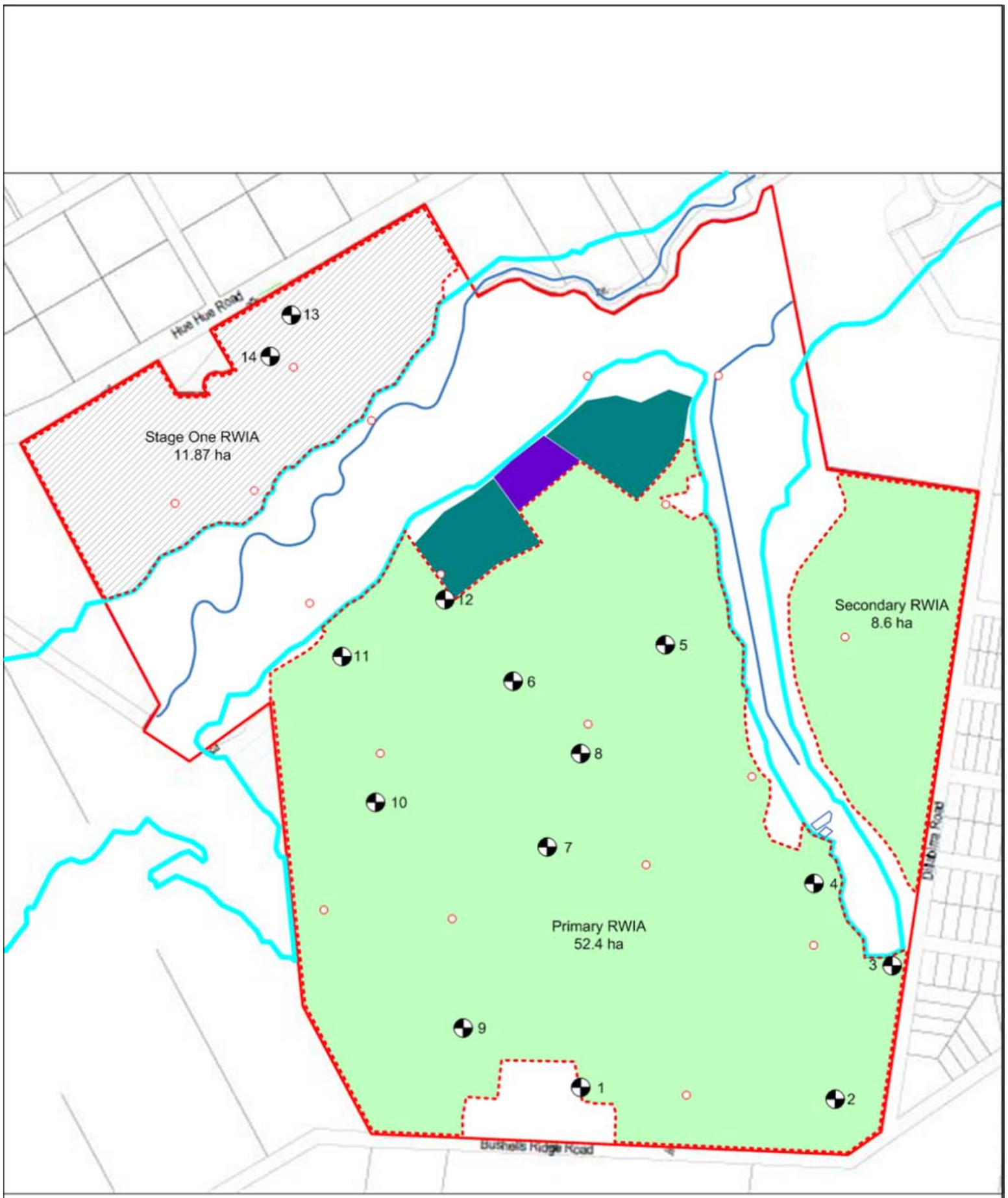


FIGURE 3: SITE PLAN SHOWING PREFERRED RWIAS

- Recycled Wastewater Treatment Plant
- Proposed Stormwater Detention Basins
- Soil Bore Hole
- Douglas Partners (2010) Geotechnical Assessment Soil Test Pit
- Applied Buffers
- Surface watercourses
- Recycled Water Irrigation Areas
- Site Boundary
- 1% ARI Flood Level

Project: LCA for Recycled Water Management Scheme, Wyee
Drawn: Jasmin Kable
Date: 13 February 2013
Scale: 1:4680 (approx) @A3

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Whitehead & Associates Environmental Consultants Pty Ltd

7 Site Assessment

7.1 Site Constraints

Based on the desktop review and site investigations, a number of site features have been assessed for limitations to RWI. These are presented and discussed in Table 1 as well as the degree of limitation identified with reference to the AGWR (2006) assessment criteria. The degree of limitation describes the site capability for a land application system or recycled water irrigation scheme; where major limitations require further assessment and mitigation measures to reduce the public and environmental health risks associated with the constraint.

Table 1: Site Constraints

Constraint	General Degree of Limitation
Landform: The Site is generally situated on undulating terrain of generally low relief, except for the local relief of 65 m along the central southern boundary. The typical landform consists of convergent slopes with broad crests and ridgelines with gently inclined slopes. There is a broad poorly drained floodplain located in the central region of the Site (divergent slopes).	Moderate
Climate: Climatic data for use in water balance calculations was obtained from a nearby Bureau of Meteorology (BoM) weather station Wyee (Wyee Farms Road) 61082 (1899-2013) and Wyee data drill (1970-2007). The Wyee BoM weather station is relatively close to the Site and is expected to provide climatic data that is representative of typical site conditions. The Site experiences a temperate climate, typical of south-eastern Australia. Average annual rainfall at Wyee is 1,192.4 mm. Mean monthly rainfall ranges from a high of 132.4 mm in March to a low of 69 mm in August. Average annual pan evaporation is 1,348 mm.	Minor
Slope: The Site is situated on slightly inclined slopes with a floodplain located in the central region of the Site. The Site has a slope range of approximately 0% - 8%, with an average of less than 4%.	Minor
Exposure: The aspect varies throughout the Site; however, the region to the south of Mannering Creek predominately has a north westerly aspect and the region to the north of Mannering Creek a south easterly aspect. The solar exposure and prevailing wind are generally good, especially within the proposed RWIZs.	Minor
Flood Potential: Land application (irrigation) area above the 1 in 20 year flood level: **Yes/** No Land application (irrigation) area above 1 in 100 year flood level: **Yes/** No The 1 in 100 year ARI flood level has been mapped on Figure 3 (site plan), which shows that a large portion of the northern and eastern regions of the Site are affected. In some regions, such as in the west of the Site, filling and grading could be implemented to ensure that it will not be flood affected. As the land application area will be located above the 1 in 100 year ARI flood level, flooding presents a moderate limitation for RWI.	Moderate

Constraint	General Degree of Limitation
Stormwater run-on and upslope seepage: The Site has a minor potential for stormwater run-on. Stormwater generated from development areas will be diverted around the available RWIZs to stormwater detention basins proposed to be located either side of the RWP. There were no areas of existing or potential upslope seepage observed at the time of the site inspection.	Minor
Erosion Potential: Erosion and slumping were noted around the creek banks (depths to 1 m), especially along the intermittent drainage line to the west of the Site near BH 10 and BH 11. The gentle slopes and good vegetation cover at the Site limits the potential for erosion within the main body of the Site away from the drainage lines. Small areas of minor erosion, mainly due to stock movement (cattle runs), were observed to the east of BH 13, which dissects the central portion of the Site, up to BH 7. Maintenance of good groundcover will be required to limit erosion during and following development.	Minor
Site Drainage: Given the natural slope, soil and vegetation at the Site, the indicative site drainage is considered moderate upslope and poor to very poor in downslope areas along the drainage lines. There is an indication of waterlogged soils occurring within the floodplain, in the southeast corner to the south of a dam, and to the west of the Site along the intermittent drainage line. The upslope portions of the Site, along both the northern and southern boundaries, contain clay subsoils which exhibit extensive mottling, indicating periodic wetting, but generally aerated soil conditions. Subsoil gleying and standing groundwater was observed at 250 mm depth in BH 4, within the south-east tributary drainage corridor. Site drainage poses a major limitation in this area, which can be reduced by locating the available RWIZs outside of these highly impacted regions and by reducing the design loading (irrigation) rate on the limiting soil facets (i.e. clays).	Moderate to Major
Fill: Localised areas of cutting and filling were observed along the boundary fence line between BH 1 and BH 8 and in the northwest corner of the Site associated with the remnant poultry farm. There is adequate space for the management of recycled water away from these areas.	Minor
Buffer Distances: Buffer distances are discussed further in a later section of the report (See Section 8). All of the proposed RWIZs are capable of meeting the minimum buffer distances as recommended by the AGWR (2006) guidelines.	Minor
Vegetation: The Site is predominantly cleared with a groundcover of mixed pasture grasses. There are isolated stands of forest vegetation, particularly on the crest of the slope along the southern boundary where the proposed potable water reservoir is located (eucalyptus and native grasses) and along the drainage lines (mixed vegetation and paperbark trees). Refer to the Wyee LES biodiversity study (Eco Logical Australia, 2010). There is currently no access from the central region of the Site to the north eastern region of the Site due to the dense riparian vegetation surrounding the south-east tributary.	Minor
Rocks and Rock Outcrops: No rock outcrops were observed throughout the Site. However the presence of rocks was observed around the vicinity of the remnant quarry. This poses only a minor constraint for RWI.	Minor

Constraint	General Degree of Limitation
Surface Waters: There are several surface water features located on and adjacent to the Site. Mannering Creek traverses the northern region of the Site; extending northeast to southwest. The south-east tributary, which flows into Mannering Creek, extends in a north to south orientation in the eastern region of the Site. An intermittent drainage line, extending north to south, is located in the south western portion of the Site. Numerous constructed dams are located throughout the Site; predominantly within the south-western and north-western corners. Wyee Dam is located approximately 800 m to the east of the Site along Mannering Creek. Buffer distances are discussed further in a later section of the report (See Section 8).	Moderate
Seasonal and Regional Groundwater: A review of the online NSW Department of Natural Resources (OEH) registered bore database indicated that the nearest registered groundwater bores within a 1 km radius of the Site boundaries were as follows: GW064662 696 m to the east, GW015275 630 m to the west, and GW053092 787 m to the west. The identified groundwater bores were all located outside the DEC (2003) recommended buffer distance of 250 m domestic supply wells. The available RWIZs would not be expected to be within the zone of influence of any known groundwater bore. The intermittent groundwater table is considered to be variable throughout the Site. Shallow groundwater was encountered at BH 4 during soil surveys at a depth of 250 mm. There was extensive mottling and gleying of subsoils, particularly in the lower topographical portions of the Site and adjacent to the floodplains. The majority of the bore holes, except for BH 1, 7 and 8 (to a minimal degree), exhibited mottling and/or gleying primarily within the subsoils. This indicates that the seasonal groundwater table would be expected to be <1 m below the surface at periods throughout the year. The permanent groundwater depth is unknown but it is expected to be generally greater than 3 m in reference to the information supplied. The presence of seasonal high groundwater conditions presents a moderate to major limitation for RWI at the Site.	Moderate to Major

8 Soil Assessment

8.1 Soil Landscape

A review of the 1:100,000 Soil Landscapes of Gosford-Lake Macquarie Sheet (Murphy, 1993) indicates that the Site occupies three mapped soil landscapes, including; Doyalson (do) in the northern region of the Site, Wyong (wy) along the two major drainage lines and associated floodplains and Gorokan (gk) in the southern region of the Site. The relatively large-scale mapping results in soil landscape boundaries that are inexact at the Site scale; however, site investigations found that the soil landscapes generally fell within approximate mapped boundaries as indicated in Figure 4.

The Site is underlain by Triassic bedrock of the Narrabeen Group (Clifton Subgroup) and undifferentiated Quaternary Alluvium along the drainage lines. The Gorokan soils are derived from the in-situ weathering of the Tuggerah Formation which is comprised of light coloured lithic sandstone (pebbly in parts) and interbedded with red-brown and grey-green claystone and siltstone with rare conglomerate. Generally, the Gorokan soil landscape soil profile is 1 to 2 m in depth and is comprised of:

- Topsoil: <150 mm loose dark brown loamy sand;
- A2: 100-500 mm yellowish brown hard setting clayey sand, with ironstone rock fragments common;

- B: >500 mm yellowish brown strong pedal clay (light to heavy) which is strongly acidic;
- B/C: light grey massive medium clay above the sandstone bedrock.

The generalised limitations of the Gorokan soil landscape include: very high erosion hazard, seasonal waterlogging, hard setting, strongly acidic, low fertility, plastic and impermeable.

The Doyalson soils are derived from the in-situ weathering of the Munmorah Conglomerate Formation which is comprised of conglomerate, pebbly sandstone, grey-green and grey siltstone and claystone, with minor isolated regions of coarse quartz sandstone derived from the base of the Tuggerah Formation. Generally, the Doyalson soil landscape has a variable soil profile and is comprised of:

- Do1: brown loose loamy sand with rock fragments common;
- Do2: hard setting bleached yellowish brown clayey sand with rock fragments common;
- Do3: earthy bright yellowish brown sandy clay loam with a massive structure;
- Do4: earthy light grey clay (sandy clay loam to medium clay) with mottling common;
- Do5: strong pedal clay (light to medium).

The generalised limitations of the Doyalson soil landscape include: high erosion hazard, high run-on (localised), seasonal waterlogging (localised), hard setting, stoniness, strongly acidic and low fertility.

The Wyong soils consist of Quaternary sediments; sand, clays, silt and gravels. Generally, the Wyong soil landscape soil profile is greater than 2 m in depth and is comprised of:

- Topsoil: 100- 400 mm brownish black pedal loam;
- Subsoil: mottled brownish grey plastic clay (sandy clay to heavy clay) that is often permanently waterlogged at depth with a strong anaerobic odour.

The generalised limitations of the Wyong soil landscape include: flooding, seasonal waterlogging, permanent waterlogging (localised), stream bank erosion (localised), strongly acidic, poorly drained, impermeable, very low fertility and saline subsoils.

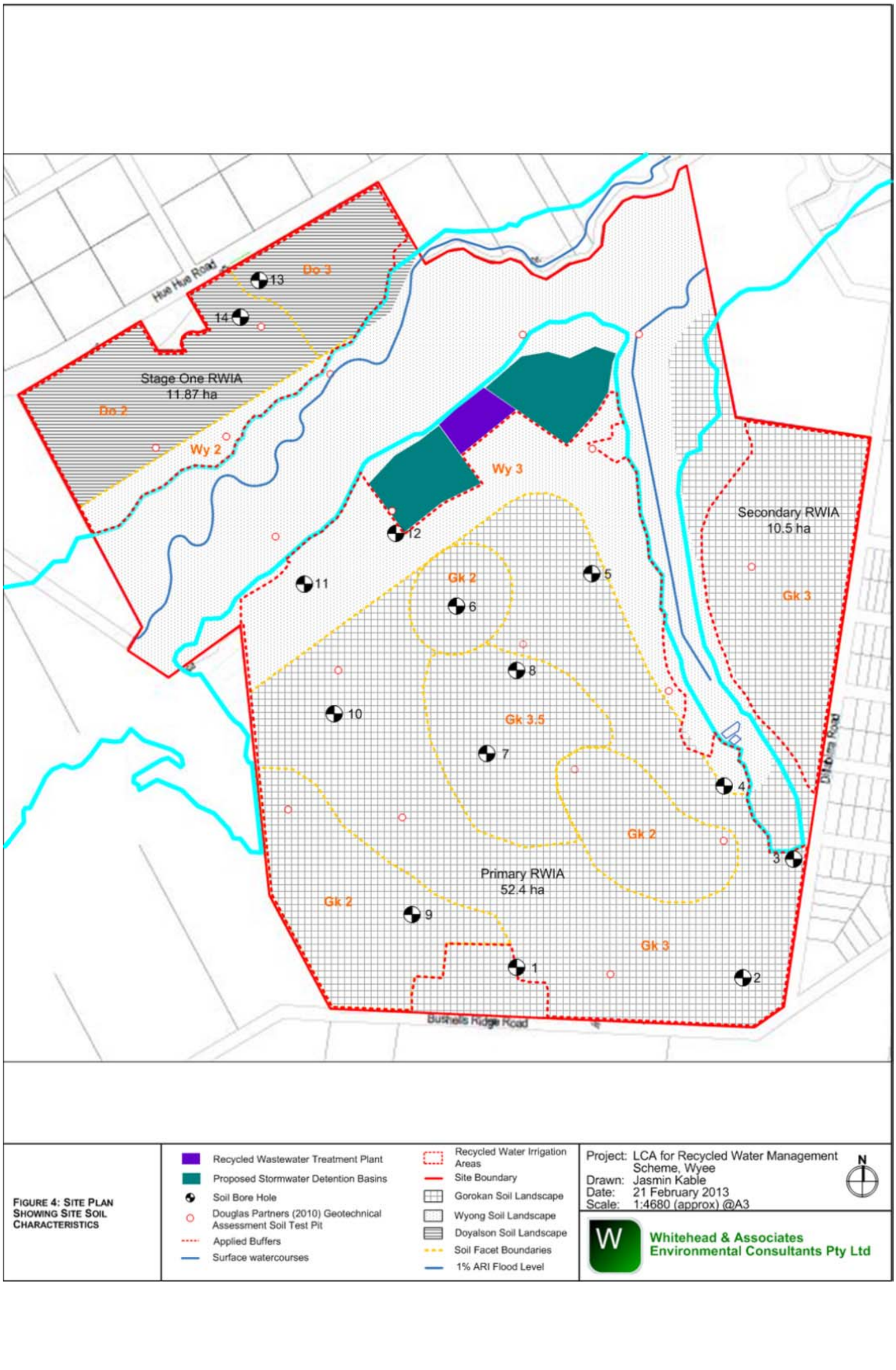

FIGURE 4: SITE PLAN SHOWING SITE SOIL CHARACTERISTICS

8.2 Soil Survey and Description

The Site soils were observed by completing fourteen (14) boreholes throughout the Site (with at least two bore holes from each soil landscape system), using a mechanical auger (locations of BH 1-BH 14 shown in Figure 3). The results from the soil survey were also compared with those from the contamination and geotechnical report conducted by Douglas Partners (2010) to validate W&A's analyses and confirm soil landscape boundaries and facet boundaries.

