Water Utilities Australia
Kooragang Water

Kooragang Water Pty Ltd

WIC Act licence application

13 April 2022

Attachment 43:

Original KIWS Environmental Impact Assessment

Environmental Impact Assessment

ENVIRONMENTAL GREEN SLIP

The State Owned Corporations Act 1989 and Hunter Water Corporation's Environmental Management System requires that Hunter Water carry out its activities in accordance with the principles of ecologically sustainable development as outlined in the *Protection of the Environment Administration Act 1991*.

In order to demonstrate due diligence and comply with the requirements of the *Environmental Planning and Assessment Act 1979 (the Act)* all Hunter Water projects involving construction or planned maintenance shall require an environmental impact assessment (EIA).

Attached is a checklist (known as an Environmental Green Slip) to be completed by Project Managers involved in construction or planned maintenance projects to ensure the appropriate EIA considerations have been made prior to making a formal submission for project approval. The Environmental Green Slip also fulfils the requirements of project determination under the Act.

Green Slip Sign-Offs

An Environmental Planner is required to endorse the Environmental Green Slip.

General Manager sign-off is required on the Environmental Green Slips where external planning approvals are required or where the value of the project exceeds $5 Million.

Where the value of the project is less than $5 Million and no external planning approvals are required the project can be determined by the relevant Group Manager. In the case of capital price path provisions is proposed that the Program Controller (Level D Manager) approve the Green Slip.

Once signed (or approved via an action email on the TRIM system) the Environmental Green Slip shall be filed on the appropriate TRIMS file or blue project file.

See ENVIRONMENTAL GREEN SLIP attached.

Rev	Date	Description	Prepared	Approved
01	March 2011	Minor amendments to January 2007 version. Amendment to delegations Implementation of new naming convention and revision control	M Thomas	

ENVIRONMENTAL GREEN SLIP#

	YES	NO	COMMENTS
Project Name: Kooragang Industrial Water Scheme (comprising KIWS plant at Steel River + supply, discharge & delivery pipelines)			**Date Created: 03 April 2012**
TRIMS Number: HW2006-3189/15/22.007			
Has an Environmental Impact Assessment been prepared for the activity/works (ie REF/SEE/EIS) in accordance with Hunter Water's requirements?	☑	☐	*Include hyperlink in TRIM to the EIA document.* See REF at HW2006-3189/15/21 See Submissions Report following REF exhibition at HW2006-3189/15/22 Also refer EPA letter HW2006-3189/15/22.088 - KIWS design also needs to ensure no discharge of RO reject to Hunter River in slack water conditions in dry weather.
Is a development application required for the work?	☐	☑	
Are any external approvals required for the work?	☑	☐	*If yes please specify what approvals* • Dewatering licence for some pipeline components from Office of Water. • Road occupation permits from Roads & Maritime Services &/or Newcastle Council • Environment Protection Licence 1638 variation from EPA. Variation to EPL 1683 to include the discharge of reject water to the Hunter River & environmental assessment of the reject water, including consideration of anti-scalant chemicals and associated toxicants within the reject stream. (HW2006-3189/15/22.088)
Is additional community or stakeholder consultation/communication required before the commencement of works?	☑	☐	*If yes provide details* • Local residents/business owners for all components. • Relevant agencies for respective pipeline components. • Newcastle City Council advice with regard to any excavations or land surface disturbance in contaminated ground in Stevenson Park, Mayfield West (refer EPA letter HW2006-3189/15/22.088).
Will an Environmental Management Plan (EMP) be required for the activity?	☑	☐	• KIWS plant at Steel River & associated pipelines to be constructed by HTA • Delivery pipeline to be contracted via tender process. • The management of the project should ensure the noise criteria provided in "Interim Construction Noise Guideline (DECC 2009) are achieved (refer EPA letter HW2006-3189/15/22.088).
Is there a list of environmental safeguards to be addressed in the EMP?	☑	☐	• See REF Tables 5-35 (construction) & 5-36 (operation)
Is an Environmental Management Representative (EMR) required to be engaged for the delivery of the project?	☐	☑	KIWS plant construction environmental management to be provided by HTA but will subject to independent audit. Delivery pipeline will require EMR services.

Hunter Water has fulfilled responsibilities under the Environmental Planning and Assessment Act 1979 (EPA Act). The REF complies with the statutory requirements of the Act and the project can proceed, subject to recommendations in the REF, where Part 5 of the Act applies.*

CREATED
PROJECT MANAGER Rahul Chhillar DATE 04/04/2012

ENDORSED
ENVIRONMENTAL PLANNER John Simpson DATE 05.04.12

GROUP MANAGER Greg Bone DATE

APPROVED
GROUP GENERAL MANAGER Peter Dennis DATE
(GM sign-off required for projects >$5million or that require external planning approval)

** Where Part 4 or Part 3A of the EPA Act applies the appropriate instrument of approval must be attached to the GREENSLIP.*

Also note the following project modifications:

- Revised product pipeline alignment & construction + Newcastle 10 WWPS diversion component - see associated e-approval at HW2006-3189/15/27.001 (J. Simpson, 15.05.13)
- Additional works on brine return line, including new vent stack & connection – see associated e-approval at HW2006-3189/15/27.002 (J. Simpson, 15.05.13)
- Construction of new alum dosing facility & aeration upgrade at Shortland WWTW - see associated e-approval at HW2006-3189/15/27.003 (J. Simpson, 12.06.13)
- Minor project amendment for additional diesel fuel storage during construction - see associated e-approval at HW2006-3189/15/24.001 (J. Simpson, 12.06.13)
- Minor project amendment for extended work hours for pipeline construction through 'The Gateway' driveway in Channel Rd Steel River – see HTA form describing works at HW2006-3189/45/5.010 & associated e-approval at HW2006-3189/15/24.005 (J. Simpson, 02.08.13).
- Minor project amendment for extension of barometric loop at Warabrook – see associated e-approval at HW2006-3189/15/24.003 (J. Simpson, 23.09.13)

Environmental Impact Assessment
ENVIRONMENTAL GREEN SLIP

The State Owned Corporations Act 1989 and Hunter Water Corporation's Environmental Management System requires that Hunter Water carry out its activities in accordance with the principles of ecologically sustainable development as outlined in the *Protection of the Environment Administration Act 1991*.

In order to demonstrate due diligence and comply with the requirements of the *Environmental Planning and Assessment Act 1979 (the Act)* all Hunter Water projects involving construction or planned maintenance shall require an environmental impact assessment (EIA).

Attached is a checklist (known as an Environmental Green Slip) to be completed by Project Managers involved in construction or planned maintenance projects to ensure the appropriate EIA considerations have been made prior to making a formal submission for project approval. The Environmental Green Slip also fulfils the requirements of project determination under the Act.

Green Slip Sign-Offs
An Environmental Planner is required to endorse the Environmental Green Slip.

General Manager sign-off is required on the Environmental Green Slips where external planning approvals are required or where the value of the project exceeds $5 Million.

Where the value of the project is less than $5 Million and no external planning approvals are required the project can be determined by the relevant Group Manager. In the case of capital price path provisions is proposed that the Program Controller (Level D Manager) approve the Green Slip.

Once signed (or approved via an action email on the TRIM system) the Environmental Green Slip shall be filed on the appropriate TRIMS file or blue project file.

See ENVIRONMENTAL GREEN SLIP attached.

Rev	Date	Description	Prepared	Approved
01	March 2011	Minor amendments to January 2007 version. Amendment to delegations Implementation of new naming convention and revision control	M Thomas	

SUPPLEMENTARY ENVIRONMENTAL GREEN SLIP

Project Name: Kooragang Industrial Water Scheme – Brine Return Line			**Date Created: 15 May 2013**
Supplementary REF covers modifications to brine return pipeline & associated works not covered in original project description (vent stack & connection point)			
TRIMS Number: HW2006-3189/15/27.002			
	YES	**NO**	**COMMENTS**
Has an Environmental Impact Assessment been prepared for the activity/works (ie REF/SEE/EIS) in accordance with Hunter Water's requirements?	☑	☐	See original project REF at HW2006-3189/15/21 See Submissions Report following REF exhibition at HW2006-3189/15/22 Also refer EPA letter HW2006-3189/15/22.088. See Supplementary REF for brine return works at HW2006-3189/15/25.001
Is a development application required for the work?	☐	☑	
Are any external approvals required for the work?	☑	☐	*If yes please specify what approvals* • Road occupation permits from Roads & Maritime Services &/or Newcastle Council. • Brine return line & associated works are covered by conditions of existing Environment Protection Licence 1638 (Shortland WWTW)
Is additional community or stakeholder consultation/communication required before the commencement of works?	☑	☐	*If yes provide details* Notice to local residents affected by construction prior to works & ongoing liaison during works as required.
Will an Environmental Management Plan (EMP) be required for the activity?	☑	☐	
Is there a list of environmental safeguards to be addressed in the EMP?	☑	☐	See section 7 of Supplementary REF. A review to be undertaken by project EMR to ensure safe guards are addressed in the EMP.
Is an Environmental Management Representative (EMR) required to be engaged for the delivery of the project?	☑	☐	EMR services to be provided by HTA for product pipeline construction

Hunter Water has fulfilled responsibilities under the Environmental Planning and Assessment Act 1979 (EPA Act). The REF complies with the statutory requirements of the Act and the project can proceed, subject to recommendations in the REF, where Part 5 of the Act applies.*

PROJECT MANAGER Tommy Zhang DATE 18 March 2013

PROJECT CONTROLLER Chris Yates DATE 19 March 2013

ENVIRONMENTAL PLANNER John Simpson DATE 15 May 2013

GROUP GENERAL MANAGER Dean McInnes DATE

(GM sign-off required for projects >$5million or that require external planning approval)

** Where Part 4 or Part 3A of the EPA Act applies the appropriate instrument of approval must be attached to the GREENSLIP.*

Kooragang Water Pty Ltd

WIC Act licence application

13 April 2022

Attachment 44:

Original KIWS Review of Environmental Factors

SINCLAIR KNIGHT MERZ

SKM

HUNTER WATER

Kooragang Industrial Water Scheme (KIWS)

REVIEW OF ENVIRONMENTAL FACTORS

- Final
- September 2011

Kooragang Industrial Water Scheme (KIWS)

REVIEW OF ENVIRONMENTAL FACTORS

- Final
- September 2011

Sinclair Knight Merz
ABN 37 001 024 095
100 Christie Street
PO Box 164
St Leonards NSW
Australia 1590
Tel: +61 2 9928 2100
Fax: +61 2 9928 2500
Web: www.skmconsulting.com

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Abbreviations

AASS	Actual Acid Sulphate Soil
AHIMS	Aboriginal Heritage Information Management System
ANZECC	Australian and New Zealand Environment Conservation Council
ARTC	Australian Rail and Track Corporation
AS	Australian Standard
ASS	Acid Sulphate Soil
ASSMAC	Acid Sulfate Soil Management and Advisory Committee
BHP	Broken Hill Proprietary
BOD	Biochemical Oxygen Demand
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CAMBA	China-Australia Migratory Bird Agreement
CEMP	Construction Environmental Management Plan
CFFMP	Construction Flora and Fauna Management Plan
CHL	Commonwealth Heritage List
CMA	Catchment Management Authority
DECCW	Department of Environment, Climate Change and Water (NSW)
DEWHA	Department of Environment, Water, Heritage and the Arts (Commonwealth)
DEWR	Department of Environment and Water Resources (Commonwealth)
DII	Department of Industry and Investment
DO	Dissolved Oxygen
DoPI	Department of Planning and Infrastructure
DPI	Department of Primary Industries
EA	Environmental Assessment
EAC	East Australia Current
EEC	Endangered Ecological Communities
EP&A Act	Environmental Planning and Assessment 1979 Act (NSW)
EPA	Environment and Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation1999 Act (Commonwealth)
EPI	Environmental Planning Instruments
EPL	Environmental Protection Licence
ERM	Environment Resources Management
FM Act	Fisheries Management 1994 Act
FMA Act	Fisheries Management Amendment Act, 1997 (NSW)
FRP	Filterable Reactive Phosphorus
GHG	Greenhouse Gases
HBT	Hollow-bearing Trees
HDD	Horizontal Directional Drilling

HWA	Hunter Water Australia
Hunter Water	Hunter Water Corporation
IPART	Independent Pricing and Regulatory Tribunal
IWP	Industrial Water Plant
IWRP	Integrated Recycled Water Strategic Plan 2004-05
JAMBA	Japan-Australia Migratory Bird Agreement
KIWS	Kooragang Industrial Water Scheme
kL	Kilolitres
km	Kilometres
kPa	Kilopascal
kWh/kL	KiloWatt Hour per KiloLitre
kWhr	KiloWatt Hours
L	Litres
LEP	Local Environmental Plan
LGA	Local Government Area
M	Metres
MF	Microfiltration
MF/RO	Microfiltration / Reverse osmosis
MF/UF	Microfiltration / Ultrafiltration
mg/L	Milligrams per Litre
ML/day	Megalitres per Day
NCC	Newcastle City Council
NES	National Environmental Significance
NFR	Non-Filterable Residue
NHL	National Heritage List
NOx	Oxides of Nitrogen
NPW Act	National Parks and Wildlife Act, 1974 (NSW)
NSW	New South Wales
NV Act	Native Vegetation Act, 2003 (NSW)
NW Act	Noxious Weeds Act, 1993 (NSW)
OCP	Organochlorine Pesticide
OEH	Office of Environment and Heritage (formerly known as DECCW)
OPP	Organophosphate Pesticide
PAH	Polynuclear Aromatic Hydrocarbons
PASS	Potential Acid Sulphate Soil
PCB	Polychlorinated Biphenyl
pH	Measure of the acidity or basicity of a solution
POEO Act	Protection of the Environment Operations Act, 1997 (NSW)
QA	Quality Assurance
REF	Review of Environmental Factors
REP	Regional Environmental Plans

RFI Act	Rivers and Foreshores Improvement Act, 1948 (NSW)
RNE	Register of the National Estate
RO	Reverse Osmosis
RTA	Roads and Traffic Authority NSW
SBS	Sodium Bisulfite
SDI	Silt Density Index
SEPP	State Environmental Planning Policies
SEWPaC	Department of Sustainability, Environment, Water, Population and Communities
SHR	State Heritage Register
SIAS	Strategic Impact Assessment Studies
SIS	Species Impact Statement
SKM	Sinclair Knight Merz
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TPH	Total Petroleum Hydrocarbons
TSC Act	Threatened Species Conservation Act 1995 Act (NSW)
TSS	Total Suspended Solids
UF	Ultrafiltration
WARR Act	Waste Avoidance and Resource Recovery Act, 2001 (NSW)
WWPS	Waste Water Pumping Station
WWTW	Waste Water Treatment Works

Executive Summary

Hunter Water Corporation (Hunter Water) proposes to develop the Kooragang Industrial Water Scheme (KIWS) to provide high quality, low salinity recycled water to industrial users. Hunter Water plans to divert 12.6 megalitres per day (ML/day) of effluent from Shortland Wastewater Treatment Works (WWTW), which normally discharges to the Hunter River estuary, for further treatment at an Industrial Water Plant (IWP) before distribution to customers. The IWP would be located in the Steel River Industrial Area and would use membrane filtration (MF/UF) pre-treatment and reverse osmosis (RO) to produce industrial quality recycled water. The reject water from the membrane pre-treatment stage would be returned to Shortland WWTW. Reject water from the reverse osmosis treatment stage would be discharged from the IWP to the Burwood Beach wastewater system the majority of the time and to the Hunter River estuary in extreme wet weather events.

This Review of Environmental Factors (REF) was prepared to detail the justification for the project and the options considered for developing the KIWS; the statutory and legal requirements to carry out the KIWS; consultation with key stakeholders; and a detailed environmental impact assessment on all aspects of the construction and operation of the KIWS. Mitigation measures are also outlined to offset adverse effects. The following outlines the conclusions made about each environmental factor affected by the construction and operation of the KIWS:

Topography, Geology and Soils

The proposed development is predominantly located in areas that have been reclaimed from the Hunter River estuary. Often fill with unknown characteristics has been used to reclaim areas in Newcastle and therefore the contamination status of areas affected by the development was assessed. It was found that in most areas contaminants levels in the soils were below the relevant guidelines however, TPH, chromium, lead and benzopyrene concentrations marginally above the guidelines were found at some borehole locations. Disposal of the soil from these locations would be at an appropriately licensed waste facility. The design and construction of the pipeline in Stevenson Park (a remediated landfill) will be undertaken in consultation with Newcastle City Council to ensure that remediation measures are not comprised.

Groundwater was observed at depths of 5.5 and 6.5 meters on the IWP site (RCA 2008), however it is unlikely that groundwater will be encountered during shallow excavations associated with the construction of the IWP.

No free groundwater was encountered along any of the proposed pipeline routes, however wet soil was observed in 16 borehole sites by Coffey (2009) and two borehole sites by RCA (2008) at a depth of 0.75 and 2.5 metres below the ground's surface. As wet soil is an indicator of proximal groundwater tables the construction of all the pipelines will therefore need to consider shallow and potentially fluctuating groundwater levels, especially as 1.5 m deep excavations are required for the installation of the pipelines.

Mitigation measures during the construction phase of the development have been identified to avoid further detriments to human health and contamination of the surrounding natural environment. There are also further mitigation measures in place for construction activities in the vicinity of the Hunter River.

Water Quality

Construction of the KIWS would require the disturbance of soils, which may result in impacts on water quality after rainfall due to sediment-laden runoff from construction areas. A Soil and Water Management Plan complying with appropriate guidelines would be prepared and implemented.

The major potential impact on water quality from the KIWS would be during operation. The RO reject water would contain most of the dissolved pollutants in the effluent from Shortland WWTW in a concentrated form and therefore the disposal of this waste stream has the largest potential impact. In most weather conditions, the RO reject water would be discharged into the Burwood Beach wastewater system, where it would eventually be discharged into the Pacific Ocean. In extreme wet weather, the RO reject water would be discharged into Hunter River estuary as there would be insufficient capacity in the Burwood Beach wastewater system to receive the flows because of infiltration and inflow of stormwater into the system. When Shortland WWTW produces greater than 12 ML/day of effluent (generally in wet weather), the excess would be discharged into the Hunter River estuary. Based on projected population growth in the Shortland wastewater catchment, this would only be expected to occur in wet weather until at least 2040, as in dry weather effluent produced from Shortland WWTW will match KIWS requirements. There may, however, be periods during commissioning and maintenance of KIWS when all effluent produced by Shortland WWTW is discharged in the Hunter River estuary.

Loads of pollutants discharged in the Hunter River estuary and Pacific Ocean were calculated, and modelling of the Hunter River estuary discharge was undertaken to estimate the impact of the scheme. Also the future conditions, where the catchment of Shortland WWTW wastewater system was fully developed, were assessed.

Overall, there would be significant reduction in the loads of pollutants discharged into the Hunter River estuary, with a 39% reduction in nitrogen loads and a 51% reduction in phosphorus loads in an average rainfall year and full development of catchment. The loads of all pollutants would be below the current estuarine EPL load limits. For Burwood Beach, the load of pollutants discharged would remain below ocean EPL load limits, with the exception of nitrogen. Due to predicted growth in the catchment, wastewater system upgrade works to reduce overflows and the discharge of RO reject water from KIWS, the nitrogen load limits for Burwood Beach may be exceeded before 2020. Hunter Water is currently undertaking a Marine Environmental Assessment Program and reviewing treatment options for Burwood Beach WWTW to determine if and what upgrades are required to ensure that the impacts of Burwood Beach WWTW discharge are acceptable.

Modelling of the discharge of RO reject water in wet weather into the Hunter River estuary was undertaken. The modelling indicated that there would be a decrease in the levels of most nutrients at all sites, however, generally the decrease would be small and would have minor or negligible impacts.

Modelling of key toxicants during worst case RO reject water discharge in dry weather indicate that the increase in toxicant levels would be minor and are unlikely to have any impact.

More testing of RO reject water once the final design is completed would be needed to determine any other potential toxicity issues associated with chemicals used in the treatment process.

Aquatic Ecology

The aquatic ecology of the potentially impacted areas contains many important flora and fauna species including threatened species and ecologically important habitats such as seagrasses, salt marshes and mangroves. However, in the Hunter River estuary especially, there are significant pressures on the ecological health of aquatic communities due to land reclamation, stormwater runoff, point source pollution discharges, fishing, shipping and catchment development.

The main potential impact on aquatic ecology from the KIWS is from changes in water quality due the disposal of the RO reject water. As noted in the **Section 5.2.3**, there would be a significant reduction in the load of pollutants discharged into the Hunter River estuary. Although there may be no measureable improvement in the health of the aquatic environment in the Hunter River estuary because other sources of impact are likely to be more significant, the KIWS would result in less potential for impacts compared with the existing situation.

At Burwood Beach, the pollutant loads would remain similar and would be below the current EPL load limits, except for nitrogen – and this is being addressed through the Marine Environmental Assessment Program and a review of treatment options. Therefore apart from potential impacts from increased nitrogen discharge, aquatic ecological impacts would not be greater that already assessed for relevant development and licensing approvals.

Terrestrial Ecology

The study area has been highly modified by industrial and urban development and consequently there are only small areas of remnant vegetation remaining. One EEC (Coastal Saltmarsh) was identified as being potentially impacted by the Recycled Water Pipeline however it is isolated and small and has already been disturbed. With the careful location of the pipeline, further disturbance of this EEC would be avoided. No threatened flora, fauna and or migratory birds or their potential habitat would be impacted by the KIWS.

Cultural Heritage

The cultural heritage assessment found that there is only one remnant historic garden potentially impacted by the proposed development. This historic garden is separated from the proposed pipeline by a retaining wall and therefore no mitigation is required. Only one registered indigenous heritage site within 100 meters of the proposed pipeline was identified and this site has already been destroyed by the construction of the Tourle Street Bridge. Overall the KIWS does not pose any risk to the heritage.

Noise and Vibration

The majority of noise and vibration impacts would occur during construction of the KIWS. It was predicted that there would be exceedances of noise level objectives at times during the construction of the pipelines, however, these noise impacts would be temporary and mitigated by the intervening terrain and other noise sources e.g. major roads. Mitigation measures would be implemented to offset the adverse impacts of noise on the surrounding environment during construction.

Overall, the noise impacts from the operation of the KIWS would be minimal. Noise modelling indicates that the IWP and associated infrastructure would comply with the individual noise allotments specified in the Steel River Strategic Impact Assessment Study and the overall noise limits from Industrial Noise Policy. Consequently the KIWS would be largely inaudible at the nearest sensitive receivers.

Air Quality

It was found that during construction disturbed soils may result in the generation of dust, especially in windy conditions. However, by ensuring that mitigation measures are followed during and after the construction there would be no significant impacts on the surrounding environment. There would be no air quality issues with the operation of the KIWS.

Energy and Greenhouse

The main impact on Hunter Water's greenhouse gas emissions would be from the operation of the IWP. Allowing for a 30 % contingency in expected electricity use, operation of the proposed plant would increase Hunter Water's existing GHG emissions by 7% (i.e. an additional 5153.5 tCO_2-e per year). Hunter Water would either purchase renewable energy or carbon offsets to fully mitigate the impact of the increased greenhouse generation from the operation of the KIWS. Emissions would also be reduced through energy efficient building design and equipment selection. The MF/RO process is considered to be the most energy efficient and environmentally sustainable option for generating high quality water for the identified customers. Additionally, the proposal would avoid greenhouse gas emissions generated by the supply of 9 ML/day of potable water (ie treatment and pumping energy use).

Soil Contamination and Waste

Small volumes of waste may be generated during the construction and operation of the KIWS. Where possible waste would be minimised, recycled or reused. Waste requiring disposal would be classified using the OEH Waste Classification Guidelines before being disposed of at an appropriately licensed facility.

Traffic and Access

The main impacts on traffic and access would be caused by activities associated with the construction of the pipelines especially as some pipelines would cross major arterial roads. Where pipeline crossings of major roads are proposed, underboring would be used to minimise traffic impacts. Other impacts caused during construction are temporary in nature and include increases in road traffic, road lane closures, disruption of pedestrian pathways, and loss of or disruption to property access.

Activities involved with the operation of the IWP and pipelines, including inspections and maintenance, would cause minimal disturbance to traffic and access. The IWP would only generate four additional trucks movement every week for chemical deliveries and approximately three additional light vehicle movements per day for operation and maintenance.

Mitigation measures would be implemented to minimise the impact of the proposed development on traffic and access during the construction including preparation and implementation of traffic management plans, consulting with property owners and the public on access being blocked or road closures in advance, and working with the Roads and Traffic Authority (RTA) and Newcastle City Council (NCC) on the design and construction planning.

Hazardous Chemical and Dangerous Goods

An assessment using the SEPP 33 Guidelines was used to identify potential hazards during the operation of the KIWS. The production of industrial water at the IWP would require the use of chemicals, primarily to keep the membranes clean and operating efficiently. All of the chemicals used at the IWP are either Class 8 or not classified as dangerous goods and thus do not pose a major risk to explosion or fire. The volumes of chemicals stored would be below the SEPP33 screening level threshold and would be stored in facilities complying with Australian standards.

Human Health

The use of recycled water may pose a potential health risk to the users in the customers' facilities. The main human health risk associated with the non-drinking use of recycled water is from the presence of residual pathogens after treatment. An exposure and treatment risk assessment was undertaken to determine whether the proposed uses and treatment processes reduced the pathogens levels in the recycled water to acceptable levels. The risk assessment process was based upon *National Guidelines for Water Recycling: Managing Health and Environmental Risks* (2006). The risk assessment found the treatment process was sufficient to reduce the risk (based on its intended uses) to acceptable levels for indictor and persistent pathogens. Further validation of the treatment process is required once the scheme becomes operational.

Conclusion

Overall the construction and operation of the KIWS would not result in any significant long term environmental impacts on the cultural and natural environment. There may be some short term adverse effects from noise, dust, disturbance of soils and traffic impacts, however, these can be minimised through design, construction planning and standard construction management measures.

The impacts from the operation of the KIWS would mostly be negligible with environmental aspects such as noise, traffic, waste, terrestrial flora and fauna, air quality and soils largely unaffected. The main negative impact would be from the production of greenhouse gases from the electricity used to produce the industrial water – however these would be offset through the purchase of renewable energy or carbon offsets. However, operation of the KIWS would have some positive environmental benefits including:

- Saving up to 9ML/day of potable water; and
- Significant reduction in the load of pollutants discharged into the Hunter River estuary.

1. Introduction

1.1. Overview

Hunter Water Corporation (Hunter Water) proposes to develop the Kooragang Industrial Water Scheme (KIWS) to provide high quality, low salinity recycled water to industrial users. Hunter Water has identified several large industrial customers in the Kooragang Island and Mayfield industrial areas as potential users of the high quality recycled water to substitute for the use of potable water.

Hunter Water plans to divert approximately 12.6 megalitres per day (ML/day) of effluent from Shortland Wastewater Treatment Works (WWTW), which is normally discharged to the Hunter River estuary, for further treatment at an Industrial Water Plant (IWP) before distribution to customers. To provide sufficient effluent from Shortland WWTW to meet the required industrial water flows for the scheme, it is proposed to divert up to 7 ML/day of untreated wastewater from the Burwood Beach wastewater system to Shortland WWTW. The IWP would be located in the Steel River Industrial Area and would use membrane filtration (MF/UF) pre-treatment and reverse osmosis (RO) to produce industrial quality recycled water. The reject water from the membrane pre-treatment stage would be returned to Shortland WWTW. Reject water from the reverse osmosis treatment stage would be discharged from the IWP to the Burwood Beach wastewater system the majority of the time. In extreme wet weather events, RO reject water would be discharged into the Hunter River estuary. An 8 km pipeline from the IWP to customers on Kooragang Island would be constructed to supply 9 ML/day of industrial recycled water.

In addition, Hunter Water plans to undertake a minor upgrade of Shortland WWTW as a separate project. The environmental impacts of the Shortland WWTW upgrade are assessed in a separate Review of Environmental Factors (REF).

Sinclair Knight Merz (SKM) has prepared this REF for the proposed KIWS on behalf of Hunter Water. The Concept Design has been undertaken by Hunter Water Australia (HWA) concurrently with the REF to ensure that environmental requirements have been considered and incorporated during the design phase.

1.2. Purpose of this Report

The purpose of the REF is to fully assess the impacts of the proposed works and to determine whether or not the proposed works are likely to have a significant impact on the environment. This REF describes the scope of the proposed works, the requirements for the works under State and Commonwealth environmental legislation, and the environmental safeguards that would be implemented in conjunction with the works.

This REF has been prepared to satisfy Hunter Water's requirements for environmental assessment under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

1.3. Report Structure

The REF is structured as follows:

- Executive Summary – overview of the project and summary of the REF findings;
- Introduction – introduces the REF and project;
- Description of the Proposal – provides a justification for the project, a discussion of the options considered in developing the scheme, and a detailed description of construction and ongoing operation of the KIWS;
- Statutory Context – provides information on the statutory, legislative and policy requirements for the project;
- Stakeholder Consultation – description and outcomes of the consultation process;
- Environmental Impact Assessment – contains detailed environmental impact assessment on all aspects of the construction and operation of the KIWS. Proposed environmental management measures are also provided in this section;
- Summary of Proposed Safeguards – outlines the environmental management requirements for the construction and operation of the scheme; and
- Conclusion – presents the outcomes of the REF and summarises the overall impacts of the KIWS.

2. Description of the Project

2.1. Location and Study Area

The KIWS would be located in the City of Newcastle local government area (LGA). The main components of the scheme are:

- An Industrial Water Plant (IWP) - located in the Steel River Industrial Area in Mayfield;
- a pipeline providing effluent for feedwater for the IWP - between the existing Shortland WWTW discharge pipeline and the IWP;
- two pipelines for RO reject water discharge - between the IWP and the existing Shortland WWTW discharge pipeline and between the IWP and the Burwood Beach wastewater system in Mayfield;
- a recycled water delivery pipeline - between the IWP and customers on Kooragang Island; and
- a pipeline for diverting up to 7 ML/day of wastewater from the Burwood Beach wastewater system to Shortland WWTW.

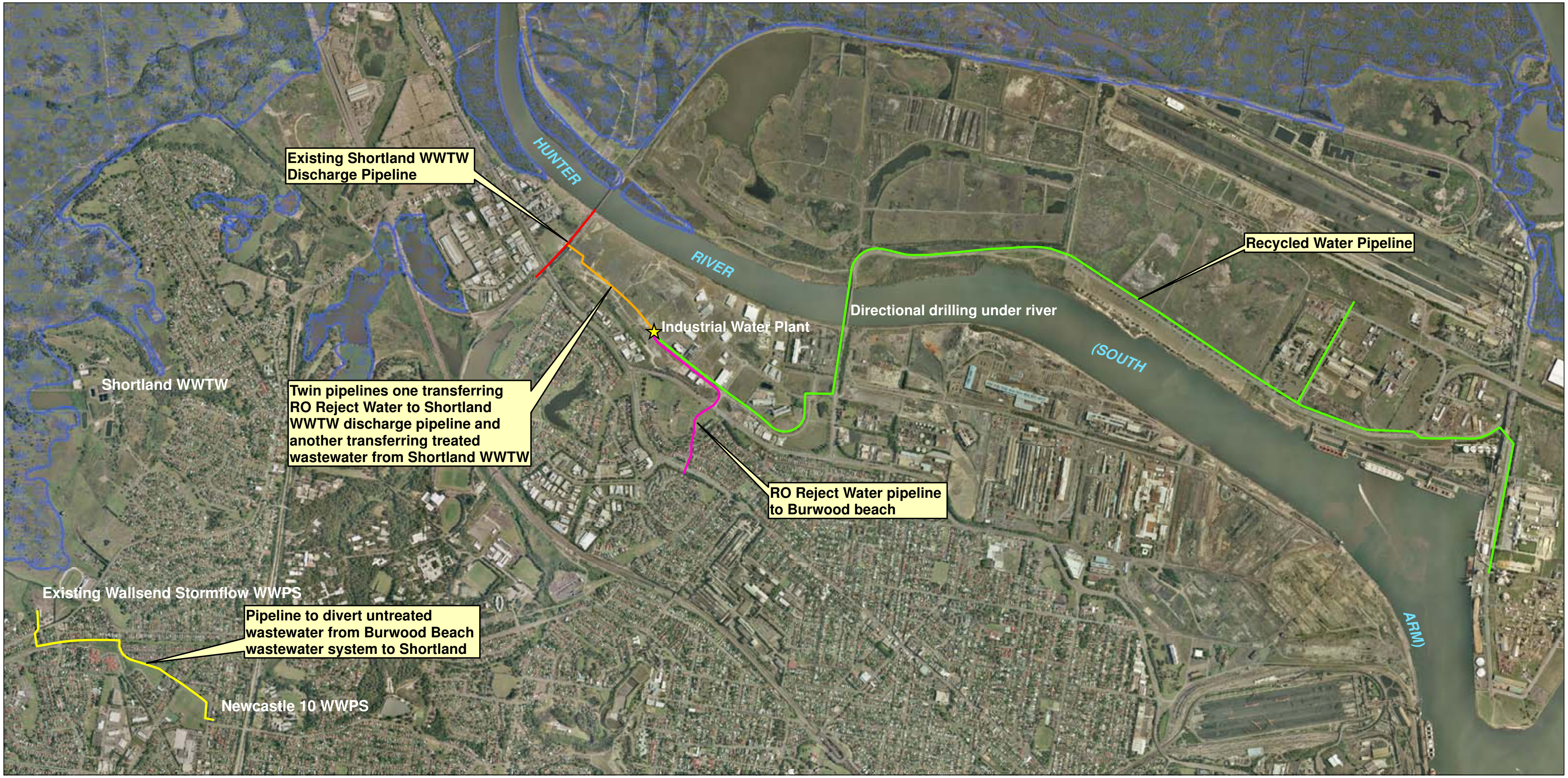
Predominant land use in this area includes port and industrial uses as well as significant areas of undeveloped land. Residential areas are located south of the IWP site (see **Figure 2-1**).

2.2. Existing Operations

There are currently no industrial recycled water schemes operated by Hunter Water in Newcastle. The KIWS and associated infrastructure would be new facilities. Shortland WWTW is located approximately 3.5 km west of the proposed site of the IWP and collects and treats wastewater from the communities of Sandgate, Shortland, Birmingham Gardens and Maryland. It also:

- Receives sewage diverted from the decommissioned Stockton WWTW and Minmi WWTW, from the University of Newcastle and Saint Joseph's Nursing Home at Sandgate; and
- Collects industrial sewage from parts of Kooragang Island, the Steel River Project and other industrial sources.

Shortland WWTW currently treats about 5 to 6 ML/day of wastewater to a secondary level and discharges the effluent into south arm of Hunter River estuary at the Australian Rail and Track Corporation (ARTC) Rail bridge at Sandgate. The pipeline from Shortland WWTW to its Hunter River estuary discharge location passes only 750 m from the proposed site of the IWP.



LEGEND

- Twin Pipelines
- RO Reject Water
- Recycled Water Pipeline
- Pipeline to Divert Wastewater
- Existing Shortland WWTW Discharge Pipeline
- Waste Water Pumping Stations and Treatment Works
- SEPP14 Wetland

DATA SOURCES
Ausimage HWC SKM

0 500
Metres

GDA MGA Zone

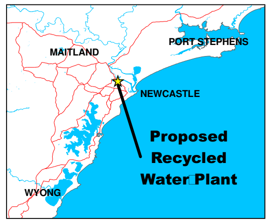


Figure 2-1 KIWS - Location of IWP and Pipelines

SINCLAIR KNIGHT MERZ

To provide 12.6 ML/day of effluent to the IWP (to produce 9 ML/day of industrial recycled water), up to 7 ML/day of wastewater would need to be transferred from the adjacent Burwood Beach wastewater system to Shortland WWTW via a new rising main to provide a total of 12.6 ML/day of treated wastewater for the IWP. Also, a minor upgrade of Shortland WWTW would be required. A description of the required upgrade at Shortland WWTW and the associated environmental impacts are contained in *Shortland WWTW Upgrade – Review of Environmental Factors* (SKM 2009).

Table 2-1 and **Table 2-2** summarise the existing effluent quality data for Shortland WWTW.

- **Table 2-1: Summary of Effluent Quality Data from Shortland WWTW (January 2003 to October 2006)**

Assessable Pollutant	Units	No. Samples	Average	Min	Max
Biochemical Oxygen Demand (BOD)	mg/L	145	3	2	21
Chemical Oxygen Demand (COD)	mg/L	36	39	8	72
Non-Filterable Residue (NFR)	mg/L	198	7	1	102
Ammonia	mg/L	104	0.7	<0.1	16.3
Nitrate	mg/L	104	5.4	0.1	9.5
Total Kjeldahl Nitrogen (TKN)	mg/L	104	2.2	0.6	14.3
Total Phosphorus (TP)	mg/L	104	4.1	0.1	10.8
Total Dissolved Solids (TDS)	mg/L	94	430	280	570
Alkalinity	mg/L	212	94	26	150

- **Table 2-2: Concentration of Metals in Effluent from Shortland WWTW**

Metal	Average Effluent Concentration (ug/L)
Cadmium	0.001
Chromium	1.3
Copper	7.7
Mercury	0.001
Lead	0.63
Selenium	0.067
Zinc	79

Shortland WWTW is subject to conditions specified in Environment Protection Licence (EPL) No.1683 issued by the Environment Protection Authority (EPA) under Section 55 of the *Protection of the Environment Operations Act 1997*. Concentration limits are specified in Clause L3 of the Licence and are summarised in **Table 2-3**.

- **Table 2-3: Shortland WWTW Licence Concentration Limits**

Pollutant	Unit	50 %ile	90 %ile	100 %ile
pH	pH	-	-	6.5 – 8.5
Total Suspended Solids	mg/L	40	80	100
Biochemical Oxygen Demand	mg/L	25	60	80

Load limits are also specified in Clause L2.2 of the Licence (refer EPL No. 1683).

Burwood Beach WWTW collects and treats wastewater from the Newcastle City area and surrounding suburbs – taking in an area bounded approximately by Dudley, Charlestown, Wallsend and Mayfield. It currently treats about 48 to 50 ML/day of wastewater via high rate secondary treatment processes. Effluent is discharged via an extended ocean outfall into the Pacific Ocean. Biosolids are also discharged to the ocean via a separate pipeline and diffusers. Burwood Beach WWTW is included in EPL No. 1683, with Shortland WWTW.

The sewer network which eventually drains to Burwood Beach WWTW extends to within 200m of the proposed IWP. As Burwood Beach WWTW discharges off-shore, the receiving environment is well mixed, saline and has significant capacity for dilution. Therefore one of the options investigated for the disposal of reject water from the IWP is into the Burwood Beach wastewater system – where it would be treated at Burwood Beach WWTW before being discharged off-shore. Also as discussed above, up to 7 ML/day of untreated wastewater would need to be diverted from another section of the Burwood Beach wastewater system to Shortland WWTW to provide the necessary volume of water for the IWP.

2.3. Objectives of the Proposal

The overall objectives of the proposed KIWS are to:

- Provide high quality recycled water that meets industrial users' requirements;
- Substitute recycled water for potable water uses;
- Maximise the use of existing Hunter Water resources and infrastructure; and
- Maximise the environmental benefits of the proposal while minimising the environmental impacts to acceptable levels.

2.4. Need for the Proposal

The need for the KIWS includes:

- Environmental factors and growing population trends in the Lower Hunter area;
- Hunter Water's commitment to meet the water security needs of a growing population and to manage drought;
- Hunter Water's objective to optimise water recycling opportunities; and
- The economic benefits for industrial water customers in the Kooragang industrial area.

2.4.1. Water Security

The Operating Licence issued by the NSW Government requires Hunter Water to have in place an Integrated Water Resources Plan that responds to the water needs of its area of operations.

The Lower Hunter is the sixth largest urban area in Australia and one of the State's major centres of economic activity. Water supply in the lower Hunter is vulnerable to drought – the dams of the Lower Hunter fill quickly but they empty quickly as well. Water levels in the Lower Hunter dams drop faster than most other major Australian urban centres during drought because they are shallow and have high evaporation rates. The population is also expected to continue to grow as people are attracted by the Lower Hunter lifestyle and employment opportunities, with the Department of Planning and Infrastructure predicting an extra 160,000 people between 2006 and 2031.

Sufficient water supply and drought security is essential to support growth and continue the region's strong contribution to the state's economy.

Water security issues were addressed in Hunter Water's *$H_2$50 Plan* published in 2008. The plan set out how Hunter Water would meet water demands until 2058 and focussed on projects announced by the NSW Government in 2006. The announcement included a major scheme to provide recycled water for use in the Kooragang industrial precinct.

The *$H_2$50 Plan* will be replaced by a new Lower Hunter Water Plan. The plan will consider a range of options to secure the region's water supply, including demand management, recycling, stormwater harvesting, desalination and surface water and groundwater sources.

The plan is being developed by the Metropolitan Water Directorate of NSW Department of Finance and Services in collaboration with Hunter Water, other government agencies and the community. In the meantime Hunter Water will continue to focus on water efficiency and recycling initiatives, including the KIWS.

2.4.2. Resource Recovery

Hunter Water aims to pursue sustainable water recycling opportunities as a substitute for potable water and as a way of managing effluent discharges from wastewater treatment plants.

It is a key goal of Hunter Water's *Environmental Management Plan (2008-2013)* to conserve water supplies by ensuring efficient water use. One objective to help achieve this goal is to implement water recycling where it is environmentally and economically feasible. KIWS is one of the water recycling projects designed to meet this objective and will help Hunter Water achieve its target of increasing recycled water usage from 4,000 ML per year in 2007 to 8,000 ML per year in 2013.

2.4.3. Sustainable water solutions for customers

There are currently several industries on Kooragang Island that rely heavily on potable water for various applications such as cooling towers, steam generation, processing water, dust suppression, and washdown. These applications do not specifically require drinking quality however may require low salinity water. For low salinity water uses (e.g. Cooling towers and boilers), potable water is often further treated to remove any residual salts. Hunter Water undertook preliminary discussions with each user to gauge their interest and to determine their potential recycled water demands. Hunter Water has identified that there are also other customers interested in a supply of high quality recycled water for a range of industrial purposes. The implementation of the KIWS would mean that there may be economic benefits for industries in the Kooragang area as operational costs may be lower than if potable water was to be used.

2.5. Alternatives Considered

Presented in the following section is a description of the alternatives that were considered during the development of the IWS. These include the treatment processes and the configuration of the scheme such as the location of infrastructure.

2.5.1. Alternative Treatment Processes

2.5.1.1. Primary Treatment Process

There are a number of potential treatment processes that could be used to achieve a high quality of recycled water from effluent. However, the final end use of the recycled water and its required water quality primarily determines the treatment process. One of the likely recycled water users currently uses about 6 ML/day of potable water in its cooling towers. Even though the potable water is low in dissolved salts, further removal of salts is undertaken at an on-site demineralisation plant before the water is used in the cooling towers to ensure that there is not unacceptable buildup of salts in the cooling towers as water is evaporated.