In general, the observed Site soils from our investigation were relatively uniform across the Site and in relation to the publicised soil landscape boundaries. The Gorokan soil landscape was the dominant soil landscape type located within the proposed RWIZs.

The Site soils were generally comprised of:

Doyalson (BH 13 and 14)

- Grey brown massive loamy sand to clay sand with <10% coarse fragments, to depths of 400 mm, overlying;
- Yellow grey brown pedal sandy clay to clay with extensive mottling and gleying (indicating seasonally poor drainage).

Wyong (BH 11, 12 and 4)

- Grey brown to yellow brown massive to weakly pedal loamy sand topsoil (200-600 mm), overlying;
- Yellow grey brown pedal sandy clay with extensive mottling and waterlogged in regions closer to the drainage lines (i.e. BH 4). There was an increase in coarse fragments with depth.

Gorokan (BH 1-3 and 6-10)

- Grey brown weakly pedal to massive loamy sand to clay sand with some mottling and coarse fragments, overlying;
- Grey brown weakly pedal sandy clay with some yellow mottling and coarse sandstone cobbles;
- Localised inclusions, particularly in the southwest corner and around BH 6, consist of yellow-orange brown subsoil with extensive mottling and occasional gleying.

The Gorokan soils had a variable soil profile depth, consistent with a soil catena (i.e. varies with landscape position). For example, BH 1, located near the southern boundary of the Site, was located on a crest where the loamy sand topsoil was absent.

Overall constraints to recycled water irrigation are generally moderate at the Site due to the presence of isolated regions with clay subsoils and the presence of a high seasonal watertable with localised waterlogging adjacent to the drainage lines.

Table 2 summarises the key soil physical constraints. Borehole logs are included in Appendix A.

Table 2: Soil Physical Constraints

Constraint	General Degree of Limitation
Depth to bedrock or hardpan (mm): The bore holes were excavated to between 900 mm–1000 mm or to refusal. Shallow weathered sandstone bedrock was encountered in BH 1, 7-9 and 14 at varying depths less than 1 m.	Minor
Depth of soil to watertable: Groundwater was encountered during our soil survey in BH 4 at a depth of 250 mm. The entire soil profiles in BH 2, 4 (saturated) and 5 were very moist, indicating a seasonally perched watertable on the less permeable underlying clay subsoil. The bore holes are located within the floodplain of the south-east tributary. Mottling of the soils (primarily in the clay subsoils) indicates that there is a tendency for a seasonally perched watertable to occur, most likely after periods of protracted wet weather. However, these seasonal watertables would be infrequent and are not expected to significantly impede the operation or performance of a well-designed and managed irrigation scheme.	Moderate
Permeability category (based on AS/NZS 1547:2012): Soil permeability was not directly measured but can be inferred from observed soil properties. Table 4.2 in AS/NZS 1547:2012 describes conservative Design Irrigation Rates (DIRs) for recycled water irrigation systems depending on two important soil properties – texture and structure. Soil depth, colour, mottling and drainage characteristics are also important to consider and should guide selection of appropriate loading rates. The Site soils were differentiated into grouped soil facets within each of the soil landscapes by the most limiting layer within each profile; using our soil investigation borehole results and the results from the geotechnical report conducted by Douglas Partners (2010). This assisted in grouping the Site soils to apply an appropriate hydraulic loading rate based on soil permeability. Figure 4 includes the locations of each of the soil facets and shows that there were three differentiated soil facets distributed throughout the proposed RWIZs. These soil facets range from moderate to slowly draining soils with the following approximate indicative permeability (K_{sat}) (as per AS/NZS 1547:2012): • Facet 2: (Category 6) <0.06 m/day; • Facet 3: (Category 5) 0.06- 0.12 m/day; • Facet 3.5: (Category 4) 0.12- 0.5 m/day.	Moderate
Recommended Hydraulic Loading and Rationale: W&A recommend the following DIRs to be applied for surface irrigation for each of the soil facets within the different soil landscapes: • Facet 2: 2 mm/day; • Facet 3: 3 mm/day; • Facet 3.5: 3.5 mm/day.	Moderate
Coarse fragments %: Coarse fragments were found in both the topsoil and subsoil in numerous bore holes; generally in the northern and western portions of the Site to the south of Mannering Creek. Pebbles most likely associated with alluvial processes were found in the topsoil and weathered sandstone was found within the lower portions of the subsoil; generally at 10-30% by volume.	Minor

8.3 Soil Chemical Analysis

Representative soil samples were collected for subsequent laboratory analysis from selected boreholes. In-house analysis of pH, Electrical Conductivity (EC_e) and modified Emerson Aggregate Class (EAT) was performed on all collected samples. Ten representative soil samples of topsoil, subsoil and composites were submitted to Lanfax Laboratory for determining phosphorus adsorption (P-sorb) capacity, cation exchange capacity (CEC), and exchangeable sodium percentage (ESP).

The full results of these analyses are contained in Appendix B. Table 3 provides a summary and discussion of the soil chemical constraints relating to land application of recycled water.

Table 3: Soil Chemical Constraints

Constraint	General Degree of Limitation
pH: The pH of 1:5 soil/water suspensions was measured using a *Hanna* hand held pH / EC meter. The measured pH for all collected samples ranged from 4 to 6.1 for all soils which indicate that the soils are generally very strongly to extremely acidic. This presents a moderate limitation for RWI and can be managed through soil amendment and pasture management practices. Further discussion on proposed mitigation measures is provided in Section 12.	Moderate
Electrical Conductivity (EC_e) (dS/m): Electrical conductivity of the saturated extract (EC_e) was calculated by first measuring the electrical conductivity of 1:5 soil in water suspension and using appropriate multiplier factors to convert EC (1:5) to EC_e. All samples examined were non-saline having EC_e values between 0- 1.22 dS/m. This presents a minor limitation for RWI.	Minor
Modified Emerson Aggregate Class (EAT Class): The Emerson Aggregate Test (EAT) is a measure of soil dispersibility and susceptibility to erosion and structural degradation. It assesses the physical changes that occur in a single ped of soil when immersed in water, specifically whether the soil slakes and falls apart or disperses and clouds the water. All soil samples were classified as Emerson Class 2 (except for the topsoils of both BH 2 and BH 3 which were considered Emerson Class 1), which indicates a high dispersion potential. This presents a moderate limitation for RWI and can be managed through soil amendment and pasture management practices. Further discussion on proposed mitigation measures is provided in Section 12.	Moderate
Sodicity (Exchangeable Sodium Percentage- ESP) (%): The Exchangeable Sodium Percentage (ESP) is the proportion of sodium on the cation exchange sites reported as percentage of exchangeable cations and is an important indicator of sodicity, which affects soil structural stability and susceptibility to dispersion. The ESP is a measure of how readily the soils allow sodium from recycled water to be substituted in the soil lattice for other cations. Once accepted, the weak sodium bonds allow increased structural degradation of the soil, increasing erosion risk. It is calculated as [% Na / CEC] x 100. Hazelton & Murphy (2007) suggest: • ESP values less than 6 are rated as non-sodic; • ESP values between 6 and 15 are rated as sodic; • ESP values between 15 and 25 are rated as strongly sodic; and • ESP values greater than 25 are rated as very strongly sodic. The ten soil samples analysed recorded ESP values of between 4.2 and 5.7 for	Moderate

Constraint	General Degree of Limitation
topsoils, 1.8 and 9.4 for subsoils and 3.2 and 8 for composite samples. The identified sodic soils were found within the subsoil clays of BH 6 and 10. This presents a moderate limitation for RWI and can be managed through soil amendment and pasture management practices. Further discussion on proposed mitigation measures is provided in Section 12.	
Cation Exchange Capacity (cmol/kg): The Cation Exchange Capacity (CEC) is the capacity of the soil to hold and exchange cations [aluminium, calcium, magnesium, potassium and sodium]. It is a major controlling agent for soil structural stability, nutrient availability for plants and the soils' reaction to fertilisers and other ameliorants (Hazelton & Murphy, 2007). Like ESP, the CEC is a measure of how easily the soils accept excess cations from the recycled water. These cations are used by plants as a nutrient source; so the higher the CEC the more likely plant growth will be aided by the application of recycled water. The CEC measured in the ten soil samples analysed was between 1.8 and 2 cmol/kg for topsoils, 3.9 and 30.2 cmol/kg for subsoils, and 4 and 5.7 cmol/kg for composite samples. The clay subsoils for BH 6 and BH 9 had a high and moderate CEC rating, respectively. The low CEC values for the other soil samples indicates that though the recycled water will provide a hydraulic load to the ground surface, plant growth may be inhibited by a lack of trace nutrients, and the application of fertiliser may be beneficial. This presents a moderate limitation for RWI and can be managed through pasture management practices. Further discussion on proposed mitigation measures is provided in Section 12.	Moderate
Phosphorus Sorption Capacity (kg/ha): The Phosphorous Sorption Capacity (P-sorption) is used to calculate the potential immobilisation rate of phosphorous by the soil. The P-sorption capacity of a soil is an important feature that relates to the potential for a soil to bind any phosphorus that may not be utilised by the plants within an available RWIZ. Phosphorous is required only to a limited extent by plants as a trace nutrient, but if there is an excess of phosphorous in environments where other limiting factors are not present (such as waterways), excess phosphorous can result in very high plant growth. Typically, on land, excess phosphorous is taken up by soil adsorption, or is flushed out of the soil into groundwater or surface water bodies. In many instances, P-sorption will be the dominant phosphorus removal mechanism when applying recycled water to the land. P-sorption analysis was undertaken on the ten soil samples by Lanfax laboratories, Armidale. For the laboratory sample a five point isotherm of P-sorption capacity was generated. The methodology is described further in Patterson (2001). For the analysed soils, a nominal threshold P-sorption value (in mg/kg) is selected as the value that equates to roughly 70% of complete sorption or the point on the sorption curve where the predicted P-sorption value departs from the theoretical line. The soil profile's P-sorption capacity can be estimated by adding the contribution from each discrete horizon to achieve a total P-sorption capacity or (weighted average) for the available RWIZs. A bulk density of 1.4 g/cm^3 was assumed and the relevant soil profile depths were used for each individual soil profile P-sorption calculation. Based upon this consideration, the design P-sorption capacity of the Site soils' is estimated as 823 mg/kg, which presents a minor limitation for RWI. The P-sorption results for BH 4 and BH 14 were excluded from the Site calculation as those regions will not be irrigated on as BH 14 is located in the Stage One development and BH 4 consists of saturated soils outside of the proposed RWIZs.	Minor

9 Buffers

Buffer distances from irrigation areas are recommended to minimise risk to public health, maintain public amenity and protect sensitive environments. The AGWR (2006) guideline recommends that spray irrigation buffer zones are generally not required for high-quality recycled water suitable for domestic non-drinking water use, as is the case with the proposed RWS/RWI schemes at the Site. However, buffer zones are recommended as they can be used as a mechanism to back-stop against unidentified hazards and potential human and environmental exposure.

W&A recommend that a minimum (setback) buffer distance equivalent to the 1% annual exceedence probability (AEP) flood level be maintained between the RWIZs and surface watercourses. This recommendation is principally due to limitations identified in these areas during the site and soil assessment, including periodically waterlogged soils (high seasonal watertable) and potential flood inundation of the low-lying areas. The maintenance of the 1% AEP flood level buffer distance should be sufficient to negate any residual environmental and public health risks both on- and off-site.

The intermittent drainage line along the western boundary of the Site and dams located throughout the Site were ignored in the buffer analysis as it is expected that they will be graded out during preparation works for the recycled water irrigation scheme.

The areas comprising EECs, stormwater detention basins, the RWP, water reservoir site and conservation areas proposed in the development were excluded from the determination of the available RWIZ(s).

It should be noted that once development commences, relevant setbacks, in accordance with AGWR (2006), from dwellings will need to be applied. Recommendations to prevent off-lot discharge include the use of low-throw sprinklers, 180º inward-throwing sprinklers and/or tree or shrub screens.

10 Recycled Water Analysis

10.1 Recycled Water Generation

Wastewater generation for this development will be predominantly from domestic sources as all proposed lots within the staged subdivision are for residential development. Wastewater from each lot will be generated from the entire wastewater stream including blackwater (toilet flushing and kitchen wastes), and greywater (laundry and shower wastes).

It is proposed to provide dual reticulation to distribute recycled water to households and public open space, whist any unused excess recycled water will be irrigated in the undeveloped land associated with later development stages.

10.2 Recycled Water Quality

It is our understanding that the RWP will incorporate membrane bioreactor (MBR) technology for the treatment of wastewater from the subdivision. The RWP will be designed to accommodate the maximum daily load from the subdivision at build-out, with required provisions for peak flow management (flow-balancing) and emergency storage. Detailed designs for the proposed treatment system have not yet been finalised; however, it is assumed that technology such as this would be capable of producing recycled water which meets, or exceeds, the following criteria.

Our water and nutrient balance modelling has been designed based on these assumptions:

- Nitrogen: ≤15 mg/L;
- Phosphorus: 2-5 mg/L;
- BOD: ≤10 mg/L;
- Suspended Solids: ≤10 mg/L; and
- EC <800 µS/cm.

RWIZs will likely be accessible to the public and residents either through direct exposure or inadvertent/secondary contact. Signage would be used to identify the use of recycled water for irrigation. The proposed RWP will treat recycled water to a quality which would be considered low risk for direct human contact (DWE 2008). The proposed recycled water quality will enable urban irrigation of community areas such as the recreation zone (29) with unrestricted access.

10.3 Recycled Water Quantity

The Building & Sustainability Index (BASIX), implemented under the NSW State Environmental Planning Policy Sustainability Index 2004 (BASIX SEPP), mandates water and energy saving targets for all new residential construction in NSW. BASIX requires fixtures, fittings and appliances to have minimum ratings in accordance with AS/NZS 6400:2005 (Water Efficient Products) under the Water Efficiency Labelling and Standards (WELS) scheme.

For BASIX approval a new residential development is required to demonstrate up to 40% less potable water usage than the average 'pre BASIX' benchmark home of 90.34 kL/person/year or 247 L/person/day. The 'pre BASIX' benchmark home was determined from data collaborated by NSW Department of Water and Energy (DWE) and included regional data reflecting both demographic and climate considerations. The Site is located within the Wyee BASIX region which has been prescribed a 40% reduction target. The BASIX reduction targets were determined from data provided by the state and federal water and energy utilities as well as long-term climate data obtained from the Bureau of Meteorology.

BASIX encourages reductions in the consumption of potable water through any of the following strategies: landscape uses, fixtures, alternative water, pools and spas, and central systems. The Site will utilise an alternative water source through the reticulation of recycled water, for garden and lawns, toilets and laundry (cold water) use, to meet the BASIX reduction targets. Additional listed strategies, i.e. fixtures, may also need to be used in addition to the alternative water source to meet the target.

Design Household

An equivalent tenement (ET) occupancy value (capita per new residence) was determined based on population density information collaborated by the Client from the most recent ABS Census of Population and Housing (2011). An ET of three (3) persons per new residence was adopted, which comprised the weighted-average of the Blue Haven, Woongarrah, and Watanobbi townships, which are representative of the proposed style of the new subdivision at the Site and with similar demographics.

10.3.1 Household Water Usage

Subsequently, household water (usage) demands have been conservatively estimated for each new residence as 741 L/ET/day (3 persons x 247 L/person/day). Assuming a minimum requirement to meet the 40% BASIX reduction target, a reduction of 297 L/ET/day will be required from the total household water demand for each new

residence. Figure 5 illustrates the proportional breakdown of the water use within a residential household based on BASIX targets and WELS scheme criteria.

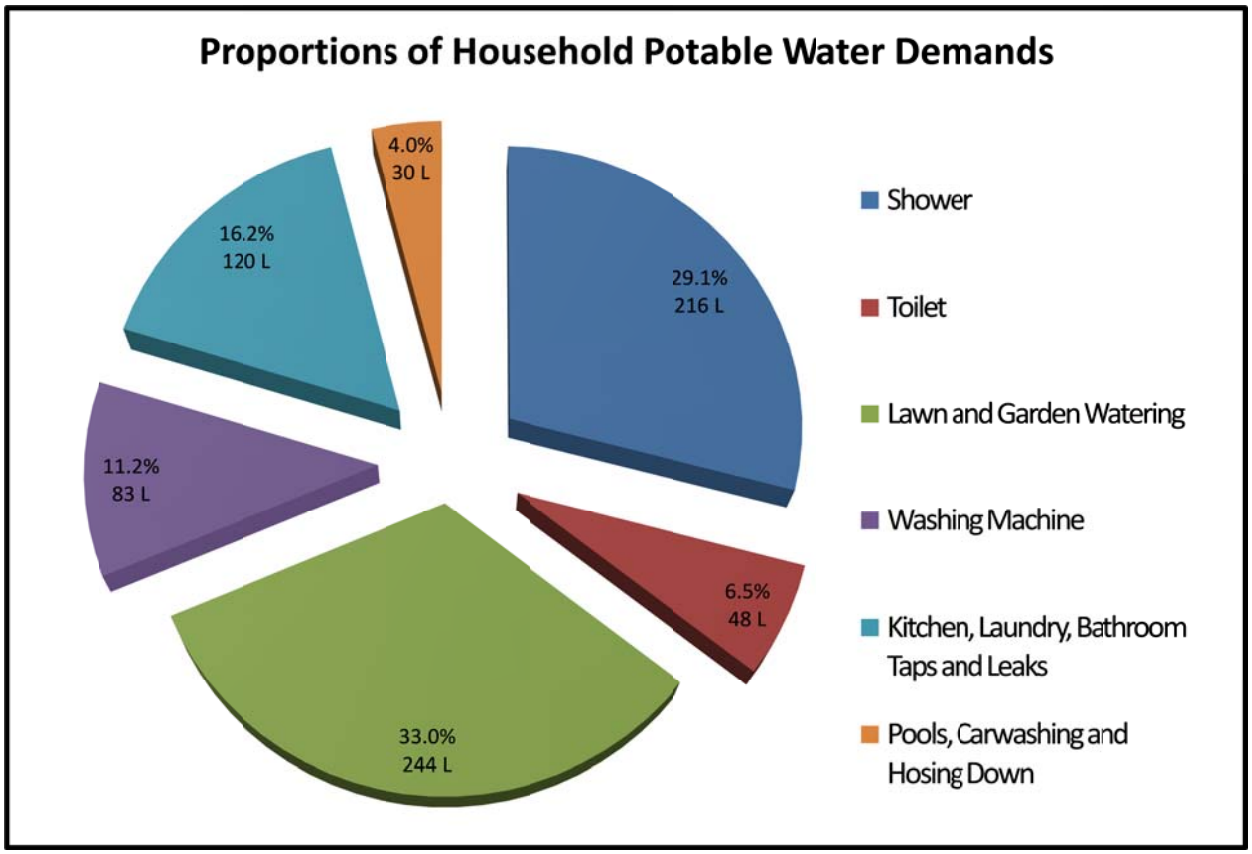

Figure 5: Proportional water usage within a residential household

The calculations and assumptions used in the proportioning of expected household usage based on BASIX and WELS scheme criteria are described further here.

Toilets

Based on the installation of retrofitted flush valves for single flush toilets only, 5.5 L / full flush is the maximum WELS scheme registered water consumption for toilets. The maximum water consumption for dual flush toilets, which will likely be installed is 4 L / flush (6 L full flush / 3 L half flush). We have assumed an average of 4 flushes/person/day (13 per weekend and 3 per weekday, averaged over the week). Therefore, the total water demand for toilets would be 48 L/ET/day. This equates to approximately 6.5% of the total household water demand.

Showers

The minimum NSW requirement, as per the Building Code Australia, for showerheads in new developments is a 3-star rating with a water consumption ranging between 4.5-9 L/min. As per BASIX calculations, for an assumed shower duration of 8 minutes (one shower a day), with a maximum allowable showerhead flow rate of 9 L/min, the total water consumption for showers would be 216 L/ET/day. This equates to approximately 29.1% of the total household water demand.

Washing Machines

BASIX requires the following WELS scheme (star) ratings to be met for washing machines: a load capacity greater than 5 kg requires greater than 3-star ratings and for less than 5 kg requires greater than 2.5-star ratings. The maximum consumption per load for a 2.5-star and a 3-star washing machine is an average 76 and 97 L/load, respectively. We have assumed the larger machine would be installed in each new

residence and also that a 'typical' 3-person household would do six (6) loads per week. Based on this, we estimate that, at 97 L/load, the total water consumption for washing machines would be 83 L/ET/day. This equates to approximately 11.2% of the total household water demand. Approximately one-third of the washing machine water usage is assumed to be with hot water (28 L/ET/day) and two-thirds with cold water (55 L/ET/day, respectively.

Kitchen, Laundry, Bathroom Taps and Leaks

The minimum BASIX requirements for taps is 3-star outlet tap sets with a maximum water consumption of 9.5 L/min and an average of 8.4 L/min. Assuming a 'typical' resident uses the taps for approximately 4 min/day at 8.4 L/min, then the estimated water consumption for taps is approximately 101 L/ET/day. This equates to approximately 13.5% of the total household water demand.

The water consumption of a dishwasher as a proportion of the total 'kitchen, laundry, bathroom taps and leaks' component was also determined. The minimum WELS scheme rating for dishwashers is 1.5-star, with a maximum water consumption of 18.6 L/wash. We have assumed a typical 3-person household does at least one wash per day. Therefore, the total water consumption for dishwashers is 18.6 L/ET/day. This equates to approximately 2.5% of the total household water demand. When combined with expected tap uses, this results in an estimated 16.2% total household water demand for 'kitchen, laundry, bathroom taps and leaks'.

The estimate of 16.2% for this particular household usage is validated by Sydney Water (2008) and Brisbane Water (QLD Department of Housing and Public Works, 2006) figures.

Pool, Car washing and Hosing Down

An approximate demand of 4% was adopted for (non-garden) external uses such as pool, car washing and hosing down. This equates to approximately 30 L/ET/day of the total household water demand. This was based on figures adopted by both Sydney Water (2008) and Brisbane Water (QLD Department of Housing and Public Works 2006).

Lawn and Garden Watering

As lawn and garden watering can include seasonal variability, it was the most difficult type of water demand to determine. By adopting the aforementioned proportions, the remaining 33% of on-lot usage is assigned for lawn and garden watering, which equates to approximately 244 L/ET/day. This value compares to an (approximate) average of other published values from Brisbane Water 42% (QLD Department of Housing and Public Works 2006) and Sydney Water 24% (2008), respectively.

10.3.2 Household Wastewater Generation

For the purposes of this report, the expected wastewater generation from the design household (ET) with a reticulated water supply is 467 L/ET/day, which is approximately 63% of the total potable water demand of 741 L/ET/day. The breakdown of the wastewater generating components of household fixtures is shown in Figure 6. The values are based on the BASIX and WELS scheme requirements and applied in the relative proportions as discussed in the previous section. It should be noted that the external household uses, lawn and garden watering and pools, car washing, and hosing down, do not contribute to the wastewater load.

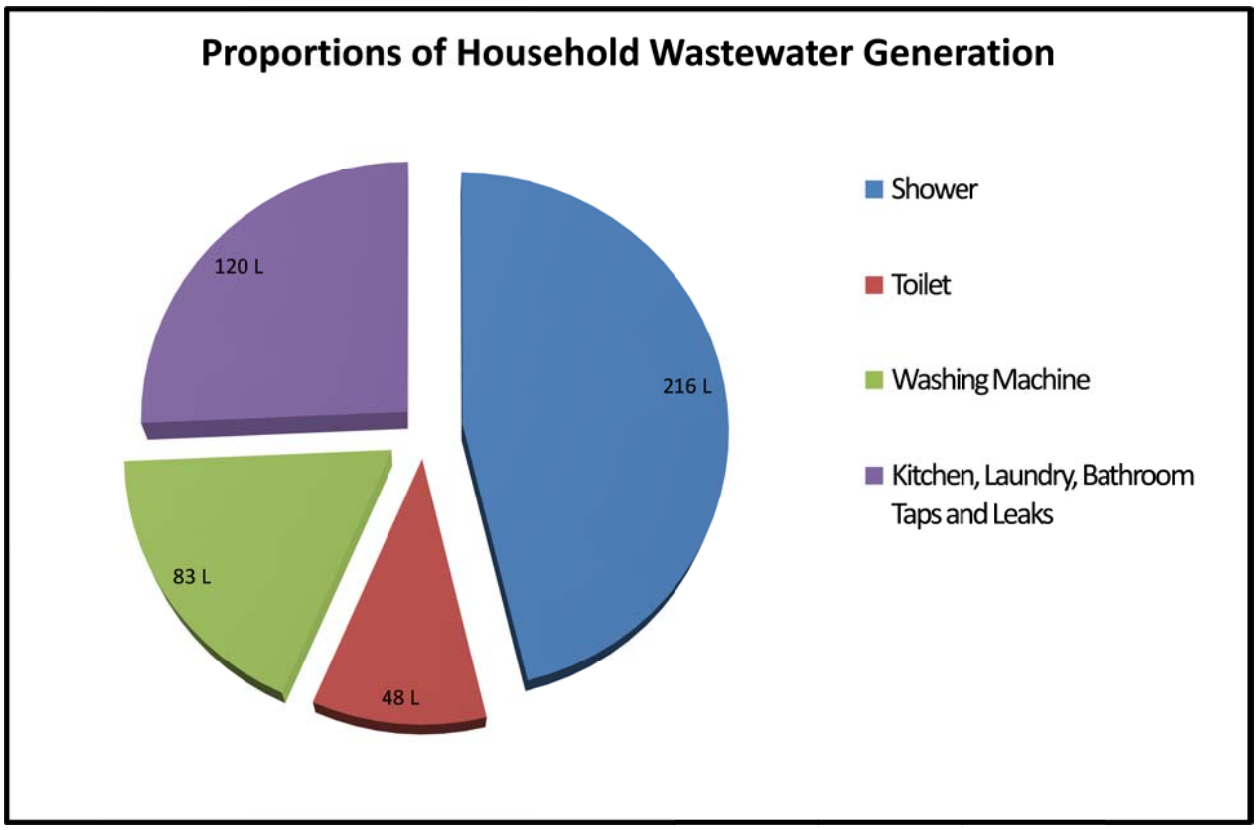

Figure 6: Proportional wastewater generation within a residential household

To determine the potential of recycled water returned to the dwellings in a dual-reticulation (third pipe) scenario, we investigated three different reuse scenarios representing annual seasonality. Table 4 shows the breakdown of each of these scenarios; peak, shoulder and low. These scenarios include the reuse of recycled water to replace potable water demand for the following uses: toilet (6.5%), lawn and garden watering (33%, 25% and 16.5%) and cold water washing machine only (7.5%).

Household Water Demand	Daily Household Potable Water Demand (L/ET/day)	Daily Household Wastewater Generation (L/ET/day)	Peak (Summer) [1] Recycled Water Reuse Potential	Shoulder (Autum/Spring)[2] Recycled Water Reuse Potential	Low (Winter) [3] Recycled Water Reuse Potential
Shower	**216**	216	0	0	0
Toilet	**48**	48	48	48	48
Lawn and Garden Watering	**244**	0	244	183	122
Washing Machine*	**83**	83	55	55	55
Kitchen, Laundry, Bathroom Taps and Leaks	**120**	120	0	0	0
Pools, Carwashing and Hosing Down	**30**	0	0	0	0
Total	**741**	**467**	347	286	225
Excess Recycled Water Available for Community Irrigation (L/ET/day)			**120**	**181**	**242**
Potable Water Demand After Reuse of Recycled Water (L/ET/day)			**394**	**455**	**516**

1. 100% of external uses 2. 75% of external uses 3. 50% of external uses.

*note washing machine reuse is for cold water tap only; therefore, reuse potential is 2/3 of total demand.

The internal reuse potential based on the peak (summer) scenario is 347 L/ET/day with the remaining 120 L/ET/day excess recycled water requiring community irrigation. The internal reuse potential based on the shoulder (autumn/spring) scenario is 286 L/ET/day with the remaining 181 L/ET/day excess recycled water requiring community irrigation. The internal reuse potential based on the low (winter) scenario is 225 L/ET/day with the remaining 242 L/ET/day excess recycled water requiring community irrigation.

Figure 7 presents a household water balance for the shoulder reuse scenario summarising the cycle of water demand, wastewater generation and reuse potential. Based on our assessment, each household has a potential to off-set between 30% (low) and 47% (peak) of the total potable water demand through the use of an alternative water (recycled water) source.

Therefore, the BASIX target of a 40% reduction in the total household water demand is readily achievable under the peak scenario. However, other methods, such as the installation of higher WELS scheme star rated fixtures, may need to be implemented in order to meet the BASIX target criteria for the entire year.

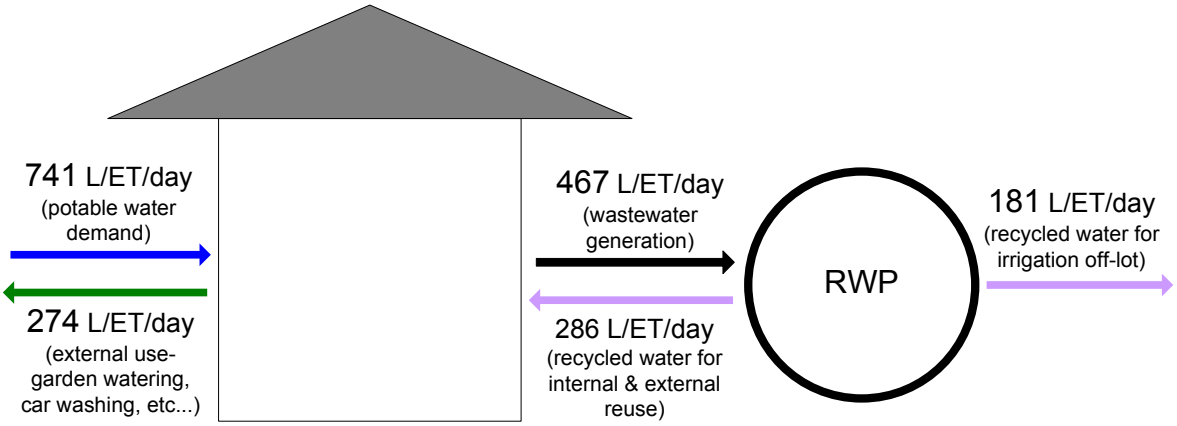

Figure 7: Household water balance for the shoulder period scenario

11 Recycled Water Management

11.1 Recommended Recycled Water Irrigation Zones

The available and appropriate areas for RWI on the Site are outlined in Figure 8. These areas exclude the recommended (minimum) setbacks from flood impacted / inundation areas as well as areas that are unsuitable for RWI such as localised fill, steep slopes or drainage lines.

Due to the nature of the development, which is to proceed in stages over a number of years, the (preliminary) RWI scheme has been developed in a manner compatible with the proposed development staging plan. The Site has been divided into three (3) Recycled Water Irrigation Zones (RWIZs) (1-3) identified for irrigation purposes and each of these has been linked to a number of development release stages. The three RWIZs include public open space surrounding the subdivision, the proposed recreation area to be located within the subdivision and, finally, the area comprising the final few release stages of the subdivision.

Three reuse/irrigation scenarios, Low, Peak and Shoulder have been modelled. Details of these scenarios are outlined in Section 11.2 below. For the three scenarios, development potential is high and the majority of reuse will occur within the recreation and open space areas identified for the Site with only Low and Shoulder Season scenarios requiring irrigation on future residential release areas; Stages 27 and 28 (Low Season) and Stage 26 (Shoulder Season) respectively.

11.2 Water and Nutrient Balance for Irrigation Area Sizing

The capacity of the RWIZs to manage the predicted hydraulic loads under seasonal variation has been assessed to determine the sustainability of the proposed irrigation scheme at the Site. The following scenarios have been assessed:

- Low Season (winter) ET_{IRR} of 242 L/day;

- Peak Season (summer) ET_{IRR} of 120 L/day;
- Shoulder Season (spring & autumn) ET_{IRR} of 181 L/day.

Both water and nutrient balances have been undertaken to determine sustainable irrigation rates for community land in the subdivision and the ultimate irrigation capacity to determine the maximum development potential of the subdivision before an alternative end-use must be found for the recycled water.

For this preliminary design, the water balance used is a monthly model adapted from the "Nominated Area Method" described in DLG (1998). These calculations determined minimum irrigation area requirements for given recycled water loads for each month of the year. The water balance can be expressed by the following equation:

Precipitation + Recycled Water Applied = Evapotranspiration + Percolation + Storage

Ideally, irrigation areas are calculated to achieve no net excess of water and hence zero wet weather storage for all months. A Design Irrigation Rate (DIR) of 3 mm/day was adopted for the Site based on the most limiting site / soil characteristics as described earlier in this report.

Conservative nutrient balances (annualised mass balance) were also undertaken to calculate the minimum area requirements to enable nutrients to be assimilated by the Site soils and vegetation. The nutrient balance used is based on the DLG (1998) methodology, but improves on this by more accurately accounting for natural nutrient cycles and processes. It acknowledges that a proportion of nitrogen will be retained in the soil through processes such as ammonification (the conversion of organic nitrogen to ammonia) and that a certain amount will be lost by denitrification, microbial digestion and volatilisation (Patterson, 2003). Patterson (2002) estimates that these processes may account for up to 40% loss of total nitrogen. We have adopted a more conservative estimate of 20% for the nitrogen losses due to soil processes.

Table 5 and Table 6 below provide details of the inputs for the water and nutrient balances for the RWI systems (surface and subsurface).

Table 5: Inputs for water balance

Data Parameter	Units	Value	Comments
Design Recycled Water Irrigation load (ET_{IRR})	L/ET/day	242	Low Season (winter)
		120	Peak Season (summer)
		181	Shoulder Season (autumn/spring)
Precipitation	mm/month	Mean rainfall	From BoM for Wyee (114 years)
Pan Evaporation	mm/month	Mean pan evaporation	From BoM Data Drill for Wyee Evaporation data (45 years)
Retained Rainfall	unitless	0.8	Proportion of rainfall that falls on the RWIZs and infiltrates the soil, allowing for up to 20% runoff from a well pastured gently sloping site

Data Parameter	Units	Value	Comments
Crop Factor	unitless	0.7-0.8	Expected annual range based on good ground cover and exposure
Design Irrigation Rate (DIR)	mm/day	3	Category 5 soils (Facet 3) from AS1547:2012, for most constrained conditions in proposed RWIZs

Table 6: Inputs for nutrient balances

Data Parameter	Units	Value	Comments
Recycled Water total nitrogen (TN)	mg/L	15	Minimum target recycled water quality from tertiary treatment system
Nitrogen lost to soil processes (denitrification and volatilisation)	annual percentage	15	Patterson (2002) Very conservative
Recycled Water total phosphorus (TP)	mg/L	5 (expected 2–5)	Minimum target recycled water quality from tertiary treatment system
Soil phosphorus sorption capacity	mg/kg	825	Weighted average for Site soils based on analyses
Nitrogen uptake rate by plants	kg/Ha/yr	250	Less than half that expected of irrigated pasture grass (DECCW, 2004 Table 4.2)
Phosphorus uptake rate by plants	kg/Ha/yr	25	Less than half that expected of irrigated pasture grass (DECCW, 2004 Table 4.2)
Design life of system (for nutrient management)	years	50	Reasonable service life for system

Table 7 summarises the results of the water and nutrient balances for the reuse design scenarios. Printouts of example water and nutrient balance spread sheets for each are also provided in Appendix C.