Consequently, effluent from Shortland WWTW (which has about 2 to 3 times the dissolved salt concentration of potable water) would have to be desalinated to meet these requirements. Based on current technologies, reverse osmosis (RO) would be considered the most cost effective and energy efficient desalination technology for this application. No other types of desalination processes (such as distillation) were considered because:

- The energy requirements of other desalination processes are generally significantly higher and therefore their cost-effectiveness and greenhouse gas emissions make them unsustainable for a plant this size; and
- The technology and design of reverse osmosis processes is well understood and used at many other plants in Australia.

Reverse Osmosis

Reverse osmosis (RO) uses membranes with extremely small pores (down to 0.001 µm) which are small enough to allow water molecules to pass through but prevent the passage of molecules larger than a water molecule. RO is generally the favoured approach for the removal of dissolved ions particularly highly soluble salts. The membrane separates the salts and contaminants from the effluent by applying high pressures to the effluent in the membrane units, which forces most of the water molecules through the membrane whilst the contaminants/salts and the remainder of the water are left behind. The high energy costs associated with the RO process is due the high pressure required to force the water from the effluent through the membrane.

The costs and efficiency of the RO process is highly dependent on the quality of the feed water - in this case secondary effluent from Shortland WWTW. Efficiencies in the RO process can be increased where the feed water treatment is maximised using more conventional chemical or physical pre-treatment processes which are less energy intensive. Therefore the IWP would include a pre-treatment process to further improve the quality of the effluent before the RO process. Based on experience of other recycled water plants with pre-treatment and RO processes, the recovery efficiency (ratio of final recycled water to feed water) would be in the order of 75%. The relatively low salinity of the effluent from Shortland WWTW may increase the potential recoveries from a two stage single pass RO process to above 75%.

While 75% of the effluent is turned into high quality recycled water, the remaining 25% is brackish reject water containing the dissolved salts and contaminants which did not pass through the RO membranes. To achieve recoveries in excess of 75% a third RO stage is typically required. As the dissolved salts and contaminants have already been concentrated, the third RO stage is at higher risk of fouling and scaling and typically requires a greater level of operational management and higher power and chemical costs. The addition of a third RO stage is hence not as attractive from a cost and environmental perspective and the availability of feed water, or lack of, is typically the driver for attempting to achieve recoveries in excess of 75%. As there is ample availability of feed water for the IWS a third RO stage for higher recoveries was not considered to add benefit to the project.

The reject water (or concentrate) is generally not suitable for any beneficial reuse including irrigation, and therefore requires disposal.

2.5.1.2. Pre-treatment Process

As discussed above, to maximise the efficiency of the RO treatment process, effluent from Shortland WWTW would require pre-treatment before the RO process, primarily to remove solid particles in the effluent measured by the Silt Density Index (SDI) with the preference being for water with SDI of less than 3. If these solid particles were not removed, the RO membranes would rapidly clog as they have no 'backwashing' ability, reducing their efficiency, increasing down time for membrane cleaning and increasing the frequency of membrane replacement.

There are two main alternatives for pre-treatment, namely:

- Sands filters or other granular mediums – generally enhanced coagulation is required with pH correction and the addition of coagulants and flocculants to enable this type of pre-treatment to be effective in consistently obtaining SDI's below 3; and
- Micro or ultra-filtration membranes – these are a physical barrier with a nominal pore size of between 0.01 and 0.2 micron and hence do not require chemicals to be added to guarantee the removal of suspended solids. These are considered low pressures membranes and are typically operated between 20 and 200 kPa.

Micro or ultra-filtration membranes were selected as the preferred option for pre-treatment because, in comparison to granular filters, they:

- Are a physical barrier to particulates and will deliver low SDI's even with rapidly changing feedwater quality;
- Use less chemicals for treatment to an equivalent level;
- Require less operator intervention; and
- Require less space.

Membrane Filtration

Membranes are a thin film or barrier that allows the preferential transfer of fluids and soluble compounds from one side of the membrane to the other. The membranes are typically characterised by their pore size with a range of different membrane types commercially available in

Australia. The types of membranes proposed for this project would typically include the micro-filtration (MF) or ultra-filtration (UF) range of membranes. These membranes are characterised by pore sizes in the range of 0.2 or 0.01 micron and can effectively remove particulate and colloidal material.

Membrane filtration is capable of consistently delivering a filtered water of turbidity less than 0.1 NTU without the addition of chemicals. Colour along with other dissolved contaminants, including salts, are not removed by MF/UF membranes. The main objective of membrane filtration is to remove bacterial and particulate matter from the feed water to reduce fouling of the RO membranes.

As feed water is filtered through the membranes solids are removed and accumulate at the membrane surface. If these solids were not removed periodically, the membranes would clog and cease to operate hence they need to be removed to maintain flow through the membranes. Different membrane suppliers offer different solutions for reducing solids concentrations around the membranes however they follow the same principle- the accumulated solids are dislodged from the membrane surface into the bulk water around the membrane. All or a portion of this dirty water is then removed from the tank/vessel containing the membranes. The reject water generated by pre-treatment membranes typically averages out to be 5% of the daily plant inlet flow (95% recovery).

The reject stream from a membrane filtration process is characterised by a high solids concentration (20 times the feed stream). The solids generated by filtering the Shortland WWTW effluent would primarily consist of inert and biological solids that have been carried over from the activated sludge process.

2.5.2. Configuration of Scheme

To ensure value for money, to provide scope for future augmentation and to minimise environmental impacts, various configurations of the KIWS were considered. Configuration refers primarily to the location of key assets such as the IWP, storages and pipelines and the use of existing infrastructure such as Shortland WWTW and its associated infrastructure.

Each of the configurations was developed on the basis that there was a minimum demand of 9 ML/day of desalinated industrial water from potential customers on Kooragang Island and south of the Hunter River estuary. These customers were selected as they are geographically separated providing a representative estimate of the costs for pipelines from the IWP to the end users. This provides a common basis for the initial comparison of the different scheme configurations.

The alternative configurations assessed are presented in the following **Table 2-4**.

Table 2-4: Comparison of Different Scheme Configurations

Option	Advantages/Disadvantages
Option 1 (MF/RO plant at Shortland WWTW) Supply of desalinated (MF/RO dual membrane treatment) recycled water from Shortland WWTW	*Advantages* - Lower land costs due to use of land at Shortland WWTW *Disadvantages* - Moderate loss of land for future upgrades of Shortland WWTW - Increased pumping costs for industrial water and reject water discharge
Option 2 (MF plant at Shortland WWTW and RO plant at Hunter River Dechlorination Site) Supply of desalinated recycled water from the Hunter River Dechlorination Site which includes a membrane filtration (MF/UF) pre-treatment plant at Shortland WWTW with a desalination (RO) plant at the Hunter River Dechlorination Site.	*Advantages* - Lower land costs due to use of land at Shortland WWTW *Disadvantages* - More complex management and poorer integration because of separation of pre-treatment and RO process - Minor loss of land for future upgrades of Shortland WWTW - Additional pipeline required for transfer of pre-treated water from Shortland WWTW to Dechlorination site
Option 3 (MF/RO plant at Hunter River Dechlorination Site) Supply of desalinated (MF/RO dual membrane treatment) recycled water from the Hunter River Dechlorination Site	*Advantages* - Significantly minimises new pumping and pipeline requirements - Maximises use of existing infrastructure *Disadvantages* - Land of sufficient size must be available and purchased
Option 4 (MF/RO plant at a new location) Supply of desalinated (MF/RO dual membrane treatment) recycled water from a plant located at a new location	*Advantages* - Provides flexibility in the location the scheme *Disadvantages* - Land of sufficient size must be available and purchased - Is likely to have increased pipeline lengths and pumping costs compared with other options
Option 5 (MF plant at Shortland WWTW and RO plant on Kooragang Island) Supply of desalinated water from a new location which includes a membrane filtration (MF/UF) pre-treatment plant at Shortland WWTW with a desalination (RO) plant at a new location somewhere on Kooragang Island.	*Advantages* - Lower land costs due to use of land at Shortland WWTW *Disadvantages* - More complex management and poorer integration because of separation of pre-treatment and RO process - Minor loss of land for future upgrades of Shortland WWTW - Limits potential users to Kooragang Island unless another river crossing is provided

The overall estimated lifecycle costs taking in consideration both the initial capital costs and ongoing operational costs were relatively similar between the 5 options, ranging between $56 million and $60 million. Given the error of margin with these preliminary costs, there was no obviously cheaper or more expensive option. Therefore the primary criteria in the selection of a preferred option were based upon the operational characteristics of the scheme and its capacity to be expanded in the future.

The following general conclusions about the options were developed:

- Separation of the MF process from the RO process (i.e. Options 2 and 5) was considered undesirable because of the operational difficulties in integrating and managing the treatment process as two separate locations. Also additional lengths of pipelines are generally required if the two processes are separated;
- Locating the IWP on Kooragang Island limited the potential users unless another pipeline river crossing was provided;
- Although locating the IWP at Shortland WWTW had cost advantages as no additional land would need to be acquired, these were negated because generally longer pipelines would be required to deliver the industrial water to users and to dispose of reject water to the Burwood Beach wastewater system. However, if reject water was able to discharged into the Hunter River, this option may be preferred;
- For future expansion of the recycled water scheme, additional wastewater would need to be diverted to Shortland WWTW or sourced from a new purpose-built treatment plant. In locating the IWP at Shortland WWTW either the options for further expansion of the recycled water scheme would be limited or the costs of disposing the concentrate into the Burwood Beach wastewater system would increase (as the concentrate would have to discharged further downstream in the sewer network, requiring a longer pipeline);
- Although additional land would need to be purchased to locate the IWP at or near the Dechlorination site, this configuration had a number of advantages over other options as it:
  - Maximised the use of existing pipeline infrastructure;
  - Provided a number of options for expansion of the scheme in the future;
  - Was located in closer proximity to potential users of recycled water.

The option of locating the IWP (both MF and RO processes) at a site near the Dechlorination site (Option 3) was selected as the preferred option.

SKM

2.5.3. Potential River Crossings

To supply industrial water to Kooragang Island users, a pipeline crossing of the south arm of the Hunter River estuary would be required. The Hunter River estuary ranges from 250 m – 600 m in width in areas where the pipeline may cross.

A number of options were considered and these are detailed in **Table 2-5** below.

- **Table 2-5: Hunter River Estuary Pipeline Crossing Options**

Option	Discussion
Existing Hunter River Tunnel	Hunter Water already has a tunnel under the Hunter River. The tunnel currently contains a 1350 mm and a 900 mm diameter potable water main. However the tunnel is located a significant distance from the proposed IWP and considerable additional lengths of pipeline would need to be constructed to and from the tunnel. The construction and operational (i.e. pumping) costs and potential environmental impacts of the additional lengths of pipelines make this option less preferred in comparison to other options.
Rail Bridge Crossing	Hunter Water currently has a single 600 mm diameter rising main from Kooragang Waste Water Pumping Station (WWPS) attached to the ARTC Rail Bridge. The bridge also supports the existing effluent discharge pipeline from Shortland WWTW. The owners of the rail bridge, ARTC were consulted about the possibility of attaching the proposed recycled water pipeline to the bridge. However they indicated that they would not support this option due to concerns about access to the bridge for construction and maintenance of the pipeline and the loads applied to the bridge from the proposed new pipeline.
Tourle Street Bridge crossing	Hunter Water currently has a single 600 mm water main attached to the Tourle Street Bridge. The bridge was redesigned in 2006 and the redesign allowed for a single 600 mm diameter main. RTA advised that the 600mm main alone created loads that were just within the allowable working stresses for a 6 girder configuration. If any additional services were to be attached then an additional girder would be required in each span, to carry the additional load. The bridge was refurbished in 2008 and to attach a new pipeline would require additional structural works to the bridge. As well as the costs of the additional work there may be significant disruptions to traffic due to the works. Due to the costs and potential disruption this option is less preferred when compared to other options.
Horizontal Directional Drilling (HDD) river crossing	A horizontal directional drill could be undertaken to construct a new pipeline under the Hunter River. Directional drilling contractors and pipeline engineers have been consulted on the feasibility and costs of this option and have indicated that despite poor geotechnical conditions, installation of the river pipeline crossing is technically feasible and cost effective given the constraints. Directional drilling also has less environmental impact as it does not require trenching or as much disturbance of the ground/river bed. This is the preferred option for the pipeline crossing of the south arm of the Hunter River estuary.

2.6. Description of the Proposal

2.6.1. Introduction

Figure 2-1 shows an overview of the KIWS which consists of the following components:

- A 750 m pipeline to divert up to 12.6 ML/day of effluent from the Shortland WWTW discharge pipeline to the IWP at Steel River Industrial Area;
- An IWP at Steel River industrial area which produces 9 ML/day of high quality recycled water and 0.6 ML/day of reject water from the UF/MF process and 3 ML/day of reject water from the reverse osmosis (RO) process;
- An 8 km pipeline from the IWP to industry on Kooragang Island to transfer high quality recycled water;
- A 1 km pipeline from the IWP to a sewer in the Burwood Beach wastewater system to transfer the reject water from the RO process in dry weather;
- Discharge of the reject water from the RO process via the existing Burwood Beach ocean outfall in most weather conditions;
- A 750 m pipeline from the IWP to the Shortland WWTW discharge pipeline to transfer reject water from the RO process in extreme wet weather;
- Discharge of the reject water from the RO process via the existing Shortland WWTW discharge infrastructure in wet weather;
- A 1.5 km diversion pipeline to allow for the transfer of waste water from the Burwood Beach wastewater system to Shortland WWTW; and
- Discharge of the reject water from the UF/MF process into the Shortland wastewater system.

2.6.2. Industrial Water Plant (IWP)

2.6.2.1. Location

The preferred option was to locate the IWP near the Dechlorination site (which is near the ARTC Rail Bridge crossing the south Arm of the Hunter River). While land was not available directly at the Dechlorination site, available and suitable land was identified at the Steel River industrial area. Hunter Water has purchased 0.8 hectares of land in the industrial area.

2.6.2.2. Plant Infrastructure

Figure 2-2 shows the layout of the IWP which consists of:

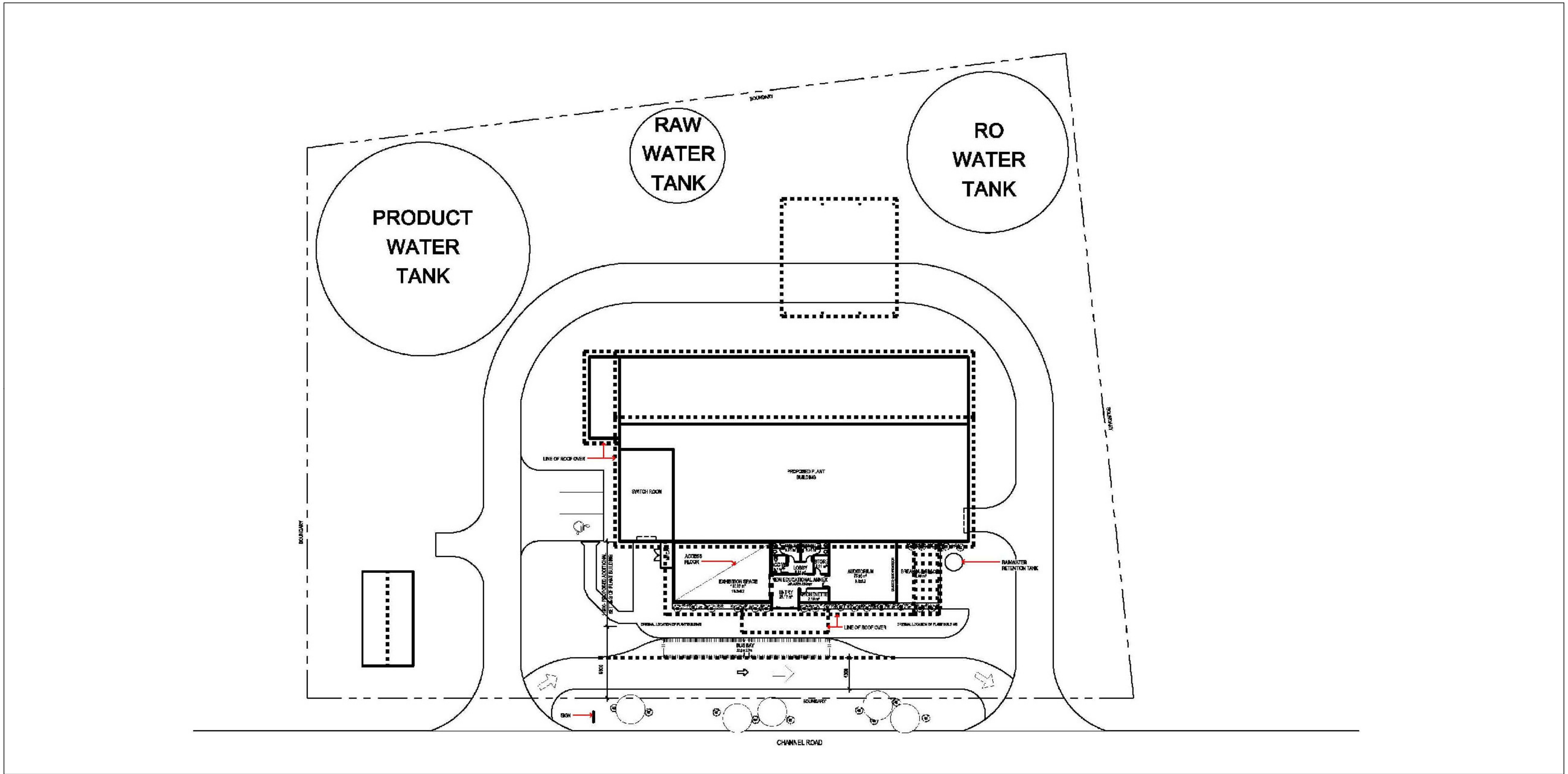
- A main building approximately 25 metres wide by 50 metres long and 7 metres high containing the UF/MF membranes, the RO membranes, pumps and operations office;
- Education Facility providing an exhibition space, auditorium, amenities and kitchenette;
- A separate bunded chemical storage facility;
- A 4.7 ML recycled water storage tank;
- A 2.2 ML RO feed water storage tank;
- A 0.7 ML effluent (feed water) storage tank;
- A degassing structure and tank to condition the industrial water before transfer to customers;
- A product water pumping station to pump the industrial water to customers;
- Internal pipelines connecting the various infrastructure; and
- Roads, landscaping, fencing, power lines and other associated auxiliary infrastructure.

It should be noted that the size and on-site location of these facilities may change after detailed design is completed. The IWP would use up to 12.6 ML/day of effluent from Shortland WWTW to produce up to 9 ML/day of high quality industrial water and up to 3.6 ML/day of reject water (combined MF/UF backwash and RO concentrate)

2.6.2.3. Chemical Storage

A number of chemicals would be required to produce industrial water namely:

- Aqueous ammonia – in combination with hypochlorite, ammonia is used to produce monochloramine which prevents biofouling of the membranes;
- Sodium hypochlorite – in combination with ammonia, hypochlorite is used to produce monochloramine which prevents biofouling of the membranes and is also used for membrane cleaning ;
- Sodium hydroxide (caustic) – pH adjustment of the industrial water and possibly for membrane cleaning;
- Sulfuric acid (alternatively citric acid may be preferred by some membrane suppliers) – potential to adjust pH of the feed water to the RO membranes and for membrane cleaning;
- Sodium bisulphite – for de-chlorination of feed water to the RO system if required, potential de-chlorination of RO concentrate as required and neutralisation of chemical cleaning solutions prior to disposal; and
- Antiscalant –to reduce inorganic scaling on the RO membranes.



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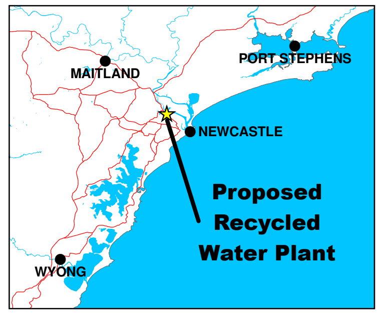


■ **Figure 2-2 KIWS - Layout of IWP**

The bulk chemical storages have been sized to ensure that they would not require refilling more than once a month. An external chemical storage area is proposed separate from the main building and would be designed in accordance with Australian Standard (AS) 3780-1994. Approximate sizes of the chemical storage facilities are:

- 22 kL storage for sodium hypochlorite;
- 5 kL storage for sodium hydroxide;
- 2.5 kL storage of aqueous ammonia;
- 1 (i.e. approximately 1,000 L) palecon container of antiscalant;
- 1 (i.e. approximately 1,000 L) palecon container of sulphuric acid; and
- 1 (i.e. approximately 1,000 L) palecon container of sodium bisulfite (SBS)

It should be noted that the size of storages and types of chemicals may change once the detailed design of the IWP has been completed.

An assessment of the risks posed by chemical storage and transport using SEPP33 guidelines is presented in **Section 5.11**.

2.6.2.4. Educational Facility

As part of the Lower Hunter Recycled Water Initiative grant agreement Hunter Water will build an educational facility attached to the Kooragang Industrial Water Plant at Steel River. The facility is to provide a high quality environment for education on sustainable urban water management and showcase the recycled water projects in the Lower Hunter. No equivalent facility currently exists in the Hunter and the facility is expected to become an extremely valuable resource for Hunter Water and the community.

The main exhibition space (125 m^2) will be large enough to accommodate up to 70 people. Viewing access of the plant will be provided via a large glass window in the exhibition space. The educational facility will also include an auditorium with capacity for 70 people (76m^2). Additional facilities will include a kitchenette, male and female toilets plus a unisex disabled toilet and a storage room.

The proposed design does not include on-site carparking with the exception of a disabled accessible parking space. The educational facility will be positioned to enable easy access from kerbside parking and will include a bus drop off located adjacent to the building entry. Sufficient kerbside parking is available for the number of vehicles expected to be parked at the facility at any time.