Table 7: Water & Nutrient Balance Results

Scenario	ET_{IRR}	Total Subdivision Daily Load (L)	Water Balance Requirement for RWIZs (m^2)	Area Required for Nitrogen Assimilation (m^2)	Area Required for Phosphorus Assimilation (m^2)	Storage Requirement (L)
Low	242	179,564	138,510	33,426	23,304	472,584
Peak	120	93,360	103,404	17,379	12,116	0
Shoulder	181	136,112	122,144	25,337	17,665	0

Table 7 demonstrates that for the proposed RWI scheme, the hydraulic load is limiting across the Site. The nitrogen and phosphorus balances require less area for sustainable assimilation and are therefore not considered limiting.

The results show that during the Low (winter) scenario, wet weather storage provision and/or alternative use for recycled water would be required once all stages of the subdivision have been fully developed.

The maximum number of dwellings which can be accommodated in the available area for each scenario has been determined. The analysis indicates at which development stage the design scenario is exceeded by the irrigation capacity, as shown in Table 8. If the Low season scenario is used for design, Stages 1 to 26 would be available for release with Stages 27 & 28, the recreation area and open space areas required for irrigation of excess recycled water as shown in Figure 8.

If the Peak season scenario is used for design, full development potential is available for the subdivision with all excess recycled water being irrigated in open space areas and recreation areas as shown in Figure 9. If the Shoulder season scenario is used for design, Stages 1 to 25, 27 & 28 would be available for development with Stage 26 required for use for irrigation of excess recycled water in conjunction with the open space and recreation areas as shown in Figure 10.

Table 8: Sustainable subdivision potential for available irrigation area

Scenario	Total No. of Dwellings which can be supported by Available Area	Recycled Water Irrigation Zones Available Area m^2	Number of Subdivision Release Stages which can be supported for each Scenario	Recycled Water Irrigation Zone Allocation
Low	742	138,510	1 to 26	Zone 1, 2 & 3 (Stage 27, 28, Recreation Area and Open Space Areas)
Peak	778	103,404	1 to 28 (full development)	Zone 1 & 2 (Recreation Area and Open Space Areas)
Shoulder	752	122,144	1 to 25 plus 27 & 28	Zone 1, 2 & 3 (Stage 26, Recreation Area and Open Space Areas)

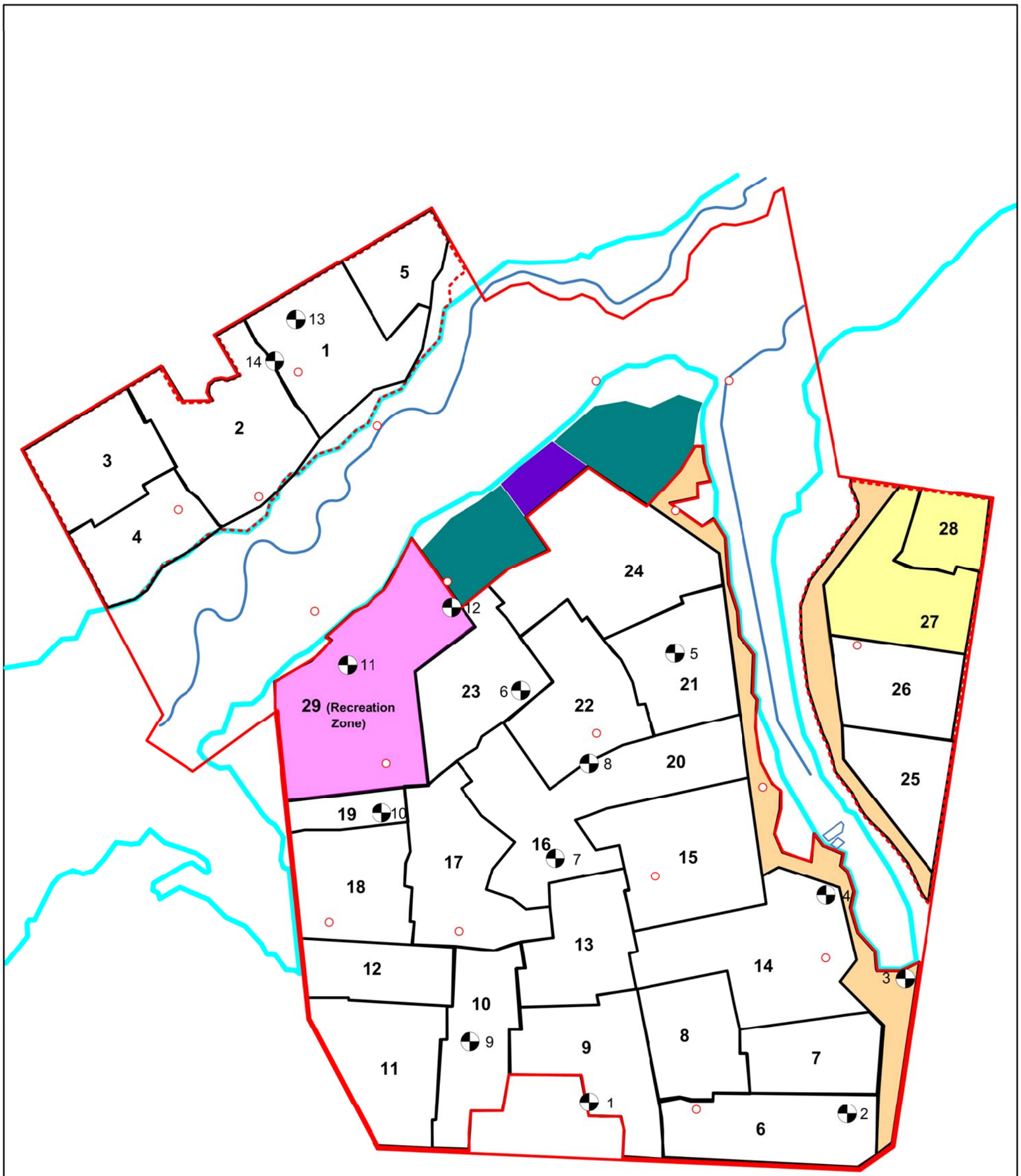

FIGURE 8: SITE PLAN SHOWING RECYCLED WATER IRRIGATION ZONES FOR THE LOW SEASON SCENARIO

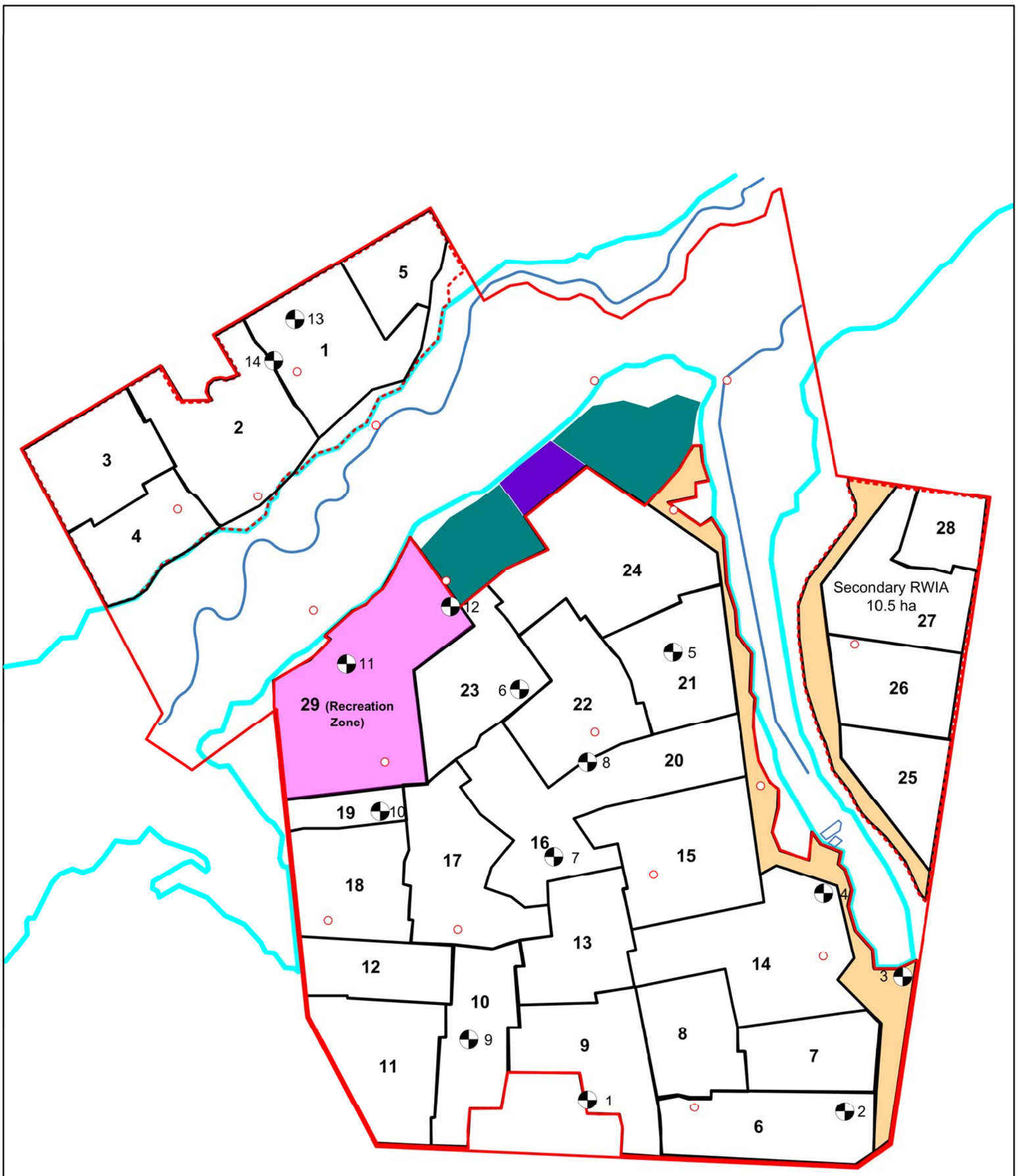

FIGURE 9: SITE PLAN SHOWING RECYCLED WATER IRRIGATION ZONES FOR THE PEAK SEASON SCENARIO

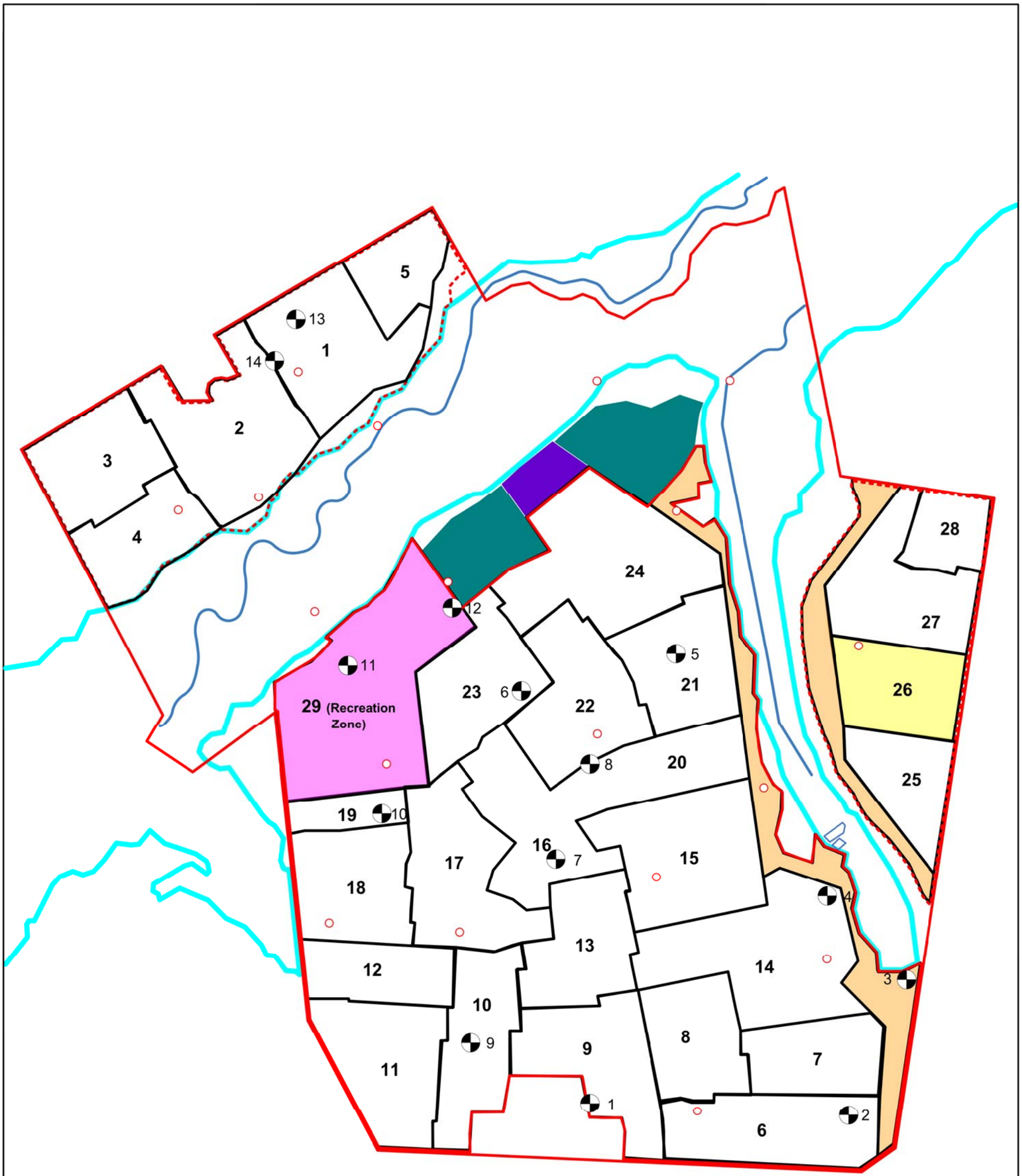

FIGURE 10: SITE PLAN SHOWING RECYCLED WATER IRRIGATION ZONES FOR THE SHOULDER SEASON SCENARIO

- Recycled Wastewater Treatment Plant
- Proposed Stormwater Detention Basins
- Soil Bore Hole
- Douglas Partners (2010) Geotechnical Assessment Soil Test Pit
- Applied Buffers Showing RWIAs
- Surface Watercourses
- Site Boundary
- 1% ARI Flood Level
- RWIZ 1- cleared areas to be re-vegetated
- RWIZ 2- Stage 29
- RWIZ 3- Stage 26

Project: LCA for Recycled Water Management Scheme, Wyee
Drawn: Jasmin Kable
Date: 8 March 2013
Scale: 1:4680 (approx) @A3

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A water balance was undertaken for each stage of the proposed subdivision to determine the suitability of different parts of the Site for irrigation of recycled water given that the Site covers a wide geographic area and contains a variety of limiting features. Appendix C contains printouts of the water and nutrient balances for a sample number of the stages. Where stages have been identified for irrigation reuse in Table 8, these stages have been selected to maximise the development potential of the Site. For example stages 10, 11, 12, 22 & 23 have limiting soils which can only sustain a DIR of 2 mm/day. This reduces the amount of irrigation (in number of potential dwellings equivalent) that could be irrigated in these larger areas and therefore these RWIZ are preferred for development rather than for irrigation.

The Low season scenario allows for irrigation in RWIZ 1 up to Stage 9, irrigation in RWIZ 2 up to Stage 20 and irrigation in RWIZ 3 up to Stage 26. Although Irrigation RWIZ 3 has been marked on the plan for irrigation purposes, this does not imply an equivalent area elsewhere on the Site is not suitable, however, land within proposed Stages 10, 11, 12, 22 & 23 will require lower design irrigation rates (DIR) than the land assigned to Stages 27 & 28.

The Low season scenario allows for the development of 742 lots of the proposed 778 lots. Even with the conditions proposed for Low season, there is a high potential for development and sustainable irrigation. Prior to development reaching Stage 26, there is an opportunity to gather a significant amount of water reuse data to more accurately determine water use within the subdivision. When development reaches Stage 26, with the collected data, a revised water balance could be undertaken to determine if development of the remaining two stages (Stage 27 & 28) could be undertaken sustainably without the requirement for alternative use of recycled water.

Wet weather storage or an alternative off-lot reuse option is required for the Low season scenario; however it would not be required until development reaches 677 lots (Stage 24). This is supported by a water balance to determine the maximum daily load which can be sustainably assimilated by the available irrigation area without the need for wet weather storage or an alternative off-lot reuse option. Once development reaches Stage 24 then wet weather storage or an alternative off-lot reuse option would be required.

11.3 Recycled Water Irrigation System

Whilst the exact details of the proposed irrigation systems are yet to be determined, with the final decision to be based on both financial and operational factors, it is considered most likely that large scale surface spray or drip irrigation by travelling irrigator would be the most suitable and preferred option.

Commercial-scale travelling irrigators are able to reliably irrigate large areas of pasture at controlled soil loading rates to ensure even irrigation distribution and avoid problems with waterlogging or runoff. The different soil types identified across the Site require that the Design Irrigation Rate (DIR) varies between 2-3.5 mm/day. An electronic control system will enable the programing of the irrigator so that correct doses of recycled water are applied in each zone. A detailed hydraulic and system design report should be prepared once final approval of the subdivision has been obtained and system selection is being undertaken.

12 Mitigation Measures

12.1 Vegetation Establishment and Management

Vegetation should be established within the proposed RWIZs. A complete vegetation cover is important to reduce the erosion hazard and optimise water and nutrient uptake.

A good cover of managed pasture (lucerne, ryegrass etc.) will be suitable for surface irrigation as suggested in this report. Achieving a nutrient balance within an irrigation area relies on nutrients being taken up by vegetation and then exported with the cut vegetation (e.g. baled or rolled). This balance can only be maintained by removing the cut material from the area.

12.2 Sodicity and Soil Improvement

Sodic soils are soils with an excess of sodium compared with calcium and magnesium on the soils' cation exchange sites. Generally, sodic soils can be highly susceptible to dispersion, erosion, structural decline and surface crusting, and can have very low infiltration capacities, low hydraulic conductivity and high shrink/swell properties on wetting and drying. These properties can reduce the soils' capacity to sustainably manage recycled water.