The building itself will be designed to complement the surrounding landuse. Low scale planting is proposed at the building perimeter to soften the external appearance of the building.

The educational facility will provide ongoing promotion and education for Hunter Water's recycled water/water security initiatives, catering for scheduled events, open days, school and interest group visits. It will be a place where the community can access information and engage with project staff.

2.6.2.5. Recycled Water Quality

As stated in **Section 2.5.1.1**, there are different quality requirements for different users depending on the use of the water. At the time of preparing this REF, a single customer was requesting 9ML/day (the total output of KIWS) of high quality desalinated recycled water. However, the final customers may require recycled water of a lesser quality (eg micro or ultra filtered water that does need to be treated by reverse osmosis to reduce salinity).

The predicted quality of the desalinated water is presented in **Table 2-6** below.

- **Table 2-6: Industrial Water Quality**

Assessable Parameter	Units	Value
Total Dissolved Solids (TDS)	(mg/L)	<50
Sodium	(mg/L)	<15
Chloride	(mg/L)	<15
Calcium	(mg/L)	<5
pH	pH units	5.5 to 7.5
Total Hardness	(mg/L)	<10
M Alkalinity	(mg/L $CaCO_3$)	<20
Silica	(mg/L)	<2
Iron	(micrograms/L)	<15
Copper	(micrograms/L)	<0.05
Potassium	mg/L	<3
Zinc	mg/L	<0.2
Fluoride	mg/L	<0.1
Sulphate	mg/L	<5
Nitrate	mg/L	<2.5
Ammonia	mg/L N	<0.5
Faecal Coliforms	col/100mL	Not detectable
Enteric Virus	No./50L	Not detectable
Cryptosporidium	No./50L	Not detectable

2.6.2.6. Reject Water

The 3 ML/day of RO reject water produced by the IWP would contain most of the soluble pollutants in the 12 ML/day of MF/UF treated effluent from Shortland WWTW. The predicted quality of the RO reject water is presented in **Table 2-7** below. This assumes that there would be reduced nutrient removal at Shortland WWTW in dry weather with the greater throughput of wastewater.

- **Table 2-7: RO Reject Water Quality**

Pollutant	Future Concentration in Effluent from Shortland WWTW (mg/L)	Concentration in Reject Water from IWP (mg/L)
Total Nitrogen	9	36
Total Phosphorus	8	32
Salinity (TDS)	530	2000
pH	7.6	7.9

Typically 70% of total nitrogen is expected to be oxidised nitrogen

Typically 90% of total phosphorus is expected to be orthophosphate

In dry weather and during most wet weather events, the RO reject water would be discharged into the Burwood Beach wastewater system via a new pipeline from the IWP to a sewer adjacent to Maitland Road approximately 800 m south of the IWP. The reject water would mix with wastewater in the sewer system and eventually drain to Burwood Beach WWTW, where it would undergo treatment before discharge into coastal waters. The RO reject water would make up about 6% of the total flow through the WWTW (currently approximately 48 ML/day). This percentage would decrease gradually as growth in the Burwood Beach wastewater catchment occurs.

In extreme wet weather events there is significant inflow and infiltration of stormwater into the Burwood Beach wastewater system resulting in a reduction in capacity in the sewer system. Consequently in extreme wet weather events there is insufficient capacity in the Burwood Beach wastewater system to receive the RO reject water from the IWP without resulting in an increase in overflows from the wastewater system. Therefore, in extreme wet weather events RO reject water from the IWP would be discharged in the south arm of the Hunter River estuary using the existing Shortland WWTW discharge infrastructure.

Approximately 0.6 ML/day of reject water would also be produced from the MF/UF treatment process. This reject water would be primarily effluent with a high concentration of suspended solids. The reject water from the MF/UF process would be discharged into the Shortland wastewater system.

2.6.2.7. Discharges to the Environment

As up to 12.6 ML/day of effluent from Shortland WWTW would be diverted to the IWP, the volume of effluent discharged from Shortland WWTW into the south arm of the Hunter River estuary would be significantly reduced – and in low inflow conditions would cease (unless KIWS is not operational for some reason). Presented in **Table 2-8** are the treatment and discharge volumes from Shortland WWTW with the operation of KIWS. It is estimated that in a wet year, 3211ML of effluent would be discharged to the Hunter River from Shortland WWTW compared to 7583ML without the operation of the KIWS. In a dry year, 1036ML of effluent would be discharged to the Hunter River from Shortland WWTW compared to 5545ML without the operation of the KIWS.

During commissioning, start-up and close down operations the IWP may not be able to receive effluent from Shortland WWTW. During these periods all effluent produced by Shortland WWTW would be discharged in the Hunter River estuary.

There will be a temporary reduction in combined loads discharged from Shortland and Burwood Beach WWTWs for most pollutants (particularly those attached to particulates and nitrogen), due to the diversion of up to 7 ML/day of untreated wastewater from the Burwood Beach wastewater system to Shortland WWTW, because Shortland WWTW has a higher level of treatment than Burwood Beach WWTW. However, the reduction in loads will decrease progressively as population growth in the Shortland catchment occurs.

The future discharge loads from Burwood Beach WWTW will increase due to growth in the wastewater catchment and discharge of the RO reject stream diverted from KIWS plant to the Burwood Beach wastewater system. Additionally, a significant program of upgrades to the Burwood Beach wastewater system is underway, which will reduce the pollutant loads discharged to the Hunter River estuary and its tributaries through overflows from the catchment but result in additional loads being delivered to Burwood Beach WWTW. The impacts of load increases on receiving water quality are discussed in **Section 5.2**.

In extreme wet weather events RO reject water from the IWP would be discharged in the south arm of the Hunter River estuary using the existing Shortland WWTW discharge infrastructure. In a wet year it is estimated that 6ML of reject water would be discharged into the Hunter River, which is equivalent to 2 days production of reject water from the KIWS (See **Table 2-8**). In a dry year it is estimated that 0.9 ML of reject water would be discharged into the Hunter River, which is equivalent to about 7 hours production of reject water from the KIWS.

The water quality impacts of dry weather and wet weather discharges to the environment are assessed in **Section 5.2**.

■ **Table 2-8: Predicted Treatment and Discharge Volumes for Shortland WWTW and KIWS**

Source	Wet Month (Feb 1990)	Wet Year (1990)	Dry Year (1993)
Inflow to Shortland WWTW (ML)	1387	7583	5545
Effluent produced by Shortland WWTW (ML)	741	6304	5415
Wet weather bypass of Shortland WWTW (ML)	646	1279	0
Effluent discharged by Shortland WWTW to Hunter River (ML)	369	1932	1036
Effluent discharged by Shortland WWTW to KIWS (ML)	372	4380	4380
Reject Water discharge by KIWS to Hunter River (ML)	5.0	6.2	0.9
Reject Water discharge by KIWS to Burwood Beach WWTW (ML)	88	1089	1094

2.6.2.8. Other Operational Characteristics

Operational Hours

The KIWS would operate 24 hours a day 7 days a week. The KIWS would only cease operating for maintenance if there was a failure in the process.

Workforce

The KIWS would require one full time and one part time staff to operate.

Power Use

The IWP would use electricity sourced from the grid as its primary power source. It is estimated that 1.48 kWhrs of electrical power would be required to produce 1000L of industrial water. Treatment of water using reverse osmosis is a relatively energy intensive process as high water pressures have to be generated by large pumps to force the water through the membranes. However in comparison to desalination of sea water using reverse osmosis (about 4 kWhrs per 1000L), the power usage required to desalinate and treat the wastewater from Shortland WWTW is substantially lower as the wastewater has a much lower salinity (about 450 mg/L) in comparison to in seawater (35,000+ mg/L).

A greenhouse gas assessment of the operation of KIWS is presented in **Section 5.8**.

Vehicle Movements

Once operational the IWP would generate approximately 110 vehicle movements (in one direction) a month. This includes 100 movements associated with operations and maintenance staff and 10 vehicle movements associated with the delivery of chemicals and other supplies.

The educational facility would generate approximately 4 bus vehicle movements a week.

2.6.2.9. Construction of Industrial Water Plant

Presented below is a description of the activities required to construct the various components of the IWP.

Industrial Water Plant

The components of the work, and the types of construction activities that would be involved for each component of the work, are detailed below.

Site preparation work

Site preparation work for the IWP would involve:

- Establishment of site compounds and access for construction works;
- Site levelling, removal of excess soil, vegetation and other earthworks; and
- Provision of services for construction.

Buildings and chemical storages

Construction of buildings and chemical storages would involve:

- Excavation for connecting services pipelines and building floors (and possibly bored piling);
- Formwork erection for concrete floor slabs;
- Concrete pours for floor slabs;
- Installation of steel building structures;
- Installation of metal sheeting for walls and roof (or block work where appropriate);
- Installation of pumps;
- Installation of UF/MF and RO filtration modules ;
- Electrical and other services installation; and
- Commissioning.

Internal pipelines

Installation of internal pipelines would involve:

- Site preparation;
- Trenching and excavation including stockpiling of spoil materials;
- Supplying, laying and testing pipelines;

- Concrete anchor blocks or piles in ground at changes in direction of the pipeline;
- Backfill and compaction of trench fill; and
- Restoration of disturbed area.

Other works

Other ancillary works would include:

- Internal road works, involving earthworks, compaction and asphalting;
- Landscaping and site restoration;
- Installation of fencing and other security infrastructure.

Construction of storage reservoirs and pumping station

Site preparation works

Construction of water storage reservoirs and pumping station would commence with basic site preparation works. Site preparation works would include:

- Establishment of site compounds and construction access;
- Site levelling, removal of excess soil, vegetation and other earthworks;
- Provision of services for construction.

The specific activities involved for reservoir and pumping station construction are outlined in the following sections.

Water storage reservoirs

Construction of water storage reservoirs would include:

- Establishment of a concrete pads for the footings or foundations of the reservoirs;
- Installation of the surface reservoir structures, including placement and welding of floor and wall sheets and installation of final supporting and connecting structures including roof support columns, roof beams, rafters, pipe fittings, stairs and access doors;
- Installation of reservoir structures (assembled and erected onsite and installed using a crane);
- Construction of auxiliary structures;
- Installation of underground connecting inflow/outflow pipelines using open trenching;
- Electrical and mechanical fitout; and
- Commissioning.

Water pumping stations

Construction of water pumping stations would include:

- Establishment of a concrete pad;
- Construction of pumping station building;
- Installation of the pumps;
- Installation of connecting inflow/outflow pipelines using open trenching techniques;
- Electrical and mechanical fitout; and
- Commissioning.

Construction Equipment

The following equipment would be used to construct the IWP:

- Piling rig;
- Excavator;
- Compactors;
- Welding equipment;
- Delivery and concrete trucks;
- Powered hand tools;
- Generators;
- Crane.

2.6.3. Pipelines

There are five new pipelines that would need to be constructed and operated (see **Figure 2-1**). These are described in greater detail below.

2.6.3.1. Pipeline to Transfer Effluent from Shortland Effluent Discharge Pipeline to IWP

To transfer effluent from Shortland WWTW to the IWP, the existing effluent discharge pipeline would be used and a new effluent diversion pipeline would need to be constructed. The new effluent diversion pipeline would be approximately 750 m in length, and would extend from the existing effluent pipeline adjacent to the western end of the Industrial Drive to the IWP. This pipeline would be constructed in undeveloped land via open trenching. There would also be some minor modifications to the existing effluent pipeline to allow the diversion of effluent to the IWP. This section of pipeline will be contained within property Lot 74 DP 270249. The pipeline would then cross underneath the railway line and connect into existing infrastructure on the western side of the railway in properties Lots 1 and 5 DP233804.

The pipeline would have a capacity to transfer 12.6 ML/day of effluent from Shortland WWTW to the IWP. The pipeline to transfer reject water from IWP to Shortland WWTW discharge pipeline will be routed beside this pipeline, for more details see **Section 2.6.3.4**.

2.6.3.2. Pipeline to Transfer Industrial Water from IWP to Customers

A new 8 km industrial water pipeline from the IWP to customers in Kooragang Island industrial areas would be constructed. The industrial water pipeline from the IWP would be constructed:

- In the road reserve of Channel Road and Murray Dwyer Circuit until the corner of McIntosh Drive;
- Across a small area of undeveloped land (Lot 16 DP 270249) between McIntosh Drive and Tourle Street;
- In the western road reserve of Tourle Street until just before the Hunter River;
- By directional drilling under the south arm of the Hunter River. The pipeline would surface about 100m west of Tourle Street on the northern side of the south arm of the Hunter River (Lot 122 DP 874949).
- Under Tourle Street and into the southern road reserve of Cormorant Road (still part of Lot 122 DP 874949);
- In the southern road reserve or parallel to Cormorant Road (Lots 7 and 3 DP 1015754) until intersection with Teal Road;

- In the median of Cormorant Road until the intersection with Heron Road (Lot 210 DP1018949 and Lot 2 DP 573972);
- In the western road reserve of Heron Road (Lot 7 DP 262783).

Primarily the pipeline would be constructed via opening trenching. However, where the pipeline crosses a major road or the Hunter River, the pipeline would be constructed via directional drilling or another trenchless method (e.g. Micro tunnelling).

The pipeline would also have scours and air valves installed at appropriate locations to allow for the drainage and re-priming of the pipeline. These would be located to avoid any impacts on environmentally sensitive areas such as EECs.

The pipeline would have a capacity to transfer up to 9 ML/day of industrial water to customers on Kooragang Island.

2.6.3.3. Pipeline to Transfer Reject Water from the IWP to Burwood Beach Wastewater System

The pipeline to transfer reject water to the Burwood Beach wastewater system is approximately 1 km in length. The pipeline would be constructed:

- In the road reserve of Channel Road until the intersection with Steel River Boulevard;
- Down Steel River Boulevard and under Industrial Drive;
- Through Stevenson Park (Lot 2 DP221557);
- In the road reserve of Purdue Avenue;
- Under Maitland Road; and
- To connect to a sewer along the southern side of Maitland Road (Lot 79 DP264659).

The pipeline would have the capacity to transfer up to 3 ML/day of RO reject water to the Burwood Beach wastewater system.

2.6.3.4. Pipeline to Transfer Reject Water from the IWP to Shortland WWTW Discharge Pipeline

This pipeline would follow the same route as the pipeline which transfers effluent from Shortland WWTW (See **Section 2.6.3.1**). However it would be substantially smaller as it would only have a maximum capacity of 3 ML/day and would only be operational in wet weather.

2.6.3.5. Pipeline to Transfer Untreated Wastewater from Burwood Beach Wastewater System to Shortland WWTW

A new 1.5km pipeline would be constructed to allow for the transfer of wastewater from the Burwood Beach wastewater system to Shortland WWTW. The pipeline route is:

- From the existing Newcastle 10 Wastewater Pumping Station (WWPS) located at the corner of Janet Road and Blue Gum Road (Lot 1 DP 1083460), where the new pipeline will head west under Blue Gum Road;
- Into Heaton Park (Lot 2 DP1082079) - the pipeline follows the alignment of the stormwater drain;
- Continuing along the stormwater drain alignment the pipeline will cross properties Lot 24 DP535992 and Lot 9 DP 230341;
- Under Fraser Road;
- Continuing along the stormwater drain alignment the pipeline crosses through properties Lot 21 DP230341 and Lot 2 DP1075635;
- Turning west the pipeline continues underneath the easement of the bicycle path;
- Crossing underneath Tille Street;
- Continuing west underneath the bicycle track,
- Turning north at property Lot 2 DP215788, the pipeline will be routed along the eastern boundary of the property;
- Crossing underneath Sandgate Road and into property Lot 2 DP608814, where it will connect with existing infrastructure at Lot 1 DP608814.

The pipeline would have the capacity to transfer approximately 7 ML/day of untreated wastewater from the Burwood Beach wastewater system to Shortland WWTW.

No above ground construction works are required at Newcastle 10 WWPS to enable this diversion. Work at the WWPS would be limited to construction of a new valve pit (below ground) and installation of a new electrical switchboard in the existing dry well (below ground).

2.6.3.6. Construction of Pipelines

The new pipelines would be installed underground using a combination of open trenching and trenchless techniques, such as thrust boring, micro tunnelling and horizontal directional drilling (HDD). Trenching is the preferred method of pipe installation as it allows open access to the pipeline during construction, and would therefore be the primary method of pipeline construction.

Boring would be undertaken when engineering or environmental constraints are such that open trenching would lead to excessive environmental or community impact, such as at major waterway (i.e. crossing of the South Arm of the Hunter River), major road and rail crossings.

Open trench excavation

Trenches would generally be between 1.3 m and 1.7 m wide to allow for adequate shoring, however, this may vary depending on geotechnical conditions. The total construction footprint for the pipeline corridors is expected to be approximately 6 m wide. The trench depth would generally be up to 1.5 m.

Construction activities associated with trenching typically include:

- Establishment of temporary site compounds at appropriate locations along the pipeline route;
- Establishment of erosion and sediment control measures;
- Implementation of traffic management measures;
- Site preparation, including pavement, footpath and/or road surface removal or vegetation removal;
- Provision of temporary access to properties where trench routes impact driveways;
- Trench excavation, including stockpiling of spoil material on the upslope side of trenches;
- Shoring and dewatering of trenches, depending upon trench depth and groundwater levels;
- Spreading of granular material such as sand or gravel along the bottom of the trench prior to pipe laying;
- Installation and testing of the pipeline;
- Construction of maintenance holes;
- Backfilling of the trench with bedding material and excavated soil; and
- Compacting of trench fill material and restoring areas disturbed by the construction works.

Trenching methods can include both machine trenching and hand trenching. Trenching would generally be carried out using excavators and a small compactor. Rockbreakers may also be required where bedrock is encountered during excavation. Hand trenching would be carried out in environmentally sensitive areas, including areas where there is a need to avoid root damage to large trees.

In trafficable areas, dependent on road authority requirements, full spoil removal may be required. In non-trafficable areas the majority of spoil from the excavation of the trenches would be used to backfill the pipeline route. Excess spoil would be classified in accordance with the Office of

Environment and Heritage (OEH) *Waste Classification Guidelines (2008)* before being disposed of at an OEH approved waste management facility.

Boring

Potential boring techniques that would be used include thrust boring, micro-tunnelling and HDD. Thrust boring and micro-tunnelling requires construction of a launch shaft (approximately 6 m long, 3 m wide and to pipeline depth) and an exit shaft of similar or smaller size. The final depth of the shafts is dependent upon the design level of the proposed pipeline. Additional space is required at the launch site to accommodate plant and equipment. Before micro-tunnelling or thrust boring can commence, the shafts need to be excavated using a rockbreaker or rock cutting wheel.

Micro-tunnelling generally involves a hole being bored by the cutting heads with the boring equipment being thrust along a straight alignment from the launching shaft to the receiving shaft by means of rods or jacks. Guidance is by laser and survey equipment, which allows for the boring of very flat grades with great accuracy. A single bore hole is restricted to a maximum length of approximately 180 to 200 m. In self-supporting strata, the pipe is generally installed after completion of the bore. In collapsible material, the pipe is typically jacked immediately behind the boring equipment or installed within a casing pipe.

Micro-tunnelling requires the use of drilling fluids to keep the drill head moving through the strata. Water is generally used as the drilling fluid for boring in rock, while bentonite slurry is typically used in soft materials. Drill cuttings are removed from the borehole via either vacuum extraction or a slurry system, which takes the cuttings to the ground surface for treatment.

With HDD, there is no need for a launch shaft to be excavated. Instead, the drilling rig sits on the ground surface and drills into the ground at an angle. The drill head is remote controlled from the surface and can be directed so that both vertical and horizontal curves can be drilled. A potential disadvantage of HDD is that the drill head can become misdirected when there is a change in strata. However, HDD is able to perform much longer bores compared to micro-tunnelling in a similar range of diameters. In a single HDD bore, a length of up to 2 km is achievable.

Activities associated with boring techniques include:

- Establishing sites for the launch and exit shafts, including:
  - Installation of erosion and sediment controls;
  - Installation of measures for management of drilling fluids and cuttings;
  - Installation of measures for management of groundwater;
  - Removal of road/footpath surfaces and clearing of vegetation, as required;

- – Installation of fencing and security measures.
- Excavation of the launch and exit shafts;
- Drilling of the borehole, including removal of spoil and cuttings;
- Insertion of the pipe into the borehole;
- Disposal at a licensed facility of excess spoil and cuttings that cannot be used in site restoration;
- Commissioning of the pipeline;
- Restoration of affected areas, including backfilling the bore shafts.

Construction equipment

The machinery to be used during the construction of the pipelines is listed below:

- Excavator;
- Small compactor;
- Saw cutters;
- Delivery and concrete trucks;
- Powered hand tools;
- Small compressor;
- Small generator; and
- Micro-tunnelling or directional drilling rigs.

2.6.3.7. Commissioning

Before the new pipeline is used, there would be a commissioning period where the new pipeline would be thoroughly tested. Commissioning would be in accordance with Hunter Water's standard operating procedures. No significant impacts are expected during the commissioning period.

2.6.3.8. Operation of Pipelines

Generally the pipelines would have a negligible impact during their operation. Impacts would be associated with regular maintenance and inspections of the pipelines and associated scours and air valves. Water main breaks could also occur, resulting in the discharge of recycled water into the Hunter River estuary. However, water main breaks are rare and generally are detected immediately due to the rapid drop in pressure in the pipeline. As the recycled water would be highly treated, no significant water quality impacts would result from the escape of recycled water into the environment. As this potential impact is considered negligible it is not further assessed in the REF.

3. Statutory Context

3.1. Overview

The NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and its associated regulation provides the framework for assessing environmental impacts of proposed developments in NSW. The EP&A Act allows for the creation of environmental planning instruments (EPIs) including local environmental plans (LEPs) and state environmental planning policies (SEPPs). Presented below is a discussion of the approval process under the EP&A Act and the relevance of specific EPIs.

Also discussed below are other legislation, policies and plans of relevance to the proposed development.

3.2. Environmental Planning Instruments

3.2.1. Newcastle Local Environmental Plan 2003

The KIWS would be located within the City of Newcastle LGA, and therefore ordinarily would be subject to relevant provisions of the *Newcastle Local Environmental Plan 2003.* However, because the proposed development is subject to the Infrastructure SEPP (See below), most of the provisions of the Newcastle LEP do not apply. Despite this, Hunter Water aims to comply with the provisions of the LEP wherever possible.

Under the LEP, utility undertakings carried out by a public authority, including for the purpose of water or sewerage undertaking, do not require development consent for development of any description at or below the surface of the ground or the installation or erection of new or replacement plant or other structures or erections. This, however, excludes development involving the erection of buildings, the installation or erection of new or replacement plant or other structures or erections so as to materially affect their design or external appearance of buildings, or pipes above the surface of the ground for the supply of water, or the formation or alteration of any means of access to a road.

IWP

The IWP would be located on land zoned *4(c) – Steel River* under the Newcastle LEP. Construction and operation of the IWP is permissible under this land zoning. The IWP would be considered a utility undertaking under Schedule 4 of the LEP.

As certain components of the IWP would include new buildings and plant, normally it would only be permissible with consent from NCC. However, the Infrastructure SEPP (discussed below) overrides the LEP and therefore the whole IWP would be permissible without consent from NCC.

Also Clause 36 of the LEP applies to the Steel River area which requires compliance with all requirements set out in Part 4 of the 1998 *Strategic Impact Assessment Study*, including air quality, noise emissions, water quality, industrial ecology, ecologically sustainable development, social and economic welfare, urban design and landscaping, and cultural, historic and landscape significance requirements. The environmental effects of any aspect of the development relating to air quality, noise emissions or water quality that have not been addressed in the *Strategic Impact Assessment Study* would need to meet any relevant standards determined by the OEH. The compliance of the components of the proposed development within the Steel River industrial areas with the 1998 *Strategic Impact Assessment Study* is discussed in relevant environmental impact assessment sections.

Pipelines

The pipelines would be located in the following land use zones under the Newcastle LEP:

- 2(a) – Residential;
- 4(b) – Port & Industry;
- 4(c) – Steel River;
- 5(a) – Special Uses; and
- 6(a) – Open Space and Recreation.

In all these zones, utility undertakings as described in **Section 3.2.1** are permissible without consent. As the pipelines and associated infrastructure would be located at or below the surface they still would be permissible without consent from NCC.

3.2.2. State Environmental Planning Policies

State Environmental Planning Policy (Infrastructure) (SEPP) 2007

The Infrastructure SEPP identifies the permissibility of different types of infrastructure and services development. The Infrastructure SEPP aims to improve the efficiency of the planning and approvals system for infrastructure projects by public authorities or persons acting on their behalf. The SEPP effectively overrides all other EPIs, with the exception of SEPP 14 (Coastal Wetlands), SEPP 26 (Littoral Rainforests) and the Major Projects SEPP.

Under the Division 18 Clause 106(2)(a) of the Infrastructure SEPP, development for the purpose of water recycling facilities may be carried out by or on behalf of a public authority or any person licensed under the Water Industry Competition Act 2006 without consent on land in a prescribed zone. The IWP is located on land zoned 4(c) Steel River. With regard to the objectives of this zone, it is considered that this zone is equivalent to the prescribed zone IN1 General Industrial as detailed in the SEPP. Therefore, development consent is not required for the IWP.

Under the Division 18 Clause 106(3)(a) of the Infrastructure SEPP, development for the purpose of sewerage reticulation may be carried out by a public authority without development consent on any land. Therefore, the KIWS pipelines do not require development consent.

As all components of the KIWS are permissible without consent, the development would be assessed under Part 5 of the EP&A Act. Therefore, a REF would be prepared (this document) and Hunter Water would be the determining authority for the development.

Clause 228 of the EP&A Regulation identifies mandatory factors to be addressed in the environmental impact assessment process. The Clause 228 factors are addressed in **Appendix A**.

3.2.3. Regional Environmental Plans

There are no Regional Environmental Plans (REPs) that apply to this project. It is noted that REPs are now deemed to be SEPPs.

3.3. Approvals, Licences and Other Statutory Matters

Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (POEO Act) is the primary piece of legislation regulating air, water and noise pollution control and waste disposal in NSW and is administered by the OEH. The POEO Act requires licences for environmental protection including waste, air, water and noise pollution control. Under the POEO Act, it is an offence to pollute without an environment protection licence. Under Section 48 of the POEO Act, premise-based scheduled activities (as defined in Schedule 1 of the Act) require an Environment Protection Licence (EPL). An EPL is required for the operation of sewage treatment systems (including treatment works, pumping stations, sewage overflow structures and reticulation system) that involve the discharge or likely discharge of wastes or by-products to land or water, with a processing capacity that exceeds 2,500 persons equivalent, or 750 kilolitres per day.

It is envisaged that KIWS would be incorporated into the existing EPL (No. 1683) for Newcastle Sewerage Scheme, which currently includes both Shortland and Burwood Beach WWTWs.

Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* (TSC Act) is administered by the OEH and provides for the protection of critical habitat and threatened species, populations and ecological communities and their habitats in NSW (with the exception of fish and marine plants).

Section 5A of the EP&A Act identifies factors that must be taken in to account in deciding whether there is likely to be a significant impact on threatened species, populations or ecological communities, or their habitats. It establishes seven factors on which this assessment must be based (the 'Seven Part Test'). Where a significant impact may occur as a result of a development proposal, a Species Impact Statement (SIS) must be prepared.

Section 5.4 assesses the potential impact of the proposed development on matters covered by the TSC Act and concludes that there would be no significant impacts and an SIS would not be required.

Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) is administered by the Department of Primary Industries (DPI). The Act provides for the conservation of NSW's aquatic resources and requires that potential impacts on threatened species and aquatic habitats are addressed during the environmental assessment process. The DPI must be informed about any direct impact on aquatic habitat.

National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NPW Act) is administered by the OEH (National Parks and Wildlife Services division) and provides for the protection, preservation and management of all Aboriginal items throughout NSW. Under Section 90 of the NPW Act, the Director-General may grant a 'Consent to Destroy' permit for any destruction, defacing or damage caused to an Aboriginal object or place.

Section 5.5 assesses the potential impact of the proposed development upon indigenous heritage and concludes there would be no direct impacts and no further approvals under this Act would be required.

Heritage Act 1977

The *Heritage Act 1977* provides for the protection of heritage items listed on the State Heritage Register (SHR). The Act provides for the protection of the State's heritage, by interim and permanent conservation orders, conservation schemes and other orders including orders for the prevention of demolition. Section 139 provides for the protection of all relics making it an offence to disturb or excavate land to discover, expose or move a relic, without a permit issued by the NSW Heritage Council. A 'relic' is defined as 'any deposit, artefact, object or material evidence that: (a) relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and (b) is of State or local heritage significance'. Section 146 requires that in the event a relic is discovered during the proposed works, whether or not a permit has been issued, the NSW Heritage Council must be notified, within a reasonable timeframe, of the location of a relic. Where potential archaeological sites have been identified, the proponent must provide an archaeological assessment, notify the Heritage Council of NSW, consider comments received and ensure that all necessary excavation permits under the Act have been granted. Approval is also required from the Heritage Council for work that could affect items listed on the SHR.

Section 5.5 assesses the potential impact of the proposed development upon European heritage and concludes there would be no direct impacts and no further approvals under this Act would be required.

Waste Avoidance and Resource Recovery Act 2001

The primary objective of the *Waste Avoidance and Resource Recovery Act 2001* (WARR Act) is to reduce waste volumes disposed of in NSW and to establish a hierarchy of avoidance, reuse, recycling and reprocessing and disposal. The WARR Act contains requirements in relation to disposal and transport of waste and prevents the disposal of waste on any land unless it is an approved waste facility.

Hunter Water has a responsibility to carry out its works and operations in accordance with the objectives of this Act. As such, the resource management hierarchy must be applied to the project. The application of the resource management hierarchy includes reducing waste at the source (i.e. through appropriate selection of raw materials and packaging), identifying re-use and recycling opportunities for construction materials before the start of construction, and separating reusable and recyclable materials from other construction wastes to minimise the volumes of waste disposed to land fill. The proposed KIWS would be constructed in accordance with the requirements of this Act.

SKM

Noxious Weeds Act 1993

The NSW *Noxious Weeds Act*, (NW Act) emphasises community cooperation to ensure a coordinated and uniform approach to the control of noxious weeds throughout the State. There are no approvals or permit requirements under the Act. However, the Act stipulates that occupiers of land must control noxious weeds on the land under their management.

The management of noxious weeds will therefore apply to the KIWS development, however as this is part of Hunter Water's standard environmental management practices will occur as an inherent component of the construction process. Mitigation measures specific to the Act will be applied and discussed in the Construction Environment Management Plan (CEMP).

Contaminated Land Management Act 1997

The *Contaminated Land Management Act 1997* enables OEH to respond to contamination risks that may cause significant harm to human health or the environment, and sets out criteria for determining whether such a risk exists. The Act gives OEH power to:

- Declare an investigation site and order an investigation;
- Declare a remediation site and order remediation to take place; and
- Agree to a voluntary proposal to investigate or remediate a site.

The OEH may also direct an organisation to investigate or remediate contaminated land. As the site of the proposed KIWS is located on a remediated site previously used by the Broken Hill Proprietary (BHP) steelworks, contaminated land may be an issue for the development of the proposal. Contamination studies and remediation of Steel River Industrial Area have been undertaken including the encapsulation of highly contaminated waste in specific containment cells and the capping of less contaminated material with clean fill. The onus will be on Hunter Water to advise the OEH if during construction it discovers new contaminated land that constitutes a significant risk of harm to people or the environment. Hunter Water will be required to advise the OEH should new contaminated material be identified during construction. Furthermore Hunter Water will be required to undertake appropriate management as defined by the Act to contain, remediate and dispose of any contaminated material uncovered throughout the construction process.

Roads Act 1993

Under the Roads Act 1993, approval is required from the appropriate roads authority to undertake any activity that may affect the operation of the road including construction. Newcastle City Council is the road authority for local roads, while the RTA is the road authority for classified roads. For the KIWS, the main activity that would require approval by the appropriate road authority would be the construction of the pipelines which may require the partial and/or temporary closure of a road. Generally the construction contractor would apply for a road occupancy licence for the period of road closure – and would be required to comply with all of the conditions of the licence. If the road was to be altered permanently in any manner, approval by the appropriate road authority of the design and construction methodology for the alteration would also be required.

Water Management Act 2000

Dewatering of the ground may be required in some areas of high groundwater levels to allow construction to be undertaken. As the Hunter River and its catchment is an area where a Water Sharing Plan is in place, the Water Management Act 2000 is the relevant legislation regarding groundwater extraction. Under Section 91F of the Act it is illegal to cause aquifer interference (ie undertake dewatering) unless approval has been obtained. Therefore if dewatering is required, approval under Section 91(3) of the Water Management Act will be required.

3.4. Commonwealth Legislation

Environment Protection Biodiversity Conservation Act 1999

The *Environmental Protection Biodiversity Conservation Act 1999* (EPBC Act) aims to provide for the protection of the environment and to promote ecologically sustainable development and the conservation of biodiversity. Under the EPBC Act, approval from the Commonwealth Minister for Sustainability, Environment, Water and Communities (SEWPaC) is required for any proposal having, or with the potential to have, a significant effect on any matter of 'National Environment Significant' (NES) as defined under the Act. The triggers contained in the EPBC Act which relate to matters of NES were considered for this proposal and are listed as follows:

- World Heritage properties – there are no World Heritage properties within the vicinity of the proposed development;
- National Heritage places – there are no National Heritage properties within the vicinity of the proposed works;
- Listed threatened species and communities – no Commonwealth listed threatened species or communities would be impacted;
- Migratory species – no migratory species would be impacted by the proposed development;
- Ramsar wetlands – no Ramsar listed wetlands would be impacted by the proposed development;

- Commonwealth marine areas – the proposal would not result in the modification or disruption of any Commonwealth marine areas;
- Great Barrier Reef Marine Park – the proposal would not result in the modification or disruption of the Great Barrier Reef Marine Park;
- Nuclear actions – the proposal is not a nuclear action.

No matter of NES would be impacted by the proposed development and therefore a referral to the Minister is not required.

4. Stakeholder Consultation

4.1. Overview

Consultation was undertaken with a range of stakeholders for the proposed KIWS during the preparation of the REF. The consultation process aims to inform stakeholders of the proposed development and encourage participation in the REF process. Details of the consultation are provided below.

4.2. Agency Consultation

A number of relevant agencies were identified and consulted regarding the proposed development as part of the consultation process. **Table 4-1** provides a summary of the responses received by the agencies. Copies of the responses are provided in **Appendix B**.

- **Table 4-1: Summary of Agency Consultation**

Agency	Issues and Comments	Section addressed in REF
Newcastle Port Corporation	No response received.	
Roads and Traffic Authority	▪ The Guide to *Traffic Generating Developments* and *Environmental Criteria for Road Traffic Noise* should be considered;	Traffic Generating Developments – Section 5.10 Road Traffic Noise - Section 5.6
	▪ Vehicular traffic routes and intersections to and from the site during construction and at operational stages should be outlined;	Construction - Section 5.10.2 Operational Stages - Section 5.10.3
	▪ Traffic impacts on existing intersections and road capacity during the construction and operating phases should be outlined;	Sections 5.10.2 and 5.9.3
	▪ Works undertaken in any classified road corridors should be identified.	Section 5.10
NSW Maritime	Potential impacts on navigation due to construction of cross Hunter River pipeline.	Section 5.10
Newcastle City Council (NCC)	▪ Discharge of waste waters;	Section 2.6.2.6 Section 5.2
	▪ The potential odour, noise and air quality impacts on surrounding commercial, industrial and residential areas;	Noise – Section 5.6 Odour and Air Quality – Section 5.7

Agency	Issues and Comments	Section addressed in REF
	▪ The Strategic Impact Assessment Study should be addressed including the noise, air and contamination report criteria;	Noise – Section 5.6 Odour and Air Quality – Section 5.7 Contamination – Section 5.1
	▪ In the event that the system malfunctions mechanisms should be in place.	Section 2
Department of Primary Industries (Fisheries)	▪ The presence of toxicants in the effluent must be addressed;	Section 5.2
	▪ The potential for the existing and future discharge salinities to interrupt the migration of prawns and larval fish between Hexham Swamp and the lower estuary must be addressed;	Section 5.3
	▪ Any dredging and reclamation activities should be outlined as well as the mitigation measures to be used;	Section 5.2
	▪ Any activities that damage marine vegetation should be outlined along with the mitigation measures to be used;	Section 5.3
	▪ Any activities that block fish passage should be outlined and the remediation or compensatory works to offset any impacts should be outlined;	Section 5.3
	▪ A threatened aquatic species assessment should be addressed;	Section 5.3.1
	▪ The commercial, recreational and indigenous fishing activities likely to be affected must be outlined.	Section 5.3
Hunter Rivers Catchment Management Authority	No response received	
Office of Environment and Heritage	▪ The quality of water discharged into the Hunter River;	Section 2.6.2.6
	▪ The proposed pipeline route and the potential impact on habitat for the *Litoria aurea* (Green and Golden Bell Frog);	Section 5.4.2
	▪ The construction of the IWP at the Steel River industrial subdivision must comply with relevant planning and construction guidelines;	Section 3.2
	▪ The current Environment Protection Licence 1683 is complied with or an application made for additional licences;	Existing licence – Section 2.2 New licence – Section 3.3

Agency	Issues and Comments	Section addressed in REF
	▪ Works with the potential to produce air pollution are identified and mitigated;	Noise – Section 5.6 Air Quality – Section 5.7
	▪ Community consultation with surrounding community regarding the noise impact from construction and operation of the IWP should be carried out;	Section 5.6
	▪ Compliance with Sections 120 and 142A of the POEO Act. In particular the impact on areas of native vegetation and impacts of any discharge should be considered;	Section 3.3 Section 5.2 Section 5.4
	▪ Mitigation measures regarding the potential direct and indirect impacts of the proposal on protected area estate and areas of high conservation value should be outlined.	Section 5.4

5. Environmental Impact Assessment

Presented in the following sections are descriptions of the existing environments, impacts associated and with the construction and operation of the KIWS and mitigation measures to minimise impacts for each environmental aspect.

5.1. Geology, Topography and Soils

5.1.1. Existing Environment

From a geological perspective the proposed KIWS is situated within the sedimentary foreland basin known as the Sydney Basin which lies in the coastal regions of southern and central New South Wales between Nowra to the south, Newcastle to the north and Ulan to the west. The Sydney Basin is bound by the Lachlan Fold Belt to the south and the New England Fold Belt to the north. It is part of the larger Sydney-Gunnedah-Bowen Basin system that extends north from the Sydney Basin into Central Queensland. The geological units that comprise the Sydney Basin were laid down in marine and marshy environments during the late Carboniferous and early Triassic, and in river and swamp environments during the cold glacial Permian periods (DPI 2009). Coal measures are an extensive component of the Sydney Basin.

The specific stratigraphic units underlying the KIWS consist of siltstone, sandstone, coal, tuff and minor carbonaceous claystone rock types from the Dempsey Formation of the Tomago Coal Measures. The Dempsey Formation has a thickness of approximately 700 metres and separates the Tomago Coal Measures from the Newcastle Coal Measures. The Tomago Coal measures underlie both the Dempsey Formation and the Newcastle Coal Measures. The coal beds in this region are near horizontal but dip slightly southward from the Hunter River region towards Sydney.

Overlying the older Permo-Carboniferous stratigraphic units is younger undifferentiated alluvium from the Quaternary that is characterised by gravel, sand, silt and clay sediments. The Quaternary alluvium sediments have been derived from estuarine and fluvial processes and consist of levee, back-swamp, point bar and overbank deposits derived from flooding events and fluctuations in sea level (DPI 2009).

The topography of the area beneath the site of the IWP consists of a flat-lying landscape which would be expected from sediments originating from low-lying estuarine, river plain and back-swamp environments. Anthropogenic waste deposits, specifically steel slag from the BHP steel works, overlie the Quaternary alluvium in this region of the Hunter River. Furthermore, land reclamation has occurred and the swampy river bank/floodplains environment has been infilled by a variety of materials including: dredged material from the Hunter River estuary, excess construction fill, building rubble and rejected coal washery material.

The soils in the Newcastle region are variable depending on the underlying geology and local relief. At the site of the proposed IWP, the soil landscape is composed of soils from the Beresfield soil landscape. Soils in the Beresfield soil landscape can be classified as Soloths and Podzolic soils. The Beresfield soil landscape is defined by undulating low hills that are residual in nature and formed in a sedimentary environment and typically have low quartz content. Hazards associated with the Beresfield soil landscape include:

- High foundation hazard;
- Water erosion hazard;
- Mine subsidence district;
- Seasonal waterlogging and high run-on on localised lower slopes; and
- Highly acid soils of low fertility

The entire pipeline which transfers reject water from the IWP to Burwood Beach wastewater system and the first 1.5 km of recycled water pipeline traverse the Beresfield soil landscape**.**

Along the Hunter River is a disturbed soil landscape that is specifically anthropogenic in nature. On the northern and southern side of the Hunter River the terrain has been raised to its present level by infilling with industrial wastes and other fill materials. On the southern side of the Hunter River in the Steel River development site, steel stag (which is largely inert), wastes from the coke ovens, and coal washery reject material from the BHP plant are common materials contained within the infill. On the northern section of the Hunter River infill material includes sediment obtained from dredging the Hunter River, excess construction fill, building rubble, bitumen and wood. The effluent pipeline from Shortland WWTW, the Hunter River reject water pipeline and approximately 4.4 km of the recycled water pipeline will be constructed on this disturbed terrain soil landscape.

On the northern side of the Hunter River near the Tourle Street Bridge, approximately 1.2km of the recycled water pipeline traverses the Fullerton Cove soil landscape. The Fullerton Cove soil landscape is classified by very poorly drained Solonchaks soils that tend to be greater than 100 cm deep. These soils have formed in tidal flat environments in brackish/estuarine waters, consequentially the relief and elevation in this environment is less than three metres, and slope gradients are low (less than 3 %) (Matthei 1995).

The untreated wastewater pipeline from the Burwood Beach wastewater system will cross sections of the Beresfield, Hexham Swamp and Killingworth soil landscapes around Jesmond to the south. Deep waterlogged Humic Gley soils are typical of the Hexham Swamp soil landscape, which have formed in broad, swampy, estuarine backplains on the Hunter River delta. Slope gradients are less than one percent and the elevation is up to two metres. A permanent water table exists approximately 60 cm below the surface in this environment and during the wet season this water table rises to the surface (Matthei 1995). Approximately 400 metres of new pipeline will be laid in the Hexham Swamp soil landscape.

The Killingworth soil landscape is an erosional landscape that has greater relief (30 – 100 m) and elevation (50 – 160 m) than any of the other landscapes found in the proposal's footprint. The slope gradient ranges between 3 – 20 %. Soils are more variable and include Yellow Podozolic soils, yellow Soloths, Gleyed Podzolic Soils, Gleyed Soloths, Loams and Lithosols. The landscape is typified by low undulating to rolling hills (Matthei 1995).

Approximately 1.1 km of the untreated wastewater pipeline from the Burwood Beach wastewater system will traverse the Killingworth soil landscape.