Soil sodicity is variable at the Site, with some topsoil and subsoil samples returning an ESP result of greater than 6%, which is considered to be sodic. While soils do not appear to be currently experiencing any appreciable drainage problems, erosion or structural decline, prolonged application of elevated-sodium recycled water could exacerbate the situation. Application of gypsum is a recognised way of reducing the effects of soil sodicity. It does this by supplying calcium to the affected soil and thereby elevating calcium concentrations with respect to sodium. It is recommended that gypsum be applied to soils in the RWIZs to reduce the potential for soil structural degradation and dispersion.

Gypsum is only slowly soluble in water so simply broadcasting it at the surface can be relatively difficult as it can take a long time for the calcium to penetrate the soil and reach the deeper soil layers. Therefore, it is necessary to incorporate gypsum into the limiting soil horizon at the time of application. One way to achieve this is to dose the irrigation water with a pre-mixed gypsum solution during the irrigation cycle. At scheme commencement, this practice should be undertaken for each irrigation area at an application rate of approximately 0.5 kg/m^2 of gypsum.

In the long term, soil sodicity within the RWIZs can be managed by the annual surface application of gypsum at a rate not less than 0.2 kg/m^2.

13 Conclusions and Recommendations

This report provides the results and recommendations of our investigations, including detailed site and soil investigations; assessment of the likely recycled water volumes from various subdivision stages; and determination of the most appropriate recycled water management technologies.

The site and soil investigation shows that the Site is diverse in terms of its physical characteristics such as topography, soil type, drainage and the presence of surface waters and groundwater; all of which influence the design and proposed location of the RWIZ(s) for surface irrigation of recycled water. The Site is highly constrained along the drainage lines and associated flood plains due to the high flood potential, presence of EECs and waterlogging of soils. However, all required buffers are achievable with regard to the location of the proposed RWIZ(s). The Site is separated into three (3) varying soil facets based on the limiting soil horizon throughout the Gorokan, Doyalson and Wyong soil landscapes. The dams and the intermittent drainage line located along the western boundary will likely be in-filled with appropriate soil and graded before commencement as outlined in this report. It is recommended that gypsum be applied to soils in the RWIZs to reduce the potential for soil structural decline and dispersion.

Having undertaken a land capability assessment of the Site at Hue Hue Road and Bushells Ridge Road Wyee, W&A consider that on-site surface irrigation is achievable up to, and including, the Stage 26 residential release if internal and external reuse of recycled water is provided to each new property (via dual-reticulation).

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Appendix A

Soil Borelogs

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Key to Soil Borelogs

Symbols

W	Watertable depth	●	Sample collected
X	Depth of refusal		

Moisture condition

D	Dry
SM	Slightly moist
M	Moist
VM	Very moist
W	Wet / saturated

Graphic Log and Textures

S - Sand LS - Loamy sand CS - Clayey sand	CL - Clay loam SCL - Sandy clay loam SiCL - Silty clay loam	Gravel (G)
SL - Sandy loam	LC - Light clay SC - Sandy clay	Parent material (stiff)
L - Loam LFS - Loam fine sandy SiL - Silty loam	MC - Medium clay HC - Heavy clay	Parent material (weathered)

Soil Bore Log

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Environmental Consultants Pty Ltd

Client:	Water Factory Company	**Test Pit No:**	**TP13**
Site:	Hue Hue Road and Bushells Road, Wyee	Excavated/logged by:	SM & JK
Date:	7 February 2013	Excavation type:	Mechanical Auger
Notes:	Surface condition good, 3% slope, south eastern aspect, wanning convergent slope, mixed pasture grasses, exposure great, located along cattle run which is compacted and eroded, as well as the presence of fill, refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1 0.2 0.3 0.4		• TP13/1	A	LS	massive	grey-brown	nil	<10%	SM	
0.5 0.6 0.7		• TP13/2	B	SC	pedal	yellow-grey brown	30% yellow-orange	nil	M	
0.8 0.9 1.0		• TP13/3	C	SC	pedal	yellow-grey brown	40% orange	20%	M	weathered parent material present with extensive gleying

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Water Factory Company	**Test Pit No:**	**TP2**
Site:	Hue Hue Road and Bushells Road, Wyee	Excavated/logged by:	SM & JK
Date:	7 February 2013	Excavation type:	Mechanical Auger
Notes:	Surface condition very moist, 1% slope, north eastern aspect, wanning convergent topography bordering on flood plain, groundcover mixed pasture grasses, exposure good (shady area to south of bore hole), indicative drainage of past inundation of the area, refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
0.2		• TP2/1	A	SL	weakly pedal	grey-brown	nil	nil	VM	
0.3										extensive gleying
0.4										
0.5										
0.6		• TP2/2	B	SC	pedal	grey-yellow brown	30% yellow to red mottling	nil	M	
0.7										
0.8										
0.9										pit terminated at 900mm
1.0										

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Water Factory Company	**Test Pit No:**	**TP3**
Site:	Hue Hue Road and Bushells Road, Wyee	Excavated/logged by:	SM & JK
Date:	7 February 2013	Excavation type:	Mechanical Auger
Notes:	Surface condition very moist, 1% slope, NNW aspect, waxing convergent topography with dam approximately 40 m away, groundcover mixed pasture grasses and mixed eucalypts, exposure poor, indicative drainage moist, refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1		• TP3/1	A	LS	massive	grey-brown	nil	nil	SM	
0.2		• TP3/2	B1	LS	massive	yellow-brown	20% yellow to orange	nil	SM	
0.3										
0.4										
0.5		• TP3/3	B2	CS	weakly pedal	orange-brown	40% orange	nil	SM	
0.6										
0.7										
0.8										
0.9										
1.0										

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Water Factory Company	**Test Pit No:**	**TP4**
Site:	Hue Hue Road and Bushells Road, Wyee	Excavated/logged by:	SM & JK
Date:	7 February 2013	Excavation type:	Mechanical Auger
Notes:	Surface condition moist but good, 2% slope, eastern aspect, wanning convergent topography on the floodplain with a drainage line directly to the east, groundcover mixed pasture grasses, expcsure good, water table depth at 250 mm, refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1 0.2		• TP4/1	A	LS	weakly pedal	yellow-brown	30% yellow	nil	M	
0.3 0.4 0.5 0.6		• TP4/2	B1	CS	weakly pedal	yellow-grey brown	30% yellow	nil	VM	
0.7 0.8		• TP4/3	B2	SC	weakly pedal	yellow-grey brown	30% orange-yellow	nil	VM	
0.9 1.0		• TP4/4	C	SC	weakly pedal	yellow-grey brown	40% yellow to red	20%		fragments <10mm

Soil Bore Log

Whitehead & Associates
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Client:	Water Factory Company	**Test Pit No:**	**TP5**
Site:	Hue Hue Road and Bushells Road, Wyee	Excavated/logged by:	SM & JK
Date:	7 February 2013	Excavation type:	Mechanical Auger
Notes:	Surface condition good, 2% slope, north eastern aspect, edge of visible floodplain with a drainage with drainage line directly to the NE, groundcover mixed pasture grasses, exposure good, indicative drainage is moist near edge of floodplain, refer site plan for positions of bcreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1 0.2 0.3 0.4		• TP5/1	A	LS	massive	grey-brown	20% yellow	nil	M	
0.5 0.6 0.7 0.8 0.9 1.0		• TP5/2	B1	SC	weakly pedal	yellow-grey brown	40% yellow to orange	10%	VM	coarse fragments <10mm

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Water Factory Company	**Test Pit No:**	**TP6**
Site:	Hue Hue Road and Bushells Road, Wyee	Excavated/logged by:	SM & JK
Date:	7 February 2013	Excavation type:	Mechanical Auger
Notes:	Surface condition good, 4% slope, north western aspect, edge of waxing convergent slope with drainage line directly to the NW, groundcover mixed pasture grasses, exposure very good, indicative drainage is moist, water table depth 950 mm, refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1		• TP6/1	A	HC	pedal	yellow-brown	50% yellow	nil	M	
0.2										
0.3										
0.4		• TP6/2	B	HC	pedal	yellow-grey brown	30% red	nil	M	extensive gleying from 700 mm
0.5										
0.6										
0.7										
0.8										
0.9										
1.0										pit terminated at 950mm

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Water Factory Company	**Test Pit No:**	**TP7**
Site:	Hue Hue Road and Bushells Road, Wyee	Excavated/logged by:	SM & JK
Date:	7 February 2013	Excavation type:	Mechanical Auger
Notes:	Surface condition good, 7% slope, north western aspect, waxing convergent slope, groundcover mixed pasture grasses, exposure very good, indicative drainage is moist, located on vehicle track near access gate, refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1		• TP7/1	A	LS	massive	grey-brown	nil	nil	M	
0.2										
0.3										
0.4		• TP7/2	B	CS	weakly pedal	yellow-brown	nil	20%	M	coarse sandstone cobbles, refusal at 450 mm
0.5										
0.6										
0.7										
0.8										
0.9										
1.0										

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Water Factory Company	**Test Pit No:**	**TP8**
Site:	Hue Hue Road and Bushells Road, Wyee	Excavated/logged by:	SM & JK
Date:	7 February 2013	Excavation type:	Mechanical Auger
Notes:	Surface condition good, 7-8% slope, north western aspect, waxing convergent slope, groundcover mixed pasture grasses, exposure very good, refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1 0.2 0.3 0.4		• TP8/1	A	LS	massive	grey-brown	nil	nil	M	
0.5 0.6 0.7		• TP8/2	B	CS	weakly pedal	yellow-grey brown	20% yellow to orange	10%	SM	coarse sandstone cobbles refusal at 750mm (sandstone)
0.8 0.9 1.0										

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Water Factory Company	**Test Pit No:**	**TP9**
Site:	Hue Hue Road and Bushells Road, Wyee	Excavated/logged by:	SM & JK
Date:	7 February 2013	Excavation type:	Mechanical Auger
Notes:	Surface condition fair, 3% slope, northern aspect, wanning divergent stepped ridge, mixed pasture grasses, long native grasses and mixed eucalpts, exposure fair (partly shaded), refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1		• TP9/1	A	LS	massive	grey-brown	nil	30%	SM	pebbles 10-40 mm diameter
0.2										
0.3		• TP9/2	B1	SC	pedal	yellow-grey brown	30% yellow	<10%	SM	
0.4										
0.5		• TP9/3	B2	HC	pedal	orange-brown	40% orange-red	<10%	SM	weathered parent material present
0.6										
0.7										refusal at 750mm
0.8										
0.9										
1.0										

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Water Factory Company	**Test Pit No:**	**TP10**
Site:	Hue Hue Road and Bushells Road, Wyee	Excavated/logged by:	SM & JK
Date:	7 February 2013	Excavation type:	Mechanical Auger
Notes:	Surface condition good, 1-2% slope, western aspect, bottom of linear divergent slope, mixed pasture grasses and sparse paperbark trees, exposure good (shaded at location of borehole), erosion along drainage line downslope, refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1		• TP10/1	A	CS	weakly pedal	grey-brown	nil	nil	SM	pebbles 10-40 mm diameter
0.2										
0.3										
0.4										
0.5										
0.6		• TP10/2	B1	SC	weakly pedal	yellow-brown	40% orange	nil	SM	
0.7										
0.8										
0.9										
1.0		• TP10/3	C	SC	pedal	orange-grey	50% orange-red	20%	SM	weathered parent material extensive gleying

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Water Factory Company	**Test Pit No:**	**TP11**
Site:	Hue Hue Road and Bushells Road, Wyee	Excavated/logged by:	SM & JK
Date:	7 February 2013	Excavation type:	Mechanical Auger
Notes:	Similar to BH 10: surface condition good, 2% slope, NNW aspect, wanning divergent slope, mixed pasture grasses and sparse paperbark trees, exposure fair to good, indicative drainage slightly moist, refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1 0.2 0.3 0.4 0.5 0.6 0.7		• TP11/1	A	LS	weakly pedal	grey-brown	nil	nil	SM	
0.8 0.9 1.0		• TP11/2	B	SC	pedal	yellow-grey brown	30% orange	<10%	M	gleying

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Water Factory Company	**Test Pit No:**	**TP12**
Site:	Hue Hue Road and Bushells Road, Wyee	Excavated/logged by:	SM & JK
Date:	7 February 2013	Excavation type:	Mechanical Auger
Notes:	Surface condition good, 3% slope, western aspect, wanning convergent slope, mixed pasture grasses, exposure great, cattle grazing in the paddock, refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1 0.2		• TP12/1	A	LS	massive	grey-brown	nil	<10%	SM	
0.3 0.4 0.5 0.6 0.7		• TP12/2	B1	SC	pedal	yellow-grey brown	30% orange	nil	SM	
0.8 0.9 1.0		• TP12/3	B2	SC	pedal	orange	50% orange-red	20%	SM	

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Water Factory Company	**Test Pit No:**	**TP13**
Site:	Hue Hue Road and Bushells Road, Wyee	Excavated/logged by:	SM & JK
Date:	7 February 2013	Excavation type:	Mechanical Auger
Notes:	Surface condition good, 3% slope, south eastern aspect, wanning convergent slope, mixed pasture grasses, exposure great, located along cattle run which is compacted and eroded, as well as the presence of fill, refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1 0.2 0.3 0.4		• TP13/1	A	LS	massive	grey-brown	nil	<10%	SM	
0.5 0.6 0.7		• TP13/2	B	SC	pedal	yellow-grey brown	30% yellow-orange	nil	M	
0.8 0.9 1.0		• TP13/3	C	SC	pedal	yellow-grey brown	40% orange	20%	M	weathered parent material present with extensive gleying

Soil Bore Log

Whitehead & Associates
Environmental Consultants Pty Ltd

Client:	Water Factory Company	**Test Pit No:**	**TP14**
Site:	Hue Hue Road and Bushells Road, Wyee	Excavated/logged by:	SM & JK
Date:	7 February 2013	Excavation type:	Mechanical Auger
Notes:	Surface condition good, 3-4% slope, south eastern aspect, warming convergent slope, mixed pasture grasses, exposure great, indicative drainage good, located north of relic farming shed, refer site plan for positions of boreholes		

PROFILE DESCRIPTION

Depth (m)	Graphic Log	Sampling depth/name	Horizon	Texture	Structure	Colour	Mottles	Coarse Fragments	Moisture Condition	Comments
0.1										
0.2		• TP14/1	A	CS	massive	grey-brown	nil	<10%	SM	
0.3										
0.4										
0.5		• TP14/2	B	HC	pedal	yellow-brown	30% yellow-orange	nil	SM	gleying
0.6										
0.7		• TP14/3	C	SC	pedal	yellow-grey brown	40% orange	nil	M	gleying pit terminated at 700mm
0.8										
0.9										
1.0										

Appendix B

Soil Analytical Test Results

Sheet 1 - Soil Sampling Schedule and Results of pH, EC and Emerson Aggregate Test Analysis

Site	Sample Name	Sample Depth (mm)	Texture Class	EAT [1]	Rating [2]	pH_f [3]	$pH_{1:5}$ [4]	Rating	$EC_{1:5}$ (µS/cm)	ECe (dS/m) [5]	Rating	Other analysis [6]
TP1	1/1	100	SC	2	High	n/a	5.0	Very strongly acid	32	0.00	Non-saline	
	1/2	400	SC	2	High	n/a	5.2	Strongly acid	23	0.00	Non-saline	
TP2	2/1	100	SL	1	High	n/a	5.0	Very strongly acid	14	0.15	Non-saline	
	2/2	400	SC	2	High	n/a	4.6	Very strongly acid	21	0.00	Non-saline	
TP3	3/1	50	LS	1	High	n/a	4.5	Extremely acid	17	0.00	Non-saline	
	3/2	200	LS	2	High	n/a	4.7	Very strongly acid	8	0.00	Non-saline	
	3/3	800	CS	2	High	n/a	4.5	Extremely acid	12	0.00	Non-saline	
TP4	4/1	100	LS	2	High	n/a	4.3	Extremely acid	13	0.00	Non-saline	
	4/2	300	CS	2	High	n/a	4.2	Extremely acid	13	0.00	Non-saline	
	4/3	700	SC	2	High	n/a	4.1	Extremely acid	17	0.00	Non-saline	
	4/4	900	SC	2	High	n/a	4.0	Extremely acid	22	0.00	Non-saline	
TP5	5/1	100	LS	2	High	n/a	4.2	Extremely acid	13	0.00	Non-saline	
	5/2	500	SC	2	High	n/a	4.0	Extremely acid	16	0.00	Non-saline	
TP6	6/1	100	HC	2	High	n/a	4.0	Extremely acid	66	0.40	Non-saline	
	6/2	400	HC	2	High	n/a	4.2	Extremely acid	203	1.22	Non-saline	
TP7	7/1	100	LS	2	High	n/a	4.5	Extremely acid	18	0.00	Non-saline	
	7/2	350	CS	2	High	n/a	4.2	Extremely acid	13	0.00	Non-saline	
TP8	8/1	100	LS	2	High	n/a	6.1	Slightly acid	81	0.00	Non-saline	
	8/2	500	CS	2	High	n/a	5.7	Moderately acid	46	0.00	Non-saline	
TP9	9/1	100	LS	2	High	n/a	5.2	Strongly acid	11	0.00	Non-saline	
	9/2	300	SC	2	High	n/a	4.9	Very strongly acid	53	0.00	Non-saline	
	9/3	500	HC	2	High	n/a	4.6	Very strongly acid	82	0.49	Non-saline	
TP10	10/1	100	CS	2	High	n/a	4.2	Extremely acid	11	0.00	Non-saline	
	10/2	300	SC	2	High	n/a	4.5	Extremely acid	10	0.00	Non-saline	
	10/3	950	SC	2	High	n/a	4.4	Extremely acid	19	0.00	Non-saline	
TP11	11/1	100	LS	2	High	n/a	4.6	Very strongly acid	19	0.00	Non-saline	
	11/2	800	SC	2	High	n/a	4.7	Very strongly acid	27	0.00	Non-saline	
TP12	12/1	100	LS	2	High	n/a	4.6	Very strongly acid	32	0.00	Non-saline	
	12/2	300	SC	2	High	n/a	4.6	Very strongly acid	27	0.00	Non-saline	
	12/3	800	SC	2	High	n/a	4.5	Extremely acid	28	0.00	Non-saline	
TP13	13/1	100	LS	2	High	n/a	5.2	Strongly acid	32	0.00	Non-saline	
	13/2	500	SC	2	High	n/a	5.0	Very strongly acid	30	0.00	Non-saline	
	13/3	650	SC	2	High	n/a	4.9	Very strongly acid	29	0.00	Non-saline	
TP14	14/1	100	CS	2	High	n/a	4.3	Extremely acid	89	0.00	Non-saline	
	14/2	500	HC	2	High	n/a	4.1	Extremely acid	202	1.21	Non-saline	
	14/3	650	HC	2	High	n/a	4.1	Extremely acid	189	1.13	Non-saline	

Notes:- (also refer Interpretation Sheet 1)

[1] The modified Emerson Aggregate Test (EAT) provides an indication of soil susceptibility to dispersion.

[2] Ratings describe the likely hazard associated with land application of treated wastewater.

[3] pH measured in the field using Raupac Indicator.

[4] pH measured on 1:5 soil:water suspensions using a *Hanna Combo* hand-held pH/EC/temp meter.

[5] Electrical conductivity of the saturated extract (Ece) = $EC_{1:5}$(µS/cm) x MF / 1000. Units are dS/m. MF is a soil texture multiplication factor.

[6] External laboratories used for the following analyses, if indicated:

- CEC (Cation exchange capacity)
- Psorb (Phosphorus sorption capacity)
- Bray Phosphorus
- Organic carbon
- Total nitrogen

Sheet 2 - Results of External Laboratory Analysis

Site	Name	Depth (mm)	CEC (me/100g)		Ca (mg/kg)		Mg (mg/kg)		Na (mg/kg)		K (mg/kg)		ESP (%)		P-sorp. (kg/ha)	Weighted P-sorp. (kg/ha)	Weighted p-sorp. (mg/kg)	
TP 1	1/1,2	400	10.4	L	97	VL	255	M	71	M	90	L	3.0	NS	10600.0	10600.0		n/a
	Total 1																1081.6	VH
TP 2	2/2	400	9.6	L	90	VL	206	M	40	L	46	VL	1.8	NS	7700.0	5560.9		n/a
	2/1 using 4/1 LS topsoil														1100.0	305.6		n/a
	Total 2																465.6	H
TP 4	4/1	100	1.8	VL	40	VL	15	VL	17	VL	13	VL	4.2	NS	1100.0	220.0		n/a
	4/2,3,4	900	4.0	VL	32	VL	71	L	30	L	14	VL	3.2	NS	2500.0	2000.0		n/a
	Total 4																158.6	M
TP 6	6/2	400	30.2	H	25	VL	769	H	650	VH	83	L	9.4	S	15600.0	15600.0		n/a
	Total 6																1172.9	VH
TP 9	9/1,2 comp	300	5.7	VL	16	VL	117	L	41	L	29	VL	3.2	NS	5100.0	3228.3		n/a
	9/3	500	12.4	M	13	VL	489	H	126	M	52	VL	4.4	NS	16700.0	6680.0		n/a
	Total 9																943.7	VH
TP 10	10/1	100	2.0	VL	69	VL	46	L	26	L	15	VL	5.7	NS	2300.0	460.0		n/a
	10/2,3	950	3.9	VL	44	VL	187	M	56	L	16	VL	6.3	S	4600.0	3680.0		n/a
	Total 10																295.7	MH
TP 14	14/1,2,3 comp (total)	650	4.5	VL	410	L	160	M	84	M	32	VL	8.0	S	2700.0	1157.2		n/a
	for 14/1 used 10/1 CS topsoil														2300	1314		n/a
	Total 14																252.19	MH
																average	*825.9*	*VH*

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Lanfax Laboratories
ABN 72 212 385 096
Proficiency tested by Aust. Soil & Plant Analysis Council Inc. ASPAC

18th February 2013

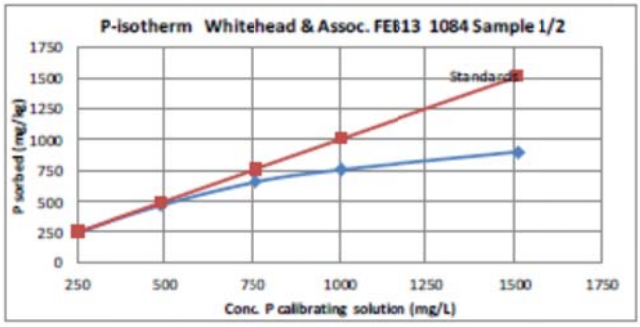
Whitehead & Associates
197 Main Road
Cardiff NSW 2285

Soil Report: Project 1084 Bushells Ridge Road Wyee
Samples received 13th February 2013, sample date 7th February 2013
Samples dried to 50°C, crushed and sieved to minus 2 mm prior to analysis

Whitehead & Assoc. 1084 - Wyee - 07Feb13													
Exc.Al+H	Ca		K		Mg		Na		Base Sat.	ESP	CEC	Ca/Mg	Site Location
cmol+/kg	mg/kg	cmol+/k	mg/kg	cmol+/kg	mg/kg	cmol+/kg	mg/kg	cmol+/kg	%	%	cmol+/k	ratio	Sample ID
7.28	97	0.48	90	0.23	255	2.09	71	0.31	30.0	3.0	10.4	0.2	1084 - sample 1/2
7.12	90	0.45	46	0.12	206	1.70	40	0.17	25.5	1.6	9.6	0.3	1084 - sample 2/2
1.36	40	0.20	13	0.03	15	0.13	17	0.08	24.2	4.2	1.6	1.5	1084 - sample 4/1
3.12	32	0.16	14	0.04	71	0.59	30	0.13	22.6	3.2	4.0	0.3	1084 - sample 4/2,3,4
20.72	25	0.13	83	0.21	769	6.32	650	2.83	31.4	9.4	30.2	0.0	1084 - sample 6/2
4.40	16	0.08	29	0.07	117	0.97	41	0.18	22.8	3.2	5.7	0.1	1084 - sample 9/1,2
7.60	13	0.06	52	0.13	489	4.03	126	0.55	38.6	4.4	12.4	0.0	1084 - sample 9/3
1.12	69	0.34	15	0.04	46	0.38	26	0.11	43.7	5.7	2.0	0.9	1084 - sample 10/1
1.84	44	0.22	16	0.04	187	1.54	56	0.24	52.6	6.3	3.9	0.1	1084 - sample 10/2,3
0.72	410	2.04	32	0.08	160	1.32	84	0.36	84.1	8.0	4.5	1.5	1084 - sample 14 comp

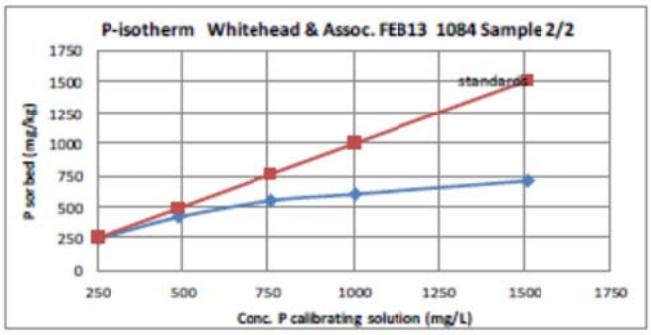
Methods: Rayment & Lyons 2011
Exchangeable acidity (H^+, Al^{3+}) Method 15 G1
Effective Cation Exchange Capacity Method 15D3 plus exchangeable acidity
Exchangeable sodium percentage ratio sodium to ECEC
P sorption modified method 9J1 - elevated equilibrating solutions, ICP determination of P

Dr Robert Patterson



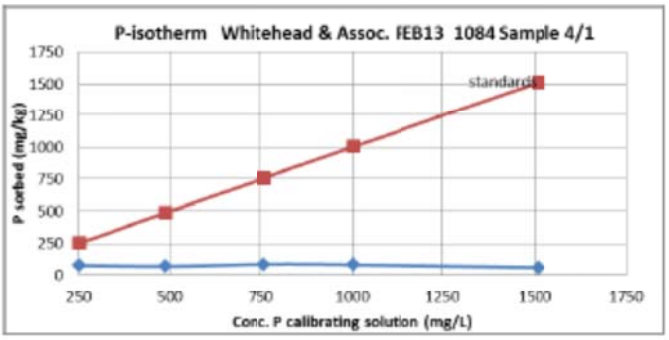
Percent sorbed is the proportion of the initial P sorbed during equilibration

Initial P mgP/L	filtrate P mg/L	sorbed P mg/kg	Sample I.D.	Percent sorbed (%)
25.2	0.26	249.8	Whitehead & Assoc. FEB13	99.0
48.8	2.15	466.6	1084 Sample 1/2	95.6
76.0	10.41	655.4		86.3
100.3	24.80	755.0		75.3
151.0	60.92	900.8		59.7
Calculated P sorption kg/ha =			10600	



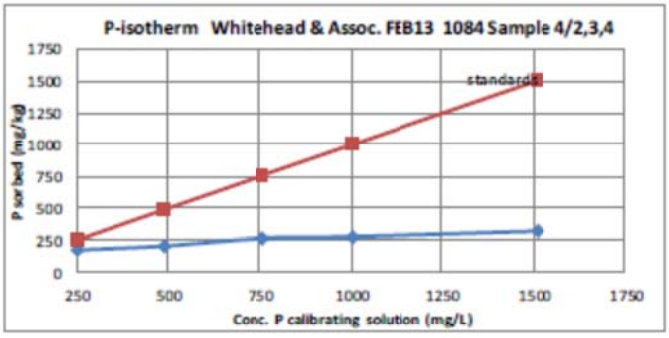
Percent sorbed is the proportion of the initial P sorbed during equilibration

Initial P mgP/L	filtrate P mg/L	sorbed P mg/kg	Sample I.D.	Percent sorbed (%)
25.2	0.78	244.6	Whitehead & Assoc. FEB13	96.9
48.8	7.01	418.0	1084 Sample 2/2	85.6
76.0	21.14	548.1		72.2
100.3	40.26	600.4		59.9
151.0	80.35	706.5		46.8
Calculated P sorption kg/ha =			7700	



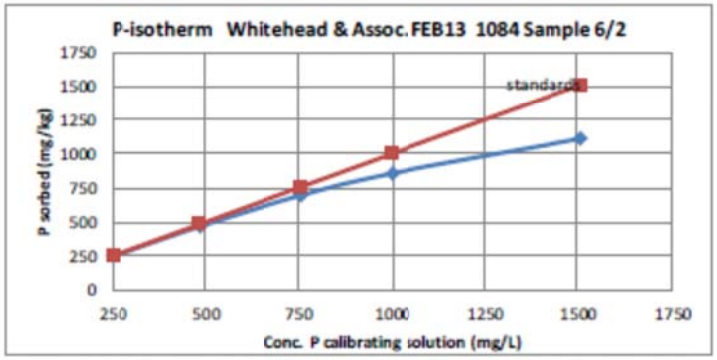
Percent sorbed is the proportion of the initial P sorbed during equilibration

Initial P	filtrate	sorbed P	Sample	Percent
mgP/L	P	mg/kg	I.D.	sorbed
	mg/L			(%)
25.2	17.56	76.8	Whitehead & Assoc. FEB13	30.4
48.8	41.88	69.3	1084 Sample 4/1	14.2
76.0	67.41	85.4		11.2
100.3	92.11	81.9		8.2
151.0	145.10	59.0		3.9
	Calculated P sorption kg/ha =	1100		



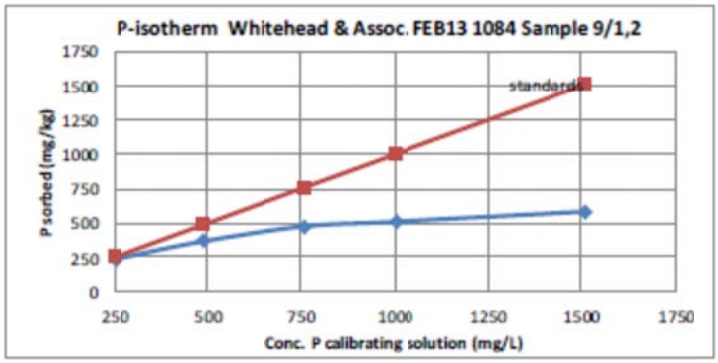
Percent sorbed is the proportion of the initial P sorbed during equilibration

Initial P	filtrate	sorbed P	Sample	Percent
mgP/L	P	mg/kg	I.D.	sorbed
	mg/L			(%)
25.2	7.67	175.7	Whitehead & Assoc. FEB13	69.6
48.8	28.12	206.9	1084 Sample 4/2,3,4	42.4
76.0	49.31	266.4		35.1
100.3	72.57	277.3		27.6
151.0	119.00	320.0		21.2
	Calculated P sorption kg/ha =	2500		



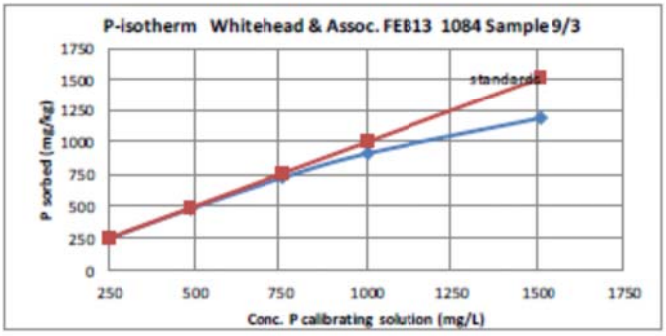
Percent sorbed is the proportion of the initial P sorbed during equilibration

Initial P	filtrate	sorbed P	Sample	Percent
mgP/L	P	mg/kg	I.D.	sorbed
	mg/L			(%)
25.2	0.23	250.1	Whitehead & Assoc. FEB13	99.1
48.8	1.71	471.0	1084 Sample 6/2	96.5
76.0	6.21	697.4		91.8
100.3	14.48	858.2		85.6
151.0	39.80	1112.0		73.6
Calculated P sorption kg/ha =		15600		



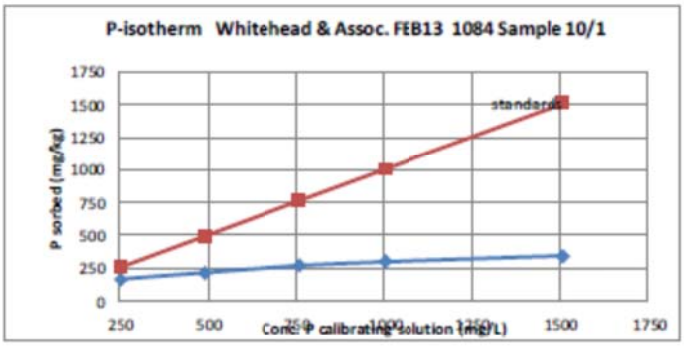
Percent sorbed is the proportion of the initial P sorbed during equilibration

Initial P	filtrate	sorbed P	Sample	Percent
mgP/L	P	mg/kg	I.D.	sorbed
	mg/L			(%)
25.2	1.46	237.8	Whitehead & Assoc. FEB13	94.2
48.8	12.04	367.7	1084 Sample 9/1,2	75.3
76.0	28.33	476.2		62.7
100.3	49.25	510.5		50.9
151.0	92.65	583.5		38.6
Calculated P sorption kg/ha =		5100		



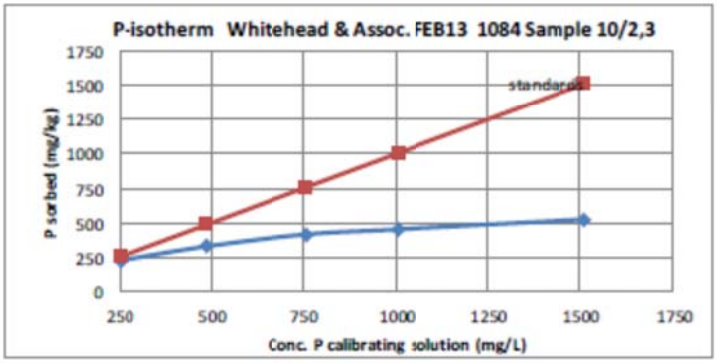
Percent sorbed is the proportion of the initial P sorbed during equilibration

Initial P	filtrate	sorbed P	Sample	Percent
mgP/L	P	mg/kg	I.D.	sorbed
	mg/L			(%)
25.2	0.18	250.6	Whitehead & Assoc. FEB13	99.3
48.8	0.84	479.7	1084 Sample 9/3	98.3
76.0	3.56	723.9		95.3
100.3	9.11	911.9		90.9
151.0	31.86	1191.4		78.9
Calculated P sorption kg/ha =			16700	



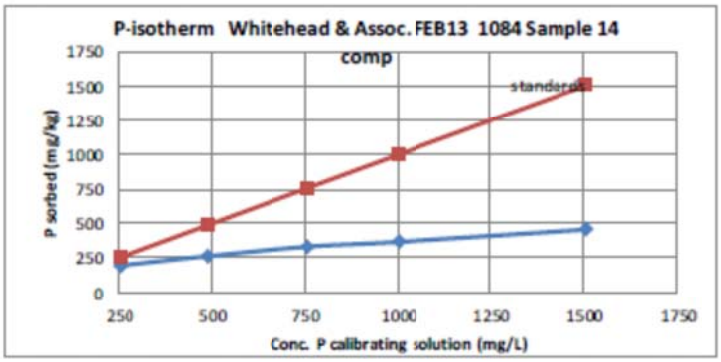
Percent sorbed is the proportion of the initial P sorbed during equilibration

Initial P	filtrate	sorbed P	Sample	Percent
mgP/L	P	mg/kg	I.D.	sorbed
	mg/L			(%)
25.2	8.96	162.8	Whitehead & Assoc. FEB13	64.5
48.8	27.64	211.7	1084 Sample 10/1	43.4
76.0	49.47	264.8		34.9
100.3	70.90	294.0		29.3
151.0	116.90	341.0		22.6
Calculated P sorption kg/ha =			2300	



Percent sorbed is the proportion of the initial P sorbed during equilibration

Initial P	filtrate	sorbed P	Sample	Percent
mgP/L	P	mg/kg	I.D.	sorbed
	mg/L			(%)
25.2	2.57	226.8	Whitehead & Assoc. FEB13	89.8
48.8	15.78	330.3	1084 Sample 10/2,3	67.7
76.0	34.25	417.0		54.9
100.3	55.01	452.9		45.2
151.0	98.55	524.5		34.7
Calculated P sorption kg/ha =			4600	