5.1.2. Construction Impacts

The construction of the pipelines and to a lesser extent the IWP would involve the disturbance and excavation of soils and rock. Based on the subsurface conditions encountered during the geotechnical investigation, excavations for the pipelines in the Steel River industrial area are expected to be within filled areas including slag layers in the upper 2 m of the soil which would present some difficulty in excavation. Other areas generally comprise sandy silty clay over sandstone rock. In a few locations sandstone is located within 1m of the surface and where the sandstone is not able to be excavated, rock hammering may be required.

Excavations for the IWP in the silty sandy gravel fill are not expected to be stable in the short-term or long-term unless additional support is provided (e.g. piling). For the pipelines only a portion of the soils would be able to be reused as the pipes and associated bedding material would displace excavated material.

There is a risk of soil erosion and runoff of sediment from disturbed areas during rainfall.

5.1.2.1. Acid Sulphate Soils

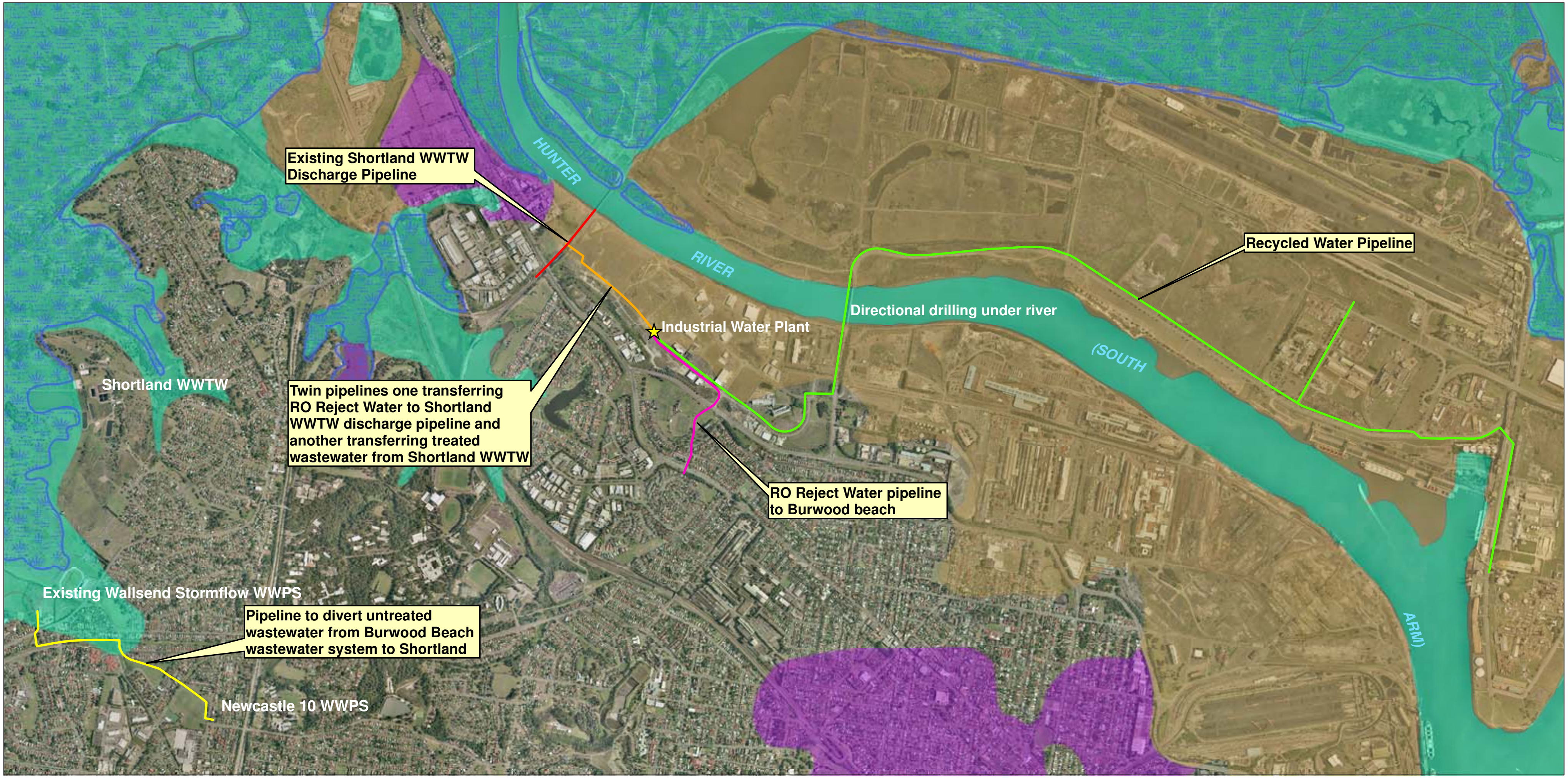
The Newcastle Acid Sulphate Soil Risk Map indicates that a large proportion of the proposal is located in regions identified as having a risk of encountering acid sulphate soils (see **Figure 5-1).** However because of infilling of the terrain, acid sulphate soils may not exist in many risk areas or occur below the level of excavation required for the pipelines. The only pipelines that were not located in acid sulphate soil risk areas include the first 1.5 km of the recycled water pipeline and all of pipeline that transfers reject water to the Burwood Beach wastewater system. Limited acid sulphate soil screening was undertaken (RCA 2008) on 29 soil samples obtained from a subset of drilled boreholes SR01 – SR33 (RCA 2008) for the reject water pipeline to the Hunter River, the recycled water pipeline on the southern side of Hunter River and the IWP site.

The Acid Sulphate Soil Manual 1998 indicates that:

- Actual Acid Sulphate Soil (AASS) may be present if the pH of the soil is <4; and
- Potential Acid Sulphate Soil (PASS) conditions may be present where the pH of soil in peroxide is < 3.5 and/or the pH change during the test is >1.

All samples tested by RCA (2008) had a field pH within the range 4.9 to 10.3, and therefore this does not indicate the presence of AASS. A pH change of >1 unit was measured in 16 samples suggesting the possible presence of PASS. These sample locations were on the reject water pipeline route to the Hunter River, the recycled water pipeline route on the southern side of Hunter River and the IWP site. As surface levels are generally above RL4m AHD and changes in pH may be caused by organic material in the soil, PASS would be unlikely. In addition, all samples tested are from above groundwater level and any PASS would have been expected to have at least partially, if not completely, oxidised. Also because the limited testing did not include definitive laboratory tests, the results are indicative and not conclusive.

Some areas where pipelines are proposed to be located in acid sulphate soils risk areas were not tested. The underboring of the Hunter River and recycled water pipeline north of the Hunter River have a high risk of encountering acid sulphate soils and further testing is required to determine whether these soils are present and to develop appropriate management plans if ASS would be disturbed.



LEGEND

- Twin Pipelines
- RO Reject Water
- Recycled Water Pipeline
- Pipeline to Divert Wastewater
- Existing Shortland WWTW Discharge Pipeline

Waste Water Pumping Stations and Treatment Works

- SEPP14 Wetland

Acid Sulfate Risk

- High Probability of Occurrence
- Low Probability of Occurrence
- NA

DATA SOURCES
Ausimage HWC SKM

0 480
Metres

GDA MGA Zone

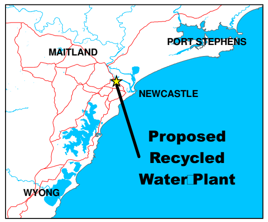


Figure 5-1 Acid Sulphate Soils

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5.1.2.2. Contamination

Due to past industrial development, some areas around the Hunter River have a legacy of contaminated soils and groundwater. Also some shoreline areas along the Hunter River have been reclaimed and in some cases the fill used for reclamation has been contaminated. In December 2008 and in January 2009, RCA Australia and Coffey Environments respectively, carried out separate soil tests to evaluate the suitability of surface and sub-surface soil conditions for the construction of the IWP and pipeline including the analysis of soils for contaminants.

The testing by RCA (2008) involved the drilling of 35 boreholes (CBR1 & CBR2 and SR01-SR33) covering the proposed routes of the pipelines for the transfer of effluent from Shortland WWTW, for the transfer of reject water from IWP to the Hunter River, and the section of recycled water pipeline located on the southern side of the Hunter River. Nine sites located within the footprint of the IWP site were also completed during this investigation by RCA (2008).

The second testing by Coffey (2009) involved drilling 45 boreholes (TL01-TL47 located along the recycled water pipeline on the northern side of the Hunter River, the reject water pipeline to Burwood Beach wastewater system and the untreated wastewater pipeline from the Burwood Beach wastewater system to Shortland WWTW (Coffey 2009). The soils were analysed for the following contaminants:

- Total Petroleum Hydrocarbons (TPH);
- Benzene, toluene, ethylbenzene, xylene (BTEX);
- Polynuclear Aromatic Hydrocarbons (PAH);
- Organochlorine and Organophosphate Pesticides (OCPs and OPPs);
- Polychlorinated Biphenyls (PCBs), and
- Heavy metals (arsenic, cadmium, chromium, copper, lead, nickel, zinc and mercury)

The results of the investigations are summarised below for each component of the KIWS.

IWP Site

At the site of the proposed IWP site, visual observations identified the presence of tar in the core retrieved from borehole SR27 at 1 m and 2.5 m depth. The tar contaminated material should be removed from the development site for appropriate disposal.

Laboratory testing of all samples for TPH revealed that only one sample SR32 (at the IWP site) was in excess of the *1999 National Environment Protection Measure* (NEPM) and the *1994 NSWEPA – Service Station guidelines for Total Petroleum Hydrocarbons (TPH)*. The TPH C10-C36 concentration at site SR32 was 1090 mg/kg, which is only marginally in excess of the NSWEPA guideline value of 1000 mg/kg and consequently is not considered to be significant for an industrial site. All other samples reported non-detection levels and are therefore below the relevant guidelines above. There is no duty to formally notify OEH of this contamination under the Contaminated Land Management Act as the individual sample is less than two and half times the respective guideline level – which is the trigger for formal notification. Also the whole Steel River industrial area is already subject to an order under the Contaminated Land Management Act.

Laboratory results of BTEX, PAH, OCP, PCB reported non-detection levels or levels that were below the *NEPM* (1999) and *NSWEPA –Service Station* (1994) guidelines. It should be noted that all samples identified as containing elevated concentrations of contamination were taken from fill material.

Heavy metal laboratory tests identified Chromium concentrations >500 mg/kg at SR28 (at the IWP site). This was determined to be Chromium III (Trivalent) (not Chromium VI which is known to cause toxic health effects) and is therefore considered not to pose an environmental or human health risk.

In summary there is no significant contamination in these areas which would limit the development or require significant remediation works.

Pipelines

At a number of boreholes along the routes of the recycled water pipeline and reject water to Burwood Beach wastewater system pipeline, soil contamination test results exceeded either the OEH or the NEPM (1999) contaminant guidelines for TPH, Benzo(a)pyrene or total PAHs (See **Table 5-1** below).

- **Table 5-1: Location of Soils which Exceed Contamination Guidelines**

Borehole Number & Depth	Location	
Recycled Water Pipeline		
TL21:0-0.2m	Cormorant Road	TPH (C10-C36) (1000 mg/kg)1360 mg/kg
TL38:0-0.1m	Cormorant Road & Teale St	Benzo(a)pyrene (5 mg/kg)7.9 mg/kg
SR06 1.5m	Channel Road	Chromium III (500 mg/kg) 627 mg/kg
Reject Water to Burwood Beach pipeline		
TL13:0.8-0.9m	Stevenson Park	Benzo(a)pyrene (5 mg/kg) 26 mg/kg Total PAHs (100 mg/kg) 340 mg/kg
TL16: 0.4-0.6m	Stevenson Park	TPH (C10-C36) (1000 mg/kg) 2800 mg/kg Benzo(a)pyrene (5 mg/kg) 19 mg/kg Total PAHs (100 mg/kg) 490 mg/kg
TL17: 0-0.1m	Purdue Avenue	Total PAHs (100 mg/kg) 170mg/kg

While these results are not evidence of significant contamination, soils excavated as part of the construction of the pipelines may not be able to be reused and would require disposal an appropriately licensed facility. Stevenson Park is a former landfill site that is the responsibility of the Newcastle City Council (NCC) and is not considered enough of a significant risk by OEH to warrant their intervention. Consultation would be undertaken with NCC during the design phase to ensure that the remediation works at the park are not comprised by the design and construction of the pipeline. This may require minor relocations of the pipeline to avoid specific areas or works in the park.

Removal and disposal of contaminated soils is discussed in **Section 5.9.**

5.1.2.3. Groundwater

IWP Site

During the drilling of boreholes by RCA (2008) at the IWP site, groundwater was encountered at depths of 5.5 m at borehole site SR30 and 6.5 m below the surface at borehole site SR27. Groundwater is therefore, not expected to be encountered in shallow excavations (2 metres) on the IWP site. It is noted however, that groundwater levels can vary dramatically with climatic conditions and the presence of perched water tables is likely after wet climatic periods.

Pipelines

No groundwater was encountered in boreholes along the routes of pipelines providing effluent from Shortland WWTW to KIWS, the reject water pipeline connecting to the existing Shortland WWTW discharge and the section of recycled water pipeline on the southern side of the Hunter River.

In Coffey (2009) investigations of the routes for pipelines to transfer RO reject water to the Burwood Beach wastewater system, the diversion of untreated wastewater from Burwood Beach wastewater system and the section of the recycled water pipeline on the northern side of the Hunter River, a general trend was observed whereby soils became *"wet"* between 0.8 to 2.5 metres below ground level. The term *"wet"* is defined by Coffey (2009) as: *"Soils that feel cool and are darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere. Free water forms on hands when handling."* Sixteen cores contained wet soils and included cores: TL01, TL04, TL12, TL18, TL23, TL26, TL28, TL29, TL30, TL31, TL38, TL38, TL38, TL40, TL42, TL45, TL46, and TL47.

Other trends noted included:

- Dry surface soils to a depth of 0.7 metres in all cores taken by Coffey (2008) along the alignments of pipelines 2.6.3.3 and 2.6.3.2; and
- All cores investigated in the Jesmond region exhibited moist conditions from the surface down to termination of the core. TL01 was an exception to this trend and it exhibited moist to dry conditions in the top 0.5 metres of the core, followed by moist conditions to 2 metres and wet soil conditions thereafter.

No core was obtained at the most northern end of the pipeline to divert untreated wastewater from the Burwood Beach wastewater system. However groundwater is likely to be encountered as this section of the pipeline crosses into the Hexham Swamp soil landscape where the water table is typically found approximately 0.6 m beneath the ground surface during the dry season and at the surface level during the wet season. Subsequently, dewatering may be required during the construction of this section of pipeline.

Groundwater would be encountered during directional drilling for the recycled water pipeline beneath the Hunter River. However, directional drilling operations are developed to minimise any groundwater ingress to reduce water management requirements.

5.1.3. Operational Impacts

There will be no effect on the topography, geology or soil during the operation of KIWS.

5.1.4. Mitigation Measures

To minimise potential impacts, the following mitigation measures will be implemented during construction:

- For the tar contamination, it may be possible to apply a surface capping to render the tar area a low human health exposure risk. If this is not practical, the tar contaminated material shall be removed from the development site for appropriate disposal elsewhere;
- Hunter Water shall liaise with Newcastle City Council during the design and construction of the pipeline through Stevenson Park to ensure that the works do not impact upon the effectiveness of the previous remediation works;
- A Soil and Water Management Plan which complies with the *Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004)* shall be prepared and implemented during construction;
- During excavation works, the presence of Acid Sulphate Soil (ASS) shall be monitored via observation of soil colour and odour. Should any indication of ASS be discovered, the Project Manager will be notified and action taken to test and implement appropriate ASS controls;

- All excess spoil shall be classified using the *Waste Classification Guidelines (DECC 2009)* and disposed of at an appropriately licensed landfill;
- Appropriate measures for the safe storage and handling of fuels, chemicals and other substances shall be employed in accordance with AS1940;
- Emergency response procedures for spills (e.g. chemicals and hydrocarbons) and other emergencies potentially causing soil contamination shall be implemented; and
- Further investigations in the likelihood of encountering groundwater shall be made during construction planning to determine appropriate construction methodologies and the need to obtain a licence for dewatering activities.

SKM

5.2. Water Quality

5.2.1. Existing Environment

Hunter River Estuary

The Hunter River Estuary is located near Newcastle approximately 160km north of Sydney in New South Wales. The Hunter River is about 300km long and enters the ocean at Newcastle. The catchment area of the Hunter River is approximately 22,000km^2 (DECCW 2008b). The estuary has a total waterway area of 26km^2 (NCC 2005) and comprises the Hunter River and its tributaries to their tidal limits, wetlands, foreshores and adjacent lands. It is a wave dominated estuary with the tidal limit reaching 45km inland at Oakhampton (DECCW 2008b).

The estuary supports a range of environmental, social and economic values such as wetlands of international importance, migratory bird species, a rich fishing and aquatic farming industry, recreation, tourism, farming and a large exporting port. However, many risks and threats can potentially affect the values of the estuary and surrounding catchment. NCC, in their State of the Environment Reporting (NCC 2005) have identified the following key pressures that affect, or have the potential to affect, the water quality and ecology of the estuary:

- Potential industrial development that would encroach upon or require the reclamation of wetlands and potential dredging of the estuary;
- Riverbank loss and erosion due to lack of riparian vegetation, poor land management practices, recreational boating, flood events and natural river processes;
- Loss of aquatic habitats such as river reedbeds (*Phragmites australis);*
- Infilling of the estuary due to long term sedimentation and erosion processes;
- Poor water quality due to agricultural activities, urban stormwater, discharges from mining operations and power generation, and water extraction;
- Introduction and spread of exotic plant and animal species and marine species via shipping operations;
- Invasion of salt marsh communities and tidal flat areas due to changes in the hydraulics of the estuary;
- Conflicts between the use of the estuary for commercial fishing and the natural environment;
- Climate changes and associated changes in weather patterns and sea level.

Burwood Beach

Burwood Beach forms part of the coastal region of the Glenrock State Conservation Area (the conservation area). The conservation area is located to the south of Newcastle city, between the Newcastle suburbs of Merewether and Dudley. It protects the last remnant of coastal temperate rainforest in the Newcastle region (DECCW 2008d). The OEH identifies several values in the conservation area:

- Important environmental values including plant communities such as grasslands, foredune, closed heath, coastal heath-scrub, gully rainforest, dry eucalypt forest on the slopes and ridges, and wetland communities, as well as a diversity of fauna;
- Natural beauty;
- Indigenous cultural values and shared history;
- Old coal mining and copper smelting site.

The coastline is characterised by elevated bedrock cliffs punctuated by pocket beaches (Umwelt, 2003). Aquatic habitats in the Conservation Area include several freshwater streams (e.g. Flaggy and Little Flaggy Creeks, Murdering Gully Creek), Glenrock Lagoon in the south and Burwood Beach.

Key water quality indicators

The key water quality indicators for assessing the impact of the KIWS on receiving waters were derived primarily from the Australian and New Zealand Environment Conservation Council (ANZECC) guidelines default trigger values for indicators of physical and chemical stressors for south-east Australian waterbodies (ANZECC/ARMCANZ 2000) and are shown in **Table 5-2.** Several additional key indicators were selected based on consideration of current water quality in the Hunter River Estuary as well as the likely toxic constituents of the KIWS reject water (brine). These additional indicators are explained below:

- Total suspended solids is a stressor that is non toxic but can directly affect ecosystems and biota (ANZECC/ARMCANZ 2000);
- Total Kjeldahl Nitrogen (TKN) was included in most datasets provided by Hunter Water. Together with Oxides of Nitrogen (NO_{x}), TKN comprises Total Nitrogen, and both NO_x and Total nitrogen (TN) are key water quality indicators of physical and chemical stressors for south-east Australian waterbodies (ANZECC/ARMCANZ, 2000).

- Chloramines will be a by-product of the treatment process. Total chlorine can provide an estimate of the levels of chloramines.

- **Table 5-2: Key water quality indicators discussed in this chapter**

Indicator	ANZECC/ARMCANZ (2000) guideline for aquatic ecosystems (estuaries)	ANZECC/ARMCANZ (2000) guideline for marine ecosystems
pH	7.0-8.5	8.0-8.4
Dissolved Oxygen (DO)	80-110% saturation	90-110% saturation
Total Suspended Solids (TSS)	-	<5mg/L for production of aquatic foods
Total Nitrogen (TN)	300µg/L	120µg/L
Oxides of Nitrogen (NO_x)	15µg/L	25µg/L
Ammonia (NH_3)	320µg/L	910µg/L
Ammonium (NH_4^+)	15µg/L	20µg/L
Total Kjeldahl Nitrogen (TKN)*	285µg/L	95µg/L
Total Phosphorous (TP)	30µg/L	25µg/L
Filterable Reactive Phosphorous (FRP/PO_4)	5µg/L	10µg/L
Chlorophyll *a* (Chl *a*)	4µg/L	1µg/L
Chlorine	3µg/L (low reliability trigger value for 95% level of protection in freshwater systems)	

* The guideline for TKN is a derived guideline, calculated by subtracting the guideline for NO_x from the guideline for TN.

Not all water quality indicators that can be used to assess and monitor estuarine and marine water quality (**Table 5-2**) were investigated. Biological indicators are not relevant because the proposed treatment process would remove bacteria and other biological parameters. In addition, some of the key indicators, such as dissolved oxygen, cannot be compared between current and proposed discharge scenarios because data was not available. As the catchment of the Hunter River estuary is highly modified and there are numerous discharges from WWTWs and other industry is unlikely that the ANZECC/ARMCANZ trigger value criteria would be achieved in the Hunter River estuary.