Percent sorbed is the proportion of the initial P sorbed during equilibration

Initial P	filtrate	sorbed P	Sample	Percent
mgP/L	P	mg/kg	I.D.	sorbed
	mg/L			(%)
25.2	5.70	195.5	Whitehead & Assoc. FEB13	77.4
48.8	22.39	264.2	1084 Sample 14 comp	54.1
76.0	42.62	333.3		43.9
100.3	63.47	368.3		36.7
151.0	105.22	457.8		30.3
Calculated P sorption kg/ha =			2700	

Appendix C

Water and Nutrient Balance Spreadsheets

Water & Nutrient Balance Scenario Low Season

Nominated Area Water Balance & Storage Calculations

Site Address: Hue Hue Road Wyee

INPUT DATA

Design Wastewater Flow	Q	179.564	L/day	Daily load from typical Expected Persons (EP) values
Design Percolation Rate	DPR	21	mm/week	Weekly Design Infiltration Percolation Rate (DPR)
Daily DPR		3.0	mm/day	Litres per sq.m. per day - based on Table M1 AS/NZS 1547:2012 for secondary effluent
Nominated Land Application Area	L	138510	m.sq	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type
Crop Factor	C	0.7-0.8	unitless	Proportion of rainfall that remains onsite and infiltrates; function of slope/cover, allowing for any runoff
Runoff Coefficient		0.8	unitless	Proportion of rainfall that appears as stormwater run-off
Rainfall Data		Wyee (Wyee Farms Road)		Mean Monthly Data (1899 - 2013)
Evaporation Data		Wyee data drill		Mean Monthly Data (1970 - 2007)

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D	\	days	31	28	31	30	31	30	31	31	30	31	30	31	366
Rainfall	R	\	mm/month	110.3	130.7	132.4	127	111.3	111.9	78.4	69	69.3	75.6	84	99	1,192
Evaporation	E	\	mm/month	171	136	121	93	63	50	58	83	109	140	149	179	1,348
Daily Evaporation				5.5	4.9	3.9	2.9	2.0	1.7	1.9	2.7	3.6	4.5	5.0	5.8	
Crop Factor	C			0.80	0.80	0.80	0.70	0.70	0.70	0.70	0.70	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	137	109	97	65	44	35	41	58	76	112	119	143	1032.6
Percolation	B	(DPR/7)xD	mm/month	93.0	84	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0	1096.0
Outputs		ET+B	mm/month	229.8	192.8	189.8	151.6	137.1	125.0	133.6	151.1	166.3	205.0	209.2	236.2	2127.6
INPUTS																
Retained Rainfall	RR	R*runoff coef	mm/month	88.24	104.56	105.92	101.6	89.04	89.52	62.72	55.2	55.44	60.48	67.2	79.2	869.12
Effluent Irrigation	W	(QxD)/L	mm/month	40.2	36.3	40.2	38.9	40.2	38.9	40.2	40.2	38.9	40.2	38.9	40.2	473.2
Inputs		RR+W	mm/month	128.4	140.9	146.1	140.5	129.2	128.4	102.9	95.4	94.3	100.7	106.1	119.4	1432.3
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	
Storage for the month	S	(RR+W)-(ET+B)	mm/month	-101.4	-51.9	-43.7	-11.1	-7.9	3.4	-30.7	-55.7	-72.0	-104.3	-103.1	-116.8	-197.6
Cumulative Storage	M		mm	0.0	0.0	0.0	0.0	0.0	3.4	0.0	0.0	0.0	0.0	0.0	0.0	3.4
Maximum Storage for Nominated Area	N		mm	3.41												
	V	NxL	L	472584												
LAND AREA REQUIRED FOR ZERO STORAGE			m²	39322	8979	66062	107738	116824	151830	78834	58048	40592	38517	37936	38455	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 151830 m²

Nutrient Balance

Site Address: Hue Hue Road

Please read the attached notes before using this spreadsheet.

SUMMARY - LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING BALANCE = 33,426 m²

INPUT DATA [1]

Wastewater Loading			Nutrient Crop Uptake				
Hydraulic Load	179,564	L/Day	Crop N Uptake	250	kg/ha/yr	which equals	68 mg/m²/day
Effluent N Concentration	15	mg/L	Crop P Uptake	25	kg/ha/yr	which equals	7 mg/m²/day
% Lost to Soil Processes (Geary & Gardner 1996)	0.15	Decimal	Phosphorus Sorption				
Total N Loss to Soil	404,019	mg/day	P-sorption result	825.88	mg/kg	which equals	11,562 kg/ha
Remaining N Load after soil loss	2,289,441	mg/day	Bulk Density	1.4	g/cm³		or
Effluent P Concentration	5	mg/L	Depth of Soil	1	m	which equals	15600 kg/ha
Design Life of System	50	yrs	% of Predicted P-sorp.[2]	0.5	Decimal		1114.285714 mg/kg

METHOD 1: NUTRIENT BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer		
Nitrogen	33426	m²
Phosphorus	23,304	m²

Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)

Nominated LAA Size	138510	m²
Predicted N Export from LAA	-2627.11	kg/year
Predicted P Export from LAA	-1620.07	kg/year
Phosphorus Longevity for LAA	-4312	Years
Minimum Buffer Required for excess nutrient	0	m²

PHOSPHORUS BALANCE

STEP 1: Using the nominated LAA Size

Nominated LAA Size	138510	m²				
Daily P Load	0.89782	kg/day	→	Phosphorus generated over life of system	16385.215	kg
Daily Uptake	0.948699	kg/day	→	Phosphorus vegetative uptake for life of system	0.125	kg/m²
Measured p-sorption capacity	1.156232	kg/m²				
Assumed p-sorption capacity	0.578	kg/m²	→	Phosphorus adsorbed in 50 years	0.578	kg/m²
Site P-sorption capacity	80074.87	kg	→	Desired Annual P Application Rate	1947.773	kg/year
				which equals	5.33836	kg/day
P-load to be sorbed	-18.57	kg/year				

NOTES

[1]. Model sensitivity to input parameters will affect the accuracy of the result obtained. Where possible site specific data should be used. Otherwise data should be obtained from a reliable source such as,

- *Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households*
- *Appropriate Peer Reviewed Papers*
- *EPA Guidelines for Effluent Irrigation*
- *USEPA Onsite Systems Manual.*

[2]. Conservative estimate based on work by Geary & Gardner (1996) and Patterson (2002).

[3]. A multiplier, normally between 0.25 and 0.75, is used to estimate actual P-sorption under field conditions which is assumed to be less than laboratory estimates.

Water & Nutrient Balance Scenario Peak Season

Nominated Area Water Balance & Storage Calculations

Site Address: Hue Hue Road Wyee

INPUT DATA

Design Wastewater Flow	Q	93,360	L/day	Daily load from typical Expected Persons (EP) values
Design Percolation Rate	DPR	21	mm/week	Weekly Design Infiltration Percolation Rate (DIPR)
Daily DPR		3.0	mm/day	Litres per sq.m. per day - based on Table M1 AS/NZS 1547:2012 for secondary effluent
Nominated Land Application Area	L	103404	m sq.	Estimates evapotranspiration as a fraction of pan evaporation: varies with season and crop type
Crop Factor	C	0.7-0.8	unitless	Proportion of rainfall that remains onsite and infiltrates; function of slope/cover, allowing for any runoff
Runoff Coefficient		0.8	unitless	Proportion of rainfall that appears as stormwater run-off
Rainfall Data		Wyee (Wyee Farms Road)		Mean Monthly Data (1899 - 2013)
Evaporation Data		Wyee data drill		Mean Monthly Data (1970 - 2007)

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D	\	days	31	28	31	30	31	30	31	31	30	31	30	31	366
Rainfall	R	\	mm/month	110.3	130.7	132.4	127	111.3	111.9	78.4	69	69.3	75.6	84	99	1,192
Evaporation	E	\	mm/month	171	136	121	93	63	50	58	83	109	140	149	179	1,348
Daily Evaporation				5.5	4.9	3.9	2.9	2.0	1.7	1.9	2.7	3.6	4.5	5.0	5.8	
Crop Factor	C			0.80	0.80	0.80	0.70	0.70	0.70	0.70	0.70	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	137	109	97	65	44	35	41	58	76	112	119	143	1032.6
Percolation	B	(DPR/7)xD	mm/month	93.0	84	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0	1096.0
Outputs		ET+B	mm/month	229.8	192.8	189.8	151.6	137.1	125.0	133.6	151.1	166.3	205.0	209.2	236.2	2127.6
INPUTS																
Retained Rainfall	RR	R*runoff coef	mm/month	88.24	104.56	105.92	101.6	89.04	89.52	62.72	55.2	55.44	60.48	67.2	79.2	869.12
Effluent Irrigation	W	(QxD)/L	mm/month	28.0	28.3	28.0	27.1	28.0	27.1	28.0	28.0	27.1	28.0	27.1	28.0	329.6
Inputs		RR+W	mm/month	116.2	129.8	133.9	128.7	117.0	116.6	90.7	83.2	82.5	88.5	94.3	107.2	1198.7
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	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 for the month	S	(RR+W)-(ET+B)	mm/month	-113.6	-63.0	-55.9	-22.9	-20.1	-8.4	-42.9	-67.9	-83.8	-116.5	-114.9	-129.0	-281.0
Cumulative 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	0.0
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m²	20445	29625	34804	59016	60220	78940	40832	30179	28284	20026	19724	18434	
MINIMUM AREA REQUIRED FOR ZERO STORAGE:				78940	m²											

Nutrient Balance

Site Address: Hue Hue Road

Please read the attached notes before using this spreadsheet.

SUMMARY - LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING BALANCE = **17,379 m²**

INPUT DATA [1]

Wastewater Loading			Nutrient Crop Uptake				
Hydraulic Load	93,360	L/Day	Crop N Uptake	250	kg/ha/yr	which equals	68 mg/m²/day
Effluent N Concentration	15	mg/L	Crop P Uptake	25	kg/ha/yr	which equals	7 mg/m²/day
% Lost to Soil Processes (Geary & Gardner 1996)	0.15	Decimal	Phosphorus Sorption				
Total N Loss to Soil	210,060	mg/day	P-sorption result	825.88	mg/kg	which equals	11,562 kg/ha
Remaining N Load after soil loss	1,190,340	mg/day	Bulk Density	1.4	g/cm³		or
Effluent P Concentration	5	mg/L	Depth of Soil	1	m		15600 kg/ha
Design Life of System	50	yrs	% of Predicted P-sorp.[2]	0.5	Decimal	which equals	1114.285714 mg/kg

METHOD 1: NUTRIENT BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer			Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nitrogen	17379	m²	Nominated LAA Size	103404	m²
Phosphorus	12,116	m²	Predicted N Export from LAA	-2150.63	kg/year
			Predicted P Export from LAA	-1283.72	kg/year
			Phosphorus Longevity for LAA	-678	Years
			Minimum Buffer Required for excess nutrient	0	m²

PHOSPHORUS BALANCE

STEP 1: Using the nominated LAA Size

Nominated LAA Size	103404	m²				
Daily P Load	0.4668	kg/day	→ Phosphorus generated over life of system		8519.1	kg
Daily Uptake	0.708247	kg/day	→ Phosphorus vegetative uptake for life of system		0.125	kg/m²
Measured p-sorption capacity	1.156232	kg/m²				
Assumed p-sorption capacity	0.578	kg/m²	→ Phosphorus adsorbed in 50 years		0.578	kg/m²
Site P-sorption capacity	59779.51	kg	→ Desired Annual P Application Rate		1454.100	kg/year
				which equals	3.98384	kg/day
P-load to be sorbed	-88.13	kg/year				

NOTES

[1]. Model sensitivity to input parameters will affect the accuracy of the result obtained. Where possible site specific data should be used. Otherwise data should be obtained from a reliable source such as,

- *Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households*
- *Appropriate Peer Reviewed Papers*
- *EPA Guidelines for Effluent Irrigation*
- *USEPA Onsite Systems Manual.*

[2]. Conservative estimate based on work by Geary & Gardner (1996) and Patterson (2002).

[3]. A multiplier, normally between 0.25 and 0.75, is used to estimate actual P-sorption under field conditions which is assumed to be less than laboratory estimates.

Water & Nutrient Balance Scenario Shoulder Season

Nominated Area Water Balance & Storage Calculations

Site Address: Hue Hue Road Wyee

INPUT DATA

Design Wastewater Flow	Q	136.112	L/day	Daily load from typical Expected Persons (EP) values
Design Percolation Rate	DPR	21	mm/week	Weekly Design Infiltration Percolation Rate (DIPR)
Daily DPR		3.0	mm/day	Litres per sq.m. per day - based on Table M1 AS/NZS 1547:2012 for secondary effluent
Nominated Land Application Area	L	122144	m sq.	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type
Crop Factor	C	0.7-0.8	unitless	Proportion of rainfall that remains onsite and infiltrates; function of slope/cover, allowing for any runoff
Runoff Coefficient		0.8	unitless	Proportion of rainfall that appears as stormwater run-off
Rainfall Data		Wyee (Wyee Farms Road)		Mean Monthly Data (1899 - 2013)
Evaporation Data		Wyee data drill		Mean Monthly Data (1970 - 2007)

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D	\	days	31	28	31	30	31	30	31	31	30	31	30	31	365
Rainfall	R	\	mm/month	110.3	130.7	132.4	127	111.3	111.9	78.4	69	69.3	75.6	84	99	1,192
Evaporation	E	\	mm/month	171	136	121	84	63	50	58	83	109	140	149	179	1,343
Daily Evaporation				5.5	4.9	3.9	2.9	2.0	1.7	1.9	2.7	3.6	4.5	5.0	5.8	
Crop Factor	C			0.80	0.80	0.80	0.70	0.70	0.70	0.70	0.70	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	137	109	97	61	44	35	41	58	76	112	119	143	1032.6
Percolation	B	(DPR/7)xD	mm/month	93.0	84	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0	1096.0
Outputs		ET+B	mm/month	229.8	192.8	189.8	151.6	137.1	125.0	133.6	151.1	166.3	205.0	209.2	236.2	2127.6
INPUTS																
Retained Rainfall	RR	R*runoff coef	mm/month	88.24	104.56	105.92	101.6	89.04	89.52	62.72	55.2	55.44	60.48	67.2	79.2	869.12
Effluent Irrigation	W	(QxD)/L	mm/month	34.5	31.2	34.5	33.4	34.5	33.4	34.5	34.5	33.4	34.5	33.4	34.5	408.7
Inputs		RR+W	mm/month	122.8	135.8	140.5	135.0	123.6	123.0	97.3	89.7	88.9	95.0	100.6	113.7	1386.9
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	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 for the month	S	(RR+W)-(ET+B)	mm/month	-107.0	-57.0	-49.3	-16.6	-13.5	-2.0	-36.3	-61.4	-77.4	-110.0	-108.6	-122.5	-258.2
Cumulative 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	0.0
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	29007	40191	50304	51667	57796	115089	59530	43999	36833	29196	28716	28876	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 115089 m^2

Nutrient Balance

Site Address: Hue Hue Road

Please read the attached notes before using this spreadsheet.

SUMMARY - LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING BALANCE = 25,337 m^2

INPUT DATA [1]

Wastewater Loading			Nutrient Crop Uptake				
Hydraulic Load	136.112	L/Day	Crop N Uptake	250	kg/ha/yr	which equals	68 mg/m^2/day
Effluent N Concentration	15	mg/L	Crop P Uptake	25	kg/ha/yr	which equals	7 mg/m^2/day
% Lost to Soil Processes (Geary & Gardner 1996)	0.15	Decimal	Phosphorus Sorption				
Total N Loss to Soil	306.252	mg/day	P-sorption result	825.88	mg/kg	which equals	11,562 kg/ha
Remaining N Load after soil loss	1,735.428	mg/day	Bulk Density	1.4	g/cm^3		or
Effluent P Concentration	5	mg/L	Depth of Soil	1	m	which equals	15600 kg/ha
Design Life of System	50	yrs	% of Predicted P-sorp.[2]	0.5	Decimal		1114.285714 mg/kg

METHOD 1: NUTRIENT BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer			Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nitrogen	25337	m^2	Nominated LAA Size	122144	m^2
Phosphorus	17,665	m^2	Predicted N Export from LAA	-2420.18	kg/year
			Predicted P Export from LAA	-1469.23	kg/year
			Phosphorus Longevity for LAA	-1240	Years
			Minimum Buffer Required for excess nutrient	0	m^2

PHOSPHORUS BALANCE

STEP 1: Using the nominated LAA Size

Nominated LAA Size	122144.3	m^2				
Daily P Load	0.68056	kg/day	→	Phosphorus generated over life of system	12420.22	kg
Daily Uptake	0.836605	kg/day	→	Phosphorus vegetative uptake for life of system	0.125	kg/m^2
Measured p-sorption capacity	1.156232	kg/m^2				
Assumed p-sorption capacity	0.578	kg/m^2	→	Phosphorus adsorbed in 50 years	0.578	kg/m^2
Site P-sorption capacity	70613.57	kg	→	Desired Annual P Application Rate	1717.632	kg/year
				which equals	4.70584	kg/day
P-load to be sorbed	-56.96	kg/year				

NOTES

[1]. Model sensitivity to input parameters will affect the accuracy of the result obtained. Where possible site specific data should be used. Otherwise data should be obtained from a reliable source such as,

- *Environment and Health Protection Guidelines: Onsite Sewage Management for Single Households*
- *Appropriate Peer Reviewed Papers*
- *EPA Guidelines for Effluent Irrigation*
- *USEPA Onsite Systems Manual.*

[2]. Conservative estimate based on work by Geary & Gardner (1996) and Paterson (2002).

[3]. A multiplier, normally between 0.25 and 0.75, is used to estimate actual P-sorption under field conditions which is assumed to be less than laboratory estimates.

Other Examples for Subdivision Stages

Water and Nutrient Balance Stage 6

Nominated Area Water Balance & Storage Calculations

Site Address: **Hue Hue Road Wyee**

INPUT DATA

Design Wastewater Flow	Q	29,500	L/day	Daily load from typical Expected Persons (EP) values	Flow Allowance	150	L/p/d
Design Percolation Rate	DIPR	21	mm/week	Weekly Design Infiltration Percolation Rate (DIPR)	No. of bedrooms	4	
Daily DPR		3.0	mm/day	Litres per sq.m. per day - based on Table M1 AS/NZS 1547:2012 for secondary effluent	Occup Rate	1.5	
Nominated Land Application Area	L	24968	m sq	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type			
Crop Factor	C	0.7-0.8	unitless	Proportion of rainfall that remains onsite and infiltrates; function of slope/cover, allowing for any runoff			
Runoff Coefficient		0.8	unitless	Proportion of rainfall that appears as stormwater run-off			
Rainfall Data		Wyee (Wyee Farms Road)		Mean Monthly Data (1899 - 2013)			
Evaporation Data		Wyee data drill		Mean Monthly Data (1970 - 2007)			

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D	\	days	31	28	31	30	31	30	31	31	30	31	30	31	**365**
Rainfall	R	\	mm/month	110.3	130.7	132.4	127	111.3	111.9	78.4	69	69.3	75.6	84	99	**1,192**
Evaporation	E	\	mm/month	171	136	121	88	63	50	58	83	109	140	149	179	**1,348**
Daily Evaporation				5.5	4.9	3.9	2.9	2.0	1.7	1.9	2.7	3.6	4.5	5.0	5.8	
Crop Factor	C			0.80	0.80	0.80	0.70	0.70	0.70	0.70	0.70	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	137	109	97	62	44	35	41	58	76	112	119	143	**1032.5**
Percolation	B	(DPR/7)xD	mm/month	93.0	84	93.0	90.0	93.0	90.0	93.0	93.0	90.0	93.0	90.0	93.0	**1095.0**
Outputs		ET+B	mm/month	229.8	192.8	189.8	151.6	137.1	125.0	133.6	151.1	166.3	205.0	209.2	236.2	**2127.5**
INPUTS																
Retained Rainfall	RR	R*runoff coef	mm/month	88.24	104.56	105.92	101.6	89.04	89.52	62.72	55.2	55.44	60.48	67.2	79.2	**959.12**
Effluent Irrigation	W	(QxD)/L	mm/month	36.6	33.1	36.6	35.4	36.6	35.4	36.6	36.6	35.4	36.6	35.4	36.6	**431.3**
Inputs		RR+W	mm/month	124.9	137.6	142.5	137.0	125.7	125.0	99.3	91.8	90.9	97.1	102.6	115.8	**1390.4**
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	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 for the month	S	(RR+W)-(ET+B)	mm/month	-104.9	-55.2	-47.3	-14.6	-11.4	0.0	-34.3	-59.3	-75.4	-107.9	-106.6	-120.4	**-222.0**
Cumulative 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	**0.0**
Maximum Storage for Nominated Area	N		mm	**0.00**												
	V	NxL	L	**0**												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	6460	9361	10902	17700	19028	24944	12902	9536	7983	6328	6232	5825	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: **24944** m^2

Nutrient Balance

Site Address: Hue Hue Road Wyee

Please read the attached notes before using this spreadsheet.

SUMMARY - LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING BALANCE = 5,491 m^2

INPUT DATA [1]

Wastewater Loading			Nutrient Crop Uptake				
Hydraulic Load	29,500	L/Day	Crop N Uptake	250	kg/ha/yr	which equals	68 mg/m^2/day
Effluent N Concentration	15	mg/L	Crop P Uptake	25	kg/ha/yr	which equals	7 mg/m^2/day
% Lost to Soil Processes (Geary & Gardner 1996)	0.15	Decimal	**Phosphorus Sorption**				
Total N Loss to Soil	66,375	mg/day	P-sorption result	825.88	mg/kg	which equals	11,562 kg/ha
Remaining N Load after soil loss	376,125	mg/day	Bulk Density	1.4	g/cm^3		**or**
Effluent P Concentration	5	mg/L	Depth of Soil	1	m	which equals	15600 kg/ha
Design Life of System	50	yrs	% of Predicted P-sorp. [2]	0.5	Decimal		1114.285714 mg/kg

METHOD 1: NUTRIENT BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer			Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nitrogen	5491	m^2	Nominated LAA Size	24968	m^2
Phosphorus	3,828	m^2	Predicted N Export from LAA	-486.91	kg/year
			Predicted P Export from LAA	-297.27	kg/year
			Phosphorus Longevity for LAA	-1682	Years
			Minimum Buffer Required for excess nutrient	0	m^2

PHOSPHORUS BALANCE

STEP 1: Using the nominated LAA Size

Nominated LAA Size	24968	m^2				
Daily P Load	0.1475	kg/day	→ Phosphorus generated over life of system		2691.875	kg
Daily Uptake	0.171014	kg/day	→ Phosphorus vegetative uptake for life of system		0.125	kg/m^2
Measured p-sorption capacity	1.156232	kg/m^2				
Assumed p-sorption capacity	0.578	kg/m^2	→ Phosphorus adsorbed in 50 years		0.578	kg/m^2
Site P-sorption capacity	14434.40	kg	→ Desired Annual P Application Rate		351.108	kg/year
				which equals	0.96194	kg/day
P-load to be sorbed	-8.58	kg/year				

NOTES

[1]. Model sensitivity to input parameters will affect the accuracy of the result obtained. Where possible site specific data should be used. Otherwise data should be obtained from a reliable source such as,

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- *Appropriate Peer Reviewed Papers*
- *EPA Guidelines for Effluent Irrigation*
- *USEPA Onsite Systems Manual.*

[2]. Conservative estimate based on work by Geary & Gardner (1996) and Patterson (2002).

[3]. A multiplier, normally between 0.25 and 0.75, is used to estimate actual P-sorption under field conditions which is assumed to be less than laboratory estimates.

Nominated Area Water Balance & Storage Calculations

Site Address: Hue Hue Road Wyee

INPUT DATA

Design Wastewater Flow	Q	3,945	L/day	Daily load from typical Expected Persons (EP) values	Flow Allowance	150	L/p/d
Design Percolation Rate	DIPR	14	mm/week	Weekly Design Infiltration Percolation Rate (DIPR)	No. of bedrooms	4	
Daily DPR		2.0	mm/day	Litres per sq.m. per day - based on Table M1 AS/NZS 1547:2012 for secondary effluent	Occup Rate	1.5	
Nominated Land Application Area	L	21620	m sq	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type			
Crop Factor	C	0.7-0.8	unitless	Proportion of rainfall that remains onsite and infiltrates; function of slope/cover, allowing for any runoff			
Runoff Coefficient		0.8	untiless	Proportion of rainfall that appears as stormwater run-off			
Rainfall Data		Wyee (Wyee Farms Road)		Mean Monthly Data (1899 - 2013)			
Evaporation Data		Wyee data drill		Mean Monthly Data (1970 - 2007)			

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D	\	days	31	28	31	30	31	30	31	31	30	31	30	31	**365**
Rainfall	R	\	mm/month	110.3	130.7	132.4	127	111.3	111.9	78.4	69	69.3	75.6	84	99	**1,192**
Evaporation	E	\	mm/month	171	136	121	88	63	50	58	83	109	140	149	179	**1,348**
Daily Evaporation				5.5	4.9	3.9	2.9	2.0	1.7	1.9	2.7	3.6	4.5	5.0	5.8	
Crop Factor	C			0.80	0.80	0.80	0.70	0.70	0.70	0.70	0.70	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	137	109	97	62	44	35	41	58	76	112	119	143	**1032.5**
Percolation	B	(DPR/7)xD	mm/month	62.0	56	62.0	60.0	62.0	60.0	62.0	62.0	60.0	62.0	60.0	62.0	**730.0**
Outputs		ET+B	mm/month	198.8	164.8	158.8	121.6	106.1	95.0	102.6	120.1	136.3	174.0	179.2	205.2	**1762.5**
INPUTS																
Retained Rainfall	RR	R*runoff coef	mm/month	88.24	104.56	105.92	101.6	89.04	89.52	62.72	55.2	55.44	60.48	67.2	79.2	**959.12**
Effluent Irrigation	W	(QxD)/L	mm/month	5.7	5.1	5.7	5.5	5.7	5.5	5.7	5.7	5.5	5.7	5.5	5.7	**66.6**
Inputs		RR+W	mm/month	93.9	109.7	111.6	107.1	94.7	95.0	68.4	60.9	60.9	66.1	72.7	84.9	**1025.7**
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	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 for the month	S	(RR+W)-(ET+B)	mm/month	-104.9	-55.1	-47.2	-14.5	-11.4	0.0	-34.2	-59.2	-75.4	-107.9	-106.5	-120.3	**-221.8**
Cumulative 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	**0.0**
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	1106	1834	2313	5918	7169	21597	3067	1884	1464	1077	1057	971	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 21597 m^2

Nutrient Balance

Site Address: Hue Hue Road Wyee

Please read the attached notes before using this spreadsheet.

SUMMARY - LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING BALANCE = **734 m^2**

INPUT DATA [1]

Wastewater Loading			Nutrient Crop Uptake				
Hydraulic Load	3,945	L/Day	Crop N Uptake	250 kg/ha/yr	which equals	68	$mg/m^2/day$
Effluent N Concentration	15	mg/L	Crop P Uptake	25 kg/ha/yr	which equals	7	$mg/m^2/day$
% Lost to Soil Processes (Geary & Gardner 1996)	0.15	Decimal	**Phosphorus Sorption**				
Total N Loss to Soil	8,876	mg/day	P-sorption result	825.88 mg/kg	which equals	11,562	kg/ha
Remaining N Load after soil loss	50,299	mg/day	Bulk Density	1.4 g/cm^3		or	
Effluent P Concentration	5	mg/L	Depth of Soil	1 m	which equals	15600	kg/ha
Design Life of System	50	yrs	% of Predicted P-sorp.[2]	0.5 Decimal		1114.285714	mg/kg

METHOD 1: NUTRIENT BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer			Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nitrogen	734	m^2	Nominated LAA Size	21620	m^2
Phosphorus	512	m^2	Predicted N Export from LAA	-522.14	kg/year
			Predicted P Export from LAA	-296.83	kg/year
			Phosphorus Longevity for LAA	-267	Years
			Minimum Buffer Required for excess nutrient	0	m^2

PHOSPHORUS BALANCE

STEP 1: Using the nominated LAA Size

Nominated LAA Size	21620	m^2				
Daily P Load	0.019725	kg/day	→ Phosphorus generated over life of system		359.98125	kg
Daily Uptake	0.148082	kg/day	→ Phosphorus vegetative uptake for life of system		0.125	kg/m^2
Measured p-sorption capacity	1.156232	kg/m^2				
Assumed p-sorption capacity	0.578	kg/m^2	→ Phosphorus adsorbed in 50 years		0.578	kg/m^2
Site P-sorption capacity	12498.87	kg	→ Desired Annual P Application Rate		304.027	kg/year
				which equals	0.83295	kg/day
P-load to be sorbed	-46.85	kg/year				

NOTES

[1]. Model sensitivity to input parameters will affect the accuracy of the result obtained. Where possible site specific data should be used. Otherwise data should be obtained from a reliable source such as,

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- *Appropriate Peer Reviewed Papers*
- *EPA Guidelines for Effluent Irrigation*
- *USEPA Onsite Systems Manual.*

[2]. Conservative estimate based on work by Geary & Gardner (1996) and Patterson (2002).

[3]. A multiplier, normally between 0.25 and 0.75, is used to estimate actual P-sorption under field conditions which is assumed to be less than laboratory estimates.

Nominated Area Water Balance & Storage Calculations

Site Address: Hue Hue Road wyee

INPUT DATA

Design Wastewater Flow	Q	31,205	L/day	Daily load from typical Expected Persons (EP) values	Flow Allowance	150	L/p/d
Design Percolation Rate	DIPR	24.5	mm/week	Weekly Design Infiltration Percolation Rate (DIPR)	No. of bedrooms	4	
Daily DPR		3.5	mm/day	Litres per sq.m. per day - based on Table M1 AS/NZS 1547:2012 for secondary effluent	Occup Rate	1.5	
Nominated Land Application Area	L	18545	m sq	Estimates evapotranspiration as a fraction of pan evaporation; varies with season and crop type			
Crop Factor	C	0.7-0.8	unitless	Proportion of rainfall that remains onsite and infiltrates; function of slope/cover, allowing for any runoff			
Runoff Coefficient		0.8	untiless	Proportion of rainfall that appears as stormwater run-off			
Rainfall Data		Wyee (Wyee Farms Road)		Mean Monthly Data (1899 - 2013)			
Evaporation Data		Wyee data drill		Mean Monthly Data (1970 - 2007)			

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Days in month	D	\	days	31	28	31	30	31	30	31	31	30	31	30	31	**365**
Rainfall	R	\	mm/month	110.3	130.7	132.4	127	111.3	111.9	78.4	69	69.3	75.6	84	99	**1,192**
Evaporation	E	\	mm/month	171	136	121	88	63	50	58	83	109	140	149	179	**1,348**
Daily Evaporation				5.5	4.9	3.9	2.9	2.0	1.7	1.9	2.7	3.6	4.5	5.0	5.8	
Crop Factor	C			0.80	0.80	0.80	0.70	0.70	0.70	0.70	0.70	0.70	0.80	0.80	0.80	
OUTPUTS																
Evapotranspiration	ET	ExC	mm/month	137	109	97	62	44	35	41	58	76	112	119	143	**1032.5**
Percolation	B	(DPR/7)xD	mm/month	108.5	98	108.5	105.0	108.5	105.0	108.5	108.5	105.0	108.5	105.0	108.5	**1277.5**
Outputs		ET+B	mm/month	245.3	206.8	205.3	166.6	152.6	140.0	149.1	166.6	181.3	220.5	224.2	251.7	**2310.0**
INPUTS																
Retained Rainfall	RR	R*runoff coef	mm/month	88.24	104.56	105.92	101.6	89.04	89.52	62.72	55.2	55.44	60.48	67.2	79.2	**959.12**
Effluent Irrigation	W	(QxD)/L	mm/month	52.2	47.1	52.2	50.5	52.2	50.5	52.2	52.2	50.5	52.2	50.5	52.2	**614.2**
Inputs		RR+W	mm/month	140.4	151.7	158.1	152.1	141.2	140.0	114.9	107.4	105.9	112.6	117.7	131.4	**1573.3**
STORAGE CALCULATION																
Storage remaining from previous month			mm/month	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 for the month	S	(RR+W)-(ET+B)	mm/month	-104.9	-55.1	-47.2	-14.5	-11.4	0.0	-34.2	-59.2	-75.4	-107.9	-106.5	-120.3	**-221.7**
Cumulative 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	**0.0**
Maximum Storage for Nominated Area	N		mm	0.00												
	V	NxL	L	0												
LAND AREA REQUIRED FOR ZERO STORAGE			m^2	6159	8546	9734	14402	15220	18545	11199	8684	7438	6045	5963	5608	

MINIMUM AREA REQUIRED FOR ZERO STORAGE: 18545 m^2

Nutrient Balance

Site Address: Hue Hue Road Wyee

Please read the attached notes before using this spreadsheet.

SUMMARY - LAND APPLICATION AREA REQUIRED BASED ON THE MOST LIMITING BALANCE = **5,809 m^2**

INPUT DATA [1]

Wastewater Loading				Nutrient Crop Uptake				
Hydraulic Load	31,205	L/Day	Crop N Uptake	250	kg/ha/yr	which equals	68	$mg/m^2/day$
Effluent N Concentration	15	mg/L	Crop P Uptake	25	kg/ha/yr	which equals	7	$mg/m^2/day$
% Lost to Soil Processes (Geary & Gardner 1996)	0.15	Decimal	**Phosphorus Sorption**					
Total N Loss to Soil	70,211	mg/day	P-sorption result	825.88	mg/kg	which equals	11,562	kg/ha
Remaining N Load after soil loss	397,864	mg/day	Bulk Density	1.4	g/cm^3		**or**	
Effluent P Concentration	5	mg/L	Depth of Soil	1	m	which equals	15600	kg/ha
Design Life of System	50	yrs	% of Predicted P-sorp. [2]	0.5	Decimal		1114.285714	mg/kg

METHOD 1: NUTRIENT BALANCE BASED ON ANNUAL CROP UPTAKE RATES

Minimum Area required with zero buffer			Determination of Buffer Zone Size for a Nominated Land Application Area (LAA)		
Nitrogen	5809	m^2	Nominated LAA Size	18545	m^2
Phosphorus	4,050	m^2	Predicted N Export from LAA	-318.40	kg/year
			Predicted P Export from LAA	-203.84	kg/year
			Phosphorus Longevity for LAA	1013	Years
			Minimum Buffer Required for excess nutrient	0	m^2

PHOSPHORUS BALANCE

STEP 1: Using the nominated LAA Size

Nominated LAA Size	18545	m^2				
Daily P Load	0.156025	kg/day	→ Phosphorus generated over life of system		2847.45625	kg
Daily Uptake	0.127021	kg/day	→ Phosphorus vegetative uptake for life of system		0.125	kg/m^2
Measured p-sorption capacity	1.156232	kg/m^2				
Assumed p-sorption capacity	0.578	kg/m^2	→ Phosphorus adsorbed in 50 years		0.578	kg/m^2
Site P-sorption capacity	10721.16	kg	→ Desired Annual P Application Rate		260.786	kg/year
				which equals	0.71448	kg/day
P-load to be sorbed	10.59	kg/year				

NOTES

[1]. Model sensitivity to input parameters will affect the accuracy of the result obtained. Where possible site specific data should be used. Otherwise data should be obtained from a reliable source such as,

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- *Appropriate Peer Reviewed Papers*
- *EPA Guidelines for Effluent Irrigation*
- *USEPA Onsite Systems Manual.*

[2]. Conservative estimate based on work by Geary & Gardner (1996) and Patterson (2002).

[3]. A multiplier, normally between 0.25 and 0.75, is used to estimate actual P-sorption under field conditions which is assumed to be less than laboratory estimates.