Existing Water Quality

Water quality in the Hunter River Estuary is influenced by freshwater flows from the Hunter River in the upper parts of the estuary, rainfall and runoff in the catchment and discharges of treated water from Shortland WWTW into the Hunter River at Railway Bridge in the South Arm (BMT WBM 2008). Water quality within the estuary has also been impacted by large vessel traffic and disposal of waste from nearby industrial lands.

Several studies have been conducted on the existing water quality of the Hunter River Estuary. The results of these studies have been summarised and used by BMT WBM (2010) to model predicted future water quality from discharge associated with the proposed KIWS. In summary, the BMT WBM (2010) report indicates that the lower estuary is dominated by high loads of suspended solids and corresponding high turbidity. Turbidity is also higher in the upstream reaches of the estuary (upper estuary), particularly after rainfall. Dissolved inorganic nitrogen has shown increasing concentrations with distance downstream, and chlorophyll-*a* concentrations are generally higher in the upstream reaches. The salinity of the lower Hunter River can fluctuate from brackish to saline, with the lowest levels of salinity occurring in winter months due to increased contributions from tributaries.

Two species of toxic dinoflagellates have been found in the Hunter River (*Alexandrium catenella* and *Alexandrium minutum*). Dinoflagellates are a large group of flagellate protists similar to algae. Some species of dinoflagellates are toxic to animals such as birds, fish and mammals, including humans. Dinoflagellates can bloom into red tides, although no blooms have been recorded in the Hunter River to date. Red tides can kill aquatic fauna and humans who eat shellfish affected by the toxins. Both species that have been recorded in the Hunter River have been associated with red tides and paralytic shellfish poisoning events in other locations (Faust and Gulledge 2002). The distribution of dinoflagellates depends on temperature, salinity, nutrients and depth.

One of the main studies used by BMT WBM to determine existing water quality in the estuary was written by Sanderson and Redden (2001). The authors compiled water quality data from 1972 to 2000 and, in combination with river flow data, discussed spatial patterns and changes in water quality. The key findings were:

- BOD in the South Arm of the Hunter River was less than in the North Arm, even though Shortland WWTW discharges into the South Arm;
- Mean Chl *a* concentrations in the lower estuary exceed the ANZECCC/ARMCANZ guideline of 4µg/L for estuaries;
- Dissolved oxygen levels were of concern both in the estuary and side creeks, with the lower estuary showing the highest levels of dissolved oxygen (DO);
- The concentration of *Enterococci* was highest in the lower estuary, and frequently exceeded the ANZECCC/ARMCANZ guideline of 230CFU/100mL for secondary contact recreation. However, these results are probably attributable to the bias towards wet weather records in the 1990s;

- Coliforms exceeded the guideline for secondary contact recreation (<1000CFU/100mL) for more than 10% of the time;
- The Hunter River Estuary has a relatively high concentration of total suspended solids (TSS) which exceeds the guideline of <5µg/L for production of aquatic foods in a marine environment. Unfortunately, a guideline does not exist for estuarine systems;
- The mean concentration of ammonia was 360µg/L which is 40µg/L higher than the ANZECCC/ARMCANZ for estuaries;
- Mean Oxidised Nitrogen (NO_x) concentrations exceeded the guideline of 15µg/L for estuaries throughout the Hunter River Estuary, and in most monitoring locations the mean value exceeded 100µg/L;
- In the lower estuary, the concentration of NO_x has appeared to increase since 1985 however the concentration of Ammonia (NH_3) seems to have decreased. The increase in NO_x can be partially attributed to the bias of the dataset where, in more recent records, wet weather events were sampled more frequently than dry weather conditions. Even so, the increase in NO_x and decrease in NH_3 indicate that the lower estuary is an oxidising environment;
- pH throughout the whole estuary varies from 6 to 9, which is outside the guideline range of 7-8.5 for estuaries;
- Mean values of total phosphorus (290µg/L) consistently exceed the guideline value of 30µg/L in estuaries. Also, total phosphorus has increased in the upper estuary, suggesting that rivers are the primary source;
- Considering the high concentrations of most nutrients in the Hunter River Estuary, it is thought that the nuisance aquatic plant growth, such as algal blooms is limited by relatively high levels of TSS and turbidity.

5.2.2. Construction Impacts

Erosion and sedimentation

Disturbance, excavation and stockpiling of soils would be required for the construction of all components of the KIWS. If not properly managed, disturbed soils can be eroded by runoff from the construction sites into the surrounding terrestrial and aquatic environments causing impacts such as sedimentation and eutrophication. Risks can be reduced to acceptable levels by developing and implementing appropriate and standard soil and water management plans as detailed in *Managing Urban Stormwater: Soils and Construction (Landcom 2004).*

Other impacts

There is a low risk of soil, groundwater and surface water contamination during the construction phase from the spillage of chemicals such as lubricants, fuels, grease and other materials required for construction.

During construction, fuel (diesel and petrol) and oils would be used by construction vehicles and equipment. At each construction area, small volumes of fuels (generally about 200 L) would be stored and used to refuel generators, saw cutters and other similar types of construction equipment.

There may be small quantities of chemicals used during construction (generally in containers of less than 20 L). Any fuels or chemicals would be stored to meet relevant standards in bunded or contained areas and a spill kit would be provided at all locations where fuels are used. The storage of large quantities of fuels on or around the site would generally be avoided and vehicles and equipment would be refuelled off site. Where on-site refuelling is unavoidable, mini-tankers would be used. Mini-tankers would be required to follow standard procedures and have a spill kit to minimise the risk and impact of spills.

5.2.3. Operational Impacts

The KIWS would have two basic modes of operation – each with different potential water quality impacts. The two different modes of operation are:

1) **Normal operation** – In this mode of operation:
   - Up to 7 ML/day of untreated wastewater would be diverted from the Burwood Beach wastewater system to Shortland WWTW. As the catchment of Shortland WWTW is developed over time and wastewater flows from the catchment increases, the volume of untreated wastewater diverted from the Burwood Beach system would decrease;
   - Up to 12.6 ML/day of secondary effluent would be transferred from Shortland WWTW to KIWS. Any effluent produced by Shortland WWTW in excess of KIWS requirements would continue to be discharged into the Hunter River estuary. On most days discharge of effluent from Shortland WWTW into the Hunter River estuary would not occur as the volume of effluent produced by Shortland WWTW would match KIWS requirements, however in wet weather some excess effluent may be produced that exceeds KIWS requirements;
   - KIWS would produce up to 9 ML/day of industrial water which would be transferred to users;
   - KIWS would produce up to 3 ML/day of RO reject water which would be discharged into the Burwood Beach wastewater system. During extreme wet weather events, reject water may not able to be discharged into the Burwood Beach wastewater system due to high

flows resulting from inflow and infiltration in the system. When the Burwood Beach wastewater system is unavailable, reject water would be discharged into the Hunter River estuary. For a dry year, discharge of RO reject water to the Hunter River estuary is estimated to be required for about 8 hours within the year and for a wet year this would be about 2 days within the year;

- KIWS would produce up to 0.6 ML/day of MF/UF reject water which would be transferred to the Shortland WWTW wastewater system;
- Burwood Beach WWTW currently treats approximately 48 ML/day of wastewater in dry weather (and greater volumes in wet weather). The 3 ML/day of RO reject water would equate to about 6% of the total flow currently treated at Burwood Beach WWTW and would be discharged with the effluent via the existing ocean outfall. This percentage would decrease over time as population growth in the catchment increases the flow through Burwood Beach WWTW.

2) **No operation** – In this mode

- Some untreated wastewater may be diverted from the Burwood Beach wastewater system to Shortland WWTW to provide stability in treatment processes. If the KIWS was not to operate for a substantial period of time, the diversion from Burwood Beach wastewater system would be gradually decreased until the diversion ceases;
- Shortland WWTW would produce secondary effluent which would be discharged into the Hunter River estuary;
- KIWS would produce no industrial water;
- KIWS would produce no RO reject water;
- KIWS would produce no MF/UF reject water;
- Burwood Beach WWTW would operate as normal, treating approximately 48 ML/day of untreated wastewater and discharging the effluent off-shore via its ocean outfall. The flow through Burwood Beach WWTW would increase over time with population growth in the catchment.

5.2.3.1. Pollutant Loads

Hunter River

With KIWS operational, Shortland WWTW would only discharge to the Hunter River estuary when greater than 12 ML/day of effluent is produced. In the majority of cases this would occur after wet weather, however, there may be some occasions in dry weather when peak flows exceed 12 ML/day. There would also be periods when KIWS is not operational due to maintenance or process failures, and all the effluent produced by Shortland WWTW would be discharged in the Hunter River estuary. As noted above, KIWS would only discharge RO reject water into the Hunter River estuary when the Burwood Beach wastewater system was unavailable after significant rainfall events.

Total nitrogen and total phosphorus loads discharged into the Hunter River estuary have been calculated for dry, average and wet years based upon the likely future operating conditions at Shortland WWTW and the operation of the KIWS (See **Table 5-3** and **Table 5-4**). With KIWS discharging RO reject water into the Burwood Beach wastewater system the majority of the time, the loads of pollutants discharged into the Hunter River estuary from Shortland WWTW would decrease significantly. It is predicted that in a year with average rainfall, the quantity of total nitrogen and total phosphorus discharged to the Hunter River estuary would decrease by 39% and 51%, respectively, in comparison to the existing conditions. Even in a year with significantly above average rainfall, there would be a 21% and 36% reduction in the load of total nitrogen and total phosphorus discharged to Hunter River estuary respectively, compared with the existing conditions. In years with below average rainfall, the loads of nutrients discharged decrease significantly as less effluent or reject water is discharged.

- **Table 5-3: Predicted Annual Loads of Total Nitrogen Discharged to Hunter River Estuary**

Source	Existing Conditions (kg/year)	Future Dry Year (kg/year)	Future Average Year (kg/year)	Future Wet Year (kg/year)
Shortland WWTW	17503	7337	10509	13681
KIWS	NA	24	94	164
Total	17503	7361	10603	13845
Change in comparison to existing loads	NA	-58%	-39%	-21%
Exceed EPL load limit (33339 kg/year)	No	No	No	No

- **Table 5-4: Annual Loads of Total Phosphorus Discharged to Hunter River Estuary**

Source	Existing Conditions (kg/year)	Future Dry Year (kg/year)	Future Average Year (kg/year)	Future Wet Year (kg/year)
Shortland WWTW	11669	3938	5641	7343
KIWS	NA	10	39	68
Total	11669	3948	5680	7411
Change in comparison to existing loads	NA	-66%	-51%	-36%
Exceed EPL load limit (17839kg/year)	No	No	No	No

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Presented in **Table 5-5** are predicted loads of key pollutants that would be discharged in the Hunter River estuary by Shortland WWTW and KIWS in existing conditions and for future discharges in dry, average rainfall and wet years. These predicted loads are very conservative as they do not consider any dilution of the raw wastewater from wet weather inflows into the wastewater system. These have also been compared against the load limits in the current EPL.

With the KIWS operational, the combined discharge of effluent from Shortland WWTW and RO reject water would not exceed any of the current EPL load limits and generally would be below or close to the current loads discharged in the Hunter River estuary from Shortland WWTW.

- **Table 5-5: Loads of Key Pollutants Discharged into Hunter River Estuary**

	Concentration (mg/L)	EPL Load limit (kg/year)	Existing (2007/08) Discharge (kg/year)	Future Dry Year (kg/year)	Future Average Year (kg/year)	Future Wet Year (kg/year)
Cadmium	0.000001	2.6	<0.1	<0.1	<0.1	<0.1
Chromium	0.0013	3.9	2.3	1.4	1.9	2.5
Copper	0.0077	51	14	8	12	15
Mercury	0.000001	1.3	<0.1	<0.1	<0.1	<0.1
Lead	0.00063	12.8	1.1	0.7	0.9	1.2
Selenium	0.000068	1.28	0.1	0.1	0.1	0.1
Zinc	0.079	383	140	83	119	155
Non-filterable residue	8	29329	14111	8319	11988	15658
Biochemical Oxygen Demand	5	15904	8820	5200	7493	9786

Burwood Beach

The future pollutant loads discharged from Burwood Beach have been estimated based upon the following assumptions:

- Projected population growth in the Burwood Beach wastewater catchment;
- 3 ML/day of RO reject water from KIWS would be discharged to Burwood Beach system; and
- Up to 7 ML/day of untreated wastewater would be diverted from Burwood Beach to Shortland WWTW to provide 12 ML/day of effluent from Shortland WWTW to meet KIWS requirements.

There will be a temporary reduction in combined loads discharged from Shortland and Burwood Beach WWTWs for most pollutants (particularly those attached to particulates and nitrogen), due to the diversion of up to 7 ML/day of untreated wastewater from the Burwood Beach wastewater system to Shortland WWTW. However, the reduction in loads will decrease progressively as population growth in the Shortland wastewater catchment occurs.

The future discharge loads from Burwood Beach WWTW will increase due to growth in the wastewater catchment and the RO reject stream from KIWS discharged into to the Burwood Beach wastewater system. Additionally, a significant program of upgrades to the Burwood Beach wastewater system is underway, which will reduce the pollutant loads discharged to the Hunter River estuary and its tributaries through reducing wastewater system overflows – however will result in additional loads being delivered to Burwood Beach WWTW. With the exception of total nitrogen, estimated future pollutant loads discharged from Burwood Beach WWTW would not exceed the existing EPL load limits, where load limits have been established. The total nitrogen load is expected to increase to about 15-20% above the existing EPL load limit by 2020.

The treatment process at Burwood Beach WWTW is not designed to remove nitrogen. As part of the Burwood Beach WWTW Stage 3 Upgrade project, a comprehensive two-year Marine Environmental Assessment Program commenced in May 2011 to address potential impacts from future effluent and biosolids discharges from Burwood Beach WWTW. This program has been developed in close consultation with the OEH and other key stakeholders. The outcomes of the marine studies will help to establish whether increasing the total nitrogen loads discharged from the plant would cause a significant environmental impact.

In parallel with the Marine Environmental Assessment Program, a range of upgrade options for Burwood Beach WWTW are being developed, including nitrogen removal process options as well as options for ceasing the discharge of biosolids to ocean (which currently contributes around 25-30% of the total nitrogen load discharged). The results of these investigations will feed into a sustainable decision-making process in 2014 to determine the scope of future upgrade works required at Burwood Beach WWTW. The preferred upgrade strategy for Burwood Beach WWTW would then be the subject of a separate concept design and EIA process. It is anticipated that any upgrade works required would be commissioned by approximately 2020. Therefore, Hunter Water may need to seek an interim increase in the total nitrogen load limit for Burwood Beach WWTW until 2020, to enable any required upgrade works to be delivered. At this stage as the predicted loads of other pollutants would be below existing EPL load limits even with the KIWS operational, no additional increases to load limits would be required.

Water Quality Modelling

Water quality modelling of two significant wet weather events (Feb 1990 and May 2003) was undertaken (see **Appendix C**) to assess the potential worst case water quality conditions in the Hunter River estuary due to the discharge of RO reject water from the KIWS (BMT WBM, 2010).

In the Feb 1990 event:

- There was significant wet weather discharge from Shortland WWTW;
- RO reject water from KIWS was discharged into the Hunter River estuary;
- There were significant inflows from the upstream catchment.

In the May 2003 event:

- There was significant wet weather discharge from Shortland WWTW;
- There was no RO reject water from KIWS discharged into the Hunter River estuary;
- There were minor inflows from the upstream catchment as the rainfall fell in the coastal region rather than the upper catchment.

The existing conditions were also modelled for comparison. The concentration of a number of water quality parameters were modelled for a period of 31 days, at various locations along the Hunter River.

The results of Feb 1990 rainfall event for a continuous discharge are displayed in **Table 5-6** for three locations: Railway Bridge (discharge location), South Arm Harbour (downstream of the discharge location) and Hexham (upstream of the discharge location). The locations of the model scenario points are shown in **Figure 5-2**.

- **Table 5-6: Wet Weather water quality modelling results from BMT WBM (2010) – 1990 wet weather event.**

Parameter	BMT WBM Model Scenario		
	Current	Future Continuous Discharge	
	Average	Average	% Diff.
Railway Bridge			
NO_3 (mg/L)	0.18	0.17	-8.3
TN (mg/L)	0.96	0.94	-2.2
PO_4 (mg/L)	0.05	0.04	-21.2
TP (mg/L)	0.07	0.06	-16.0
Marine Diatoms (µg Chl *a* /L)	0.81	0.81	0.2
South Arm Harbour			
NO_3 (mg/L)	0.07	0.07	-1.5
TN (mg/L)	0.79	0.79	-0.3
PO_4 (mg/L)	0.02	0.02	-2.9
TP (mg/L)	0.04	0.04	-1.8
Marine Diatoms (µg Chl *a* /L)	0.68	0.68	-0.2
Hexham			
NO_3 (mg/L)	0.26	0.26	-0.2
TN (mg/L)	1.25	1.25	-0.1
PO_4 (mg/L)	0.06	0.06	-0.4
TP (mg/L)	0.08	0.08	-0.3
Marine Diatoms (µg Chl *a* /L)	1.35	1.35	0.1

Note: % differences are calculated relative to the current scenario.

For the 1990 event, it is predicted there would be no increase in nutrient concentrations compared to existing conditions due to discharge from Shortland WWTW and the KIWS. This is despite wastewater inflows into Shortland WWTW increasing significantly in the future. Around the discharge location at the Railway Bridge, nutrient concentrations are predicted to decrease. At other sites upstream catchment flows generally dominate water quality in significant events where RO reject water from KIWS is discharged into the Hunter River estuary. Similar changes in nutrient concentrations were predicted for the 2003 rainfall event. Overall the wet weather modelling indicates that the combined impacts of higher wastewater inflows to Shortland WWTW and the operation of the KIWS would result in minor decreases in nutrient concentrations at the discharge location and a negligible impact on nutrient concentrations in other areas of the Hunter River estuary.

Other pollutants

No modelling of other pollutants such as metals was undertaken for the wet weather events as the KIWS would only discharge RO reject water infrequently and there would be considerable dilution from stormwater flows.

The worst case scenario would be if RO reject water from KIWS was discharged into the Hunter River estuary in dry weather, ie when there was no dilution with stormwater. This would only occur if the Burwood Beach wastewater system was unavailable due to an incident or some other uncontrolled event. While production of RO water at KIWS would be stopped and discharge of RO reject water in the Hunter River estuary would also cease, it has been assumed under a worst case scenario this would take up two days to complete. While there would be elevated nutrient concentrations around the discharge location, nutrients are not directly toxic to marine life and the overall increase in loads from two days discharge of RO reject water would be negligible in comparison to annual loads from catchment sources and wet weather discharges from Shortland WWTW. The salinity of RO reject water is significantly lower than typical estuarine waters and would not have an impact on marine ecology.

However, other constituents of the RO reject water, such as metals, may have direct toxic impacts upon marine life and therefore further consideration of their potential impacts is warranted. Based upon dry weather modelling that estimated dilutions of RO reject water at a number of locations in the Hunter River estuary and the conservative assumption that toxicant concentrations in the RO reject water would be 4 times the concentration of toxicants in Shortland WWTW effluent, the contribution of the RO reject water to toxicant concentrations in the Hunter River estuary is estimated in **Table 5-7** below. The locations selected for assessment were:

- the RO reject water discharge location at the Railway Bridge. Based on the modelling the dilution ratio of RO reject water to estuarine water at this location was about 1:200;
- downstream in the South Arm of the estuary approximately 5km downstream of the discharge location. Based on the modelling the dilution ratio of RO reject water to estuarine water at this location was about 1:2000; and
- upstream at the Hexham Bridge approximately 6km upstream of the discharge location. Based on the modelling the dilution ratio of RO reject water to estuarine water at this location was about 1:2200.

The actual toxicant concentrations in the Hunter River estuary as a result of the RO reject water discharge cannot be estimated because there is no background water quality information on toxicant concentrations in the Hunter estuary. However, the estimated contribution of RO reject water to toxicant concentrations in the Hunter River estuary can be compared to the ANZECC 2000 water quality trigger levels to provide an indication of potential risk. A 95% protection level was selected as an appropriate level of protection for the estuary given its sensitive ecological values.

For all the key toxicants assessed at no location did the RO reject water contribution exceed the 95% trigger levels (See **Table 5-8**). At the discharge location where dilution was the lowest, the

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RO reject contribution to toxicant levels was less than 1% of the 95% trigger level for all assessed toxicants except for copper and zinc, where the contribution was approximately 11% for both toxicants. Given the relatively low level of contribution to a conservative trigger level and the commitment that RO reject water would only be discharged for a maximum of two days, the potential risk of the discharge causing unacceptable impacts is low. At other locations downstream and upstream of the discharge location the RO reject water contribution to 95% trigger levels would be generally less than 1% for all toxicants.

- **Table 5-7: Estimate of KIWS contribution to toxicant concentrations in Hunter River estuary in worst case dry weather discharge**

	KIWS Brine Concentration (ug/L)	ANZECC 2000 Marine Trigger levels (95% Protection) (ug/L)	Concentration at discharge (200x dilution) (ug/L)	Concentration downstream (2000 x dilution) (ug/L)	Concentration upstream (2200 x dilution) (ug/L)
Cadmium	0.004	5.5	<0.0001	<0.0001	<0.0001
Chromium	5.200	4.4	0.026	0.003	0.002
Copper	30.735	1.3	0.154	0.015	0.014
Mercury	0.004	0.4	<0.0001	<0.0001	<0.0001
Lead	2.517	4.4	0.013	0.001	0.001
Selenium	0.270	No guideline	0.0014	0.0001	0.0001
Zinc	317.793	15	1.589	0.159	0.144

Other chemicals such as antiscalents may be in the RO reject water. However, as the detailed design and identification of the membrane supplier has not been completed, the type and quantity of other chemicals is unknown at this stage. Given that only a small volume of RO reject water would be discharged, the impact of these chemicals is likely to be minor, however further assessment would be required once more information is available.

5.2.3.2. Summary

The operation of the KWIS with RO reject water only being discharged into the Hunter River estuary after large wet weather events, would result in significant decreases in the loads of nutrients discharged into the estuary. This is despite future wastewater inflows into Shortland WWTW increasing significantly. A conservative assessment of toxicants indicates that loads discharged into the Hunter River estuary would be similar to the existing situation. The current Shortland WWTW EPL load limits would also not be exceeded with the operation of the KIWS and increased future inflows into Shortland WWTW. Even if the RO reject water was to be discharged into the Hunter River estuary in dry weather, toxicant concentrations would remain well below the 95% protection levels of the ANZECC guidelines.

When RO reject water from KIWS and excess future flows from Shortland WWTW are discharged during large rainfall events, there would be a minor decrease or no change in nutrient concentrations in the Hunter River estuary.

With the exception of total nitrogen, the estimated future pollutant loads discharged from Burwood Beach WWTW will remain within the existing EPL load limits. The potential impacts from increased total nitrogen loads on the marine environment are being assessed separately as part of a two-year Marine Environmental Assessment Program being undertaken as part of the Burwood Beach WWTW Stage 3 Upgrade project. This assessment is scheduled to be completed in 2013.

5.2.4. Mitigation Measures

Construction

- Soil and water management plans complying with *Managing Urban Stormwater: Soils and Construction (Landcom 2004)* shall be prepared and implemented

Operation

- RO reject water shall be only be discharged into the Hunter River estuary if the Burwood Beach wastewater system was not able to receive flows;
- The toxicity of other chemicals in the RO reject water (e.g. anti-scalents) shall be assessed once the detailed design has been completed and the membrane manufacturer identified. The potential toxicity of any chemicals used in the process shall be a factor in deciding on the preferred supplier of the membranes;
- Routine monitoring of receiving waters and discharge water shall be undertaken for compliance reporting and to validate water quality monitoring. A monitoring program shall be developed and implemented before operation of the KIWS commences;
- Nitrogen load limits and treatment options for the Burwood Beach WWTW shall be reviewed once the outcomes of the Marine Environmental Assessment Program are available.

5.3. Aquatic Ecology

5.3.1. Existing Environment

5.3.1.1. Burwood Beach

Burwood Beach forms part of the coastal region of the Glenrock State Conservation Area. The conservation area is surrounded by urban development in the adjacent suburbs of Merewether, Merewether Heights, Adamstown Heights and Highfields. Glenrock State Conservation Area (SCA) is the only extensive natural area remaining in the Newcastle local government area south of the Hunter River, and is valued for its natural and aesthetic attributes and recreational opportunities. The coastline is characterised by elevated bedrock cliffs punctuated by pocket beaches. Aquatic habitats in the SCA include several freshwater streams (e.g. Flaggy and Little Flaggy Creeks, Murdering Gully Creek), Glenrock Lagoon in the south and Burwood Beach. Plant communities in the conservation area comprise cleared grasslands, foredune, closed heath, coastal heath-scrub, gully rainforest, dry eucalypt forest on the slopes and ridges, and wetland communities. **Figure 5-2** depicts the location of Burwood Beach and Burwood WWTW relative to Glenrock SCA, and the suburbs of Merewether and Merewether Heights.

Burwood WWTW discharges treated effluent and sludge to the Pacific Ocean via an ocean outfall and diffusers that are located approx 1500m offshore in 22m of water. Therefore any impacts from the discharge would be limited to the marine environment.

Aquatic Ecosystems

Intertidal and Nearshore Habitats

Several groups of flora and fauna make use of the nearshore and foreshore intertidal areas of sandy beaches, including:

- Benthic fauna - those animals that live attached to or on the bottom sediments or on objects on the bottom. Definitions vary, but can include:
  - Epifauna - animals living on the surface of the sea floor, or attached to other benthic organisms (such as seagrass);
  - Infauna - animals living in the mud, such as burrowing worms;
  - Meiofauna - microscopic animals living on or near the sediments;
  - Macrofauna - larger animals living on or near the sediments;
- Littoral fauna - animals along the shoreline down to the limit of the rooted vegetation;
- Pelagic - animals and plants that occupy the open waters or oceans.

The intertidal and nearshore aquatic communities occurring at Burwood Beach and surrounds include beach, rocky shore and macroalgae habitats.

Ocean Habitats

Burwood Beach occurs in the Hawkesbury Shelf Marine Bioregion. The Bioregion covers approximately 2000 km^2 of the New South Wales Coast, and is a known area of high biodiversity. It is where the warm tropical waters of the southern Coral Sea meet with the cooler temperate waters of the Tasman Sea under the influence of the East Australia Current (EAC). The two waters meet and mix off Wollongong, forming a thermal front that results in a high concentration of plankton that bloom in spring, significantly enriching the waters of the Hawkesbury Shelf compared to the northern warmer waters. The EAC brings with it marine fauna from both the northern tropical and southern temperate provinces, providing the region with its rich biodiversity. Freshwater inflows from the region's main river systems also contribute essential nutrients that generate high biological productivity.

Fauna in the ocean habitats at Burwood Beach includes a diversity of fishes, mammals, birds and turtles, some of which are migratory. Recreational fish species commonly encountered at Burwood Beach are listed in **Table 5-8**. A full list of aquatic marine species known to occur in the Burwood Beach area is provided in **Table 5-9.**

- **Table 5-8: Recreational fish species at Burwood Beach.**

Scientific Name	Common Name
Acanthropagus Australia	Bream
Argyrosomus japonicas	Mulloway
Arripis spp.	Australian Salmon
Girella elevate	Drummer
Girella tricuspidata	Luderick
Pagrus auratus	Snapper
Pomatomus saltatrix	Tailor
Sarda australis	Australian Bonito
Trachurus novaezelandiae	Yellowtail

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Anthropogenic Values

Burwood Beach is a popular location for beach and rock platform fishing, swimming, and surfing. The beach is also a listed commercial abalone fishery catch sub-zone. As such the site is valued for its primary and secondary contact recreation opportunities, and its ability to support sustainable commercial collection of aquatic foods.

Threatened Species

A number of marine aquatic fauna species listed under the EPBC Act, TSC Act and FM Act have been recorded as having previously been detected within a 2 – 10 km radius of the Burwood Beach study area and surrounds. The TSC Act includes a total of 40 different marine fauna that are listed as threatened in the Burwood Beach region. The EPBC Act had a total of 63 threatened species and the FM Act had a total of 9 threatened species. These include a mix of mammals, reptiles, birds, sharks and ray-finned fishes, some of which are migratory, the different species are listed in **Table 5-9**.

- **Table 5-9: Threatened Marine Fauna Species listed under the TSC Act**

KEY: *L = listed; M = migratory; V = vulnerable; E = endangered; CD = conservation dependent, P = protected; PExt = presumed extinct, CE = Critically endangered*				
		EPBC Act	**TSC Act**	**FM Act**
Scientific Name	**Common Name**	**Status**		
Ray-finned Fishes				
Hippichthys penicillus	Beady Pipefish, Steep-nosed Pipefish	L		
Trachyrhamphus bicoarctatus	Bend Stick Pipefish, Short-tailed Pipefish	L		
Epinephelus daemelii	Black Cod	L	V	V
Solenostomus cyanopterus	Blue-finned Ghost Pipefish, Robust Ghost Pipefish	L		
Histiogamphelus briggsii	Briggs' Crested Pipefish, Briggs' Pipefish	L		
Syngnathoides biaculeatus	Double-ended Pipehorse, Alligator Pipefish	L		
Hippocampus abdominalis	Eastern Potbelly Seahorse, New Zealand Potbelly, Seahorse, Bigbelly Seahorse	L		P
Ephinephelus coioides	Estuary Cod	L		P
Festucalex cinctus	Girdled Pipefish	L		
Urocampus carinirostris	Hairy Pipefish	L		
Acentronura tentaculata	Hairy Pygmy Pipehorse	L		

KEY: *L = listed; M = migratory; V = vulnerable; E = endangered; CD = conservation dependent, P = protected; PExt = presumed extinct, CE = Critically endangered*				
Scientific Name	**Common Name**	**EPBC Act**	**TSC Act**	**FM Act**
Solenostomus paradoxus	Harlequin Ghost Pipefish, Ornate Ghost Pipefish	L		
Lissocampus runa	Javelin Pipefish	L		
Vanacampus margaritifer	Mother-of-pearl Pipefish	L		
Notiocampus ruber	Red Pipefish	L		
Maroubra perserrata	Sawtooth Pipefish	L		
Thunnus maccoyii	Southern Blue Fin Tuna	L		E
Solegnathus spinosissimus	Spiny Pipehorse, Australian Spiny Pipehorse	L		
Stigmatopora argus	Spotted Pipefish	L		
Filicampus tigris	Tiger Pipefish	L		
Heraldia nocturna	Upside-down Pipefish	L		
Phyllopteryx taeniolatus	Weedy Seadragon,	L		P
Hippocampus whitei	White's Seahorse, Crowned Seahorse, Sydney Seahorse	L		P
Stigmatopora nigra	Wide-bodied Pipefish, Black Pipefish	L		
Mammals				
Arctocephalus pusillus	Australian Fur Seal	L	V	
Balaenoptera musculus	Blue Whale	E, M	E	
Tursiops truncatus s. str.	Bottlenose Dolphin	L		
Balaenoptera edeni	Bryde's Whale	M		
Delphinus delphis	Common Dolphin	L		
Dugong dugon	Dugong	L	E	
Lagenorhynchus obscurus	Dusky Dolphin	M		
Megaptera novaeangliae	Humpback Whale	V, M	E	
Tursiops aduncus	Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin	L		
Orcinus orca	Killer Whale, Orca	M		
Balaenoptera acutorostrata	Minke Whale	L		
Arctocephalus forsteri	New Zealand Fur Seal	L	V	
Caperea marginata	Pygmy Right Whale	M		
Kogia breviceps	Pygmy Sperm Whale	L		
Grampus griseus	Risso's Dolphin, Grampus	L		
Eubalaena australis	Southern Right Whale	E, M	V	
Physeter macrocephalus	Sperm Whale		V	

KEY: L = listed; M = migratory; V = vulnerable; E = endangered; CD = conservation dependent, P = protected; PExt = presumed extinct, CE = Critically endangered				
Scientific Name	**Common Name**	**EPBC Act**	**TSC Act**	**FM Act**
Stenella attenuata	Spotted Dolphin	L		
Mesoplodon layardii	Strap-toothed Beaked Whale	L		
Reptiles				
Chelonia mydas	Green Turtle	V, M	V	
Dermochelys coriacea	Leathery Turtle, Leatherback Turtle	E, M	V	
Caretta caretta	Loggerhead Turtle		E	
Sharks				
Carcharodon carcharias	Great White Shark	V, M		V
Pristis zijsron	Green Sawfish, Dindagubba, Narrowsnout Sawfish	V		PExt
Carcharius taurus	Grey Nurse Shark			CE
Galeorhinus galeus	School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark	CD		
Rhincodon typus	Whale Shark	V, M		
Birds				
Diomedea exulans amsterdamensis	Amsterdam Albatross	E		
Diomedea antipodensis	Antipodean Albatross	V	V	
Rostratula australis	Australian Painted Snipe	V		
Esacus neglectus	Beach Stone-curlew		CE	
Thalassarche melanophris	Black-browed Albatross		V	
Limosa limosa	Black-tailed Godwit		V	
Pterodroma nigripennis	Black-winged Petrel		V	
Limicola falcinellus	Broad-billed Sandpiper		V	
Thalassarche bulleri	Buller's Albatross	V		
Diomedea exulans gibsoni	Gibson's Albatross	V		
Puffinus carneipes	Flesh-footed Shearwater		V	
Diomedea gibsoni	Gibson's Albatross		V	
Pterodroma leucoptera leucoptera	Gould's Petrel	E	V	
Calidris tenuirostris	Great Knot		V	
Charadrius leschenaultii	Greater Sand-plover		V	
Procelsterna cerulea	Grey Ternlet		V	
Pterodroma neglecta	Kermadec Petrel	V	V	
Charadrius mongolus	Lesser Sand-plover		V	
Puffinus assimilis	Little Shearwater		V	

SKM

KEY: L = listed; M = migratory; V = vulnerable; E = endangered; CD = conservation dependent, P = protected; PExt = presumed extinct, CE = Critically endangered				
Scientific Name	**Common Name**	**EPBC Act**	**TSC Act**	**FM Act**
Sterna albifrons	Little Tern		E	
Macronectes halli	Northern Giant-Petrel	V	V	
Pandion haliaetus	Osprey		V	
Haematopus longirostris	Pied Oystercatcher		V	
Pterodroma solandri	Providence Petrel		V	
Calidris alba	Sanderling		V	
Thalassarche cauta salvini	Salvin's Albatross	V		
Thalassarche cauta	Shy Albatross	V	V	
Phoebetria fusca	Sooty Albatross		V	
Haematopus fuliginosus	Sooty Oystercatcher		V	
Sterna fuscata	Sooty Tern		V	
Macronectes giganteus	Southern Giant-Petrel	E	E	
Xenus cinereus	Terek Sandpiper		V	
Diomedea exulans exulans	Tristan Albatross	E		
Diomedea exulans	Wandering Albatross	V	E	
Gygis alba	White Tern		V	
Fregetta grallaria	White-bellied Storm-petrel		V	
Thalassarche cauta steadi	White-capped Albatross	V		

5.3.1.2. Hunter River Estuary

The Hunter River Estuary is located in Newcastle, approximately 160 km north of Sydney, New South Wales. The Hunter River is approximately 300 km long and has a catchment area of 22,000 km^2 (DECCW 2008). The estuary is the second largest in NSW and comprises the Hunter River and its tributaries to their tidal limits, wetlands, foreshores and adjacent lands. It is a wave dominated estuary with the tidal limit reaching 45 km inland at Oakhampton, and a total waterway area of 26 km^2 (NCC 2005).

The upper reaches of the estuary are dominated by agricultural land use in the immediate river zone. There is very little remaining bushland or wetlands along the river banks. Urban settlements such as Maitland and Morpeth have developed very close to the river and tributaries, creating a high flood hazard and pollution risk. Due to the demand for industrial land, and the major changes in landuse, the estuary has been substantially modified (NCC 2005). Land clearing and reclamation for urban and industrial areas, combined with the associated restriction of tidal inundation, have severely reduced some habitat types in the estuary and river (NCC 2005). Over

50% of the Hunter Estuary wetlands have been lost over the years through reclamation and drainage controls (NCC 2005).

The lower part of the estuary is characterised by protected areas of the Hunter Wetlands National Park, industrial development at Tomago, Kooragang Island, Newcastle Harbour, Throsby Creek, and urban development at Stockton and surrounding areas of Newcastle. Surrounding land uses include further urban areas, bushland and mining/quarrying (MHL 2003:26). The Port of Newcastle (lower estuary) has extensive wharfing, boating and docking facilities. Some of these types of landuse contribute sediments and other pollutants to the estuary that threaten the health and productivity of this system (NCC 2005).

Several wetlands in the Hunter Estuary are recognised internationally for their rareness, size and representativeness. These are listed on the Ramsar List of Wetlands of International Importance as the Hunter Estuary Wetlands and comprise the previously recognised Kooragang Nature Reserve and Shortland Wetlands. Both these wetlands are now called the Hunter Wetlands Centre Australia (DECCW 2008). The two wetlands are approximately 2.5 km apart and are connected by a wildlife corridor consisting of Ironbark Creek, the Hunter River and Ash Island. Both estuarine mangroves and salt marshes exist in the wetlands, and are the largest in the Hawkesbury Shelf Bioregion.

Aquatic Ecosystems

Estuaries and their associated wetlands provide a variety of habitats that support plants and animals in a diverse and highly inter-related web of aquatic and terrestrial ecosystems. Estuaries play a major role in protecting juvenile fish from predation. They are also sources of food for juvenile and adult fish and breeding areas for some species. Estuaries are also important feeding, roosting, breeding and recuperation areas for birds and other animals. Many species of migratory waders spend their non-breeding period in Australia building up fat reserves before flying to the northern hemisphere to again breed (http://www.naturalresources.nsw.gov.au/estuaries). Estuarine habitats can be roughly differentiated by vegetation type, sediment type and depth. They include seagrasses, rocky reefs, mangroves, unconsolidated sediments of sand or mud, and saltmarshes. Of these habitat types, the most threatened are probably seagrasses, mangroves and saltmarshes.

Estuarine vegetation types in the Hunter Estuary include mangroves, saltmarsh, a variety of wetlands, Casuarinas and Melaleuca (paperbark) stands. The fauna that depend on estuarine habitats include fish, crustaceans (e.g. prawns), benthic invertebrates, amphibians, reptiles, mammals and a variety of birds. The birds include a diverse range of residential, seasonal and migratory species. Many of the bird species resident during different seasons are covered by the Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds in Danger of Extinction and their Environment (JAMBA) and the Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment (CAMBA) international agreements for protection of migratory birds and birds in danger of extinction. The significance of the Hunter Estuary in providing habitat for these internationally significant species is demonstrated by the fact that of the 66 species covered by these agreements, 38 visit the Hunter River Estuary. The amphibians, reptiles and mammals have relatively low diversity, however, Green and Golden Bell Frog populations are recognised as being of State Significance and resident populations of endemic species are present. Migratory birds, terrestrial and riparian mammals, reptiles and amphibians known to occur in the Hunter river estuary wetlands are considered in the Terrestrial Flora and Fauna technical report, which is attached as **Appendix D**.

Seagrasses

Within the Hunter River estuary there are only small areas of seagrass of the Ruppia species which cover an area of 0.15km^2 (See **Figure 5-2**). These are relatively remote from the project and are not likely to be influenced by it.

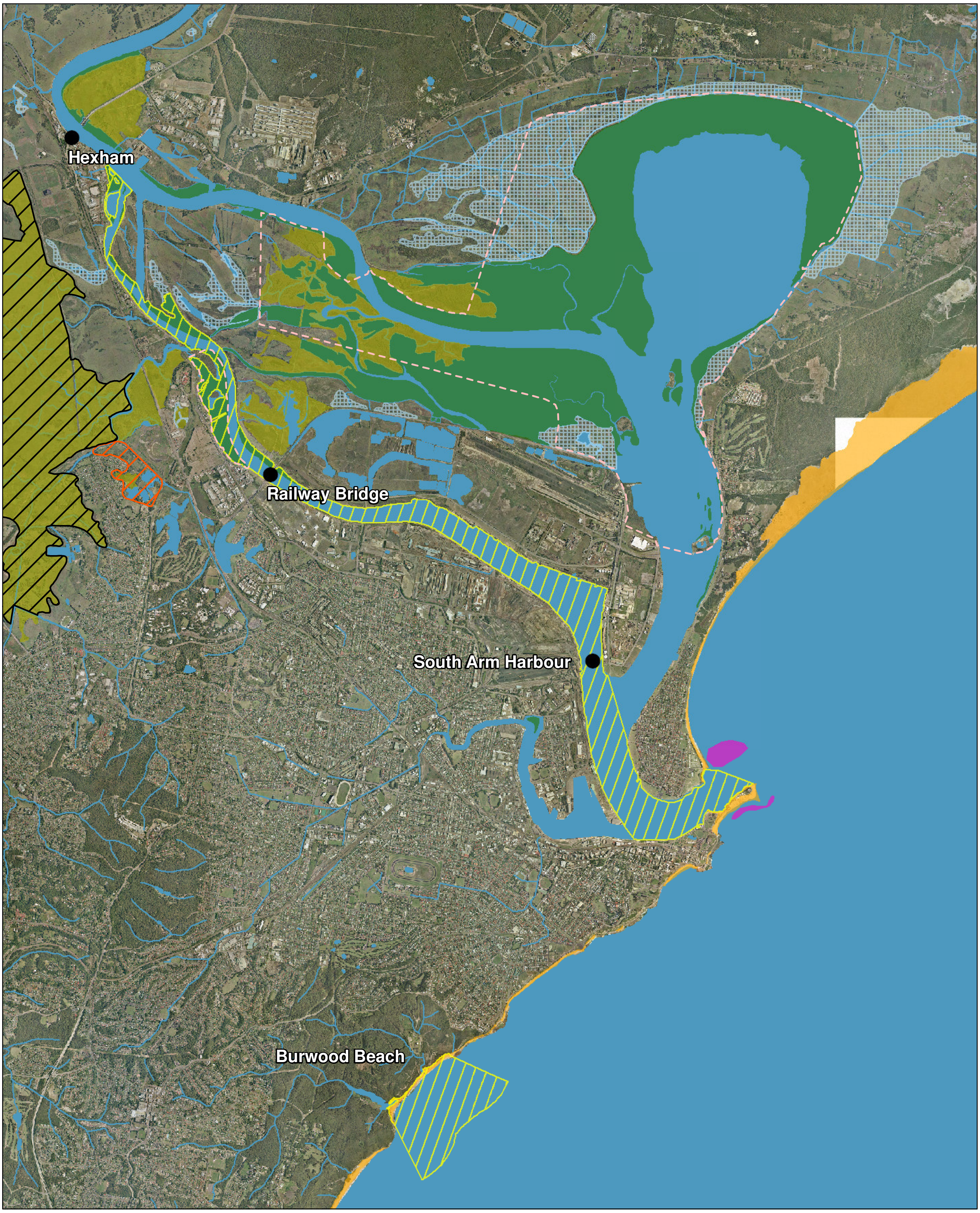
Mangroves

In the Hunter River estuary there are significant areas of mangroves, predominately *Avicennia marina* and *Aegicerus corniculatum* (See **Figure 5-2**). Approximately 16 km^2 of mangroves have been recorded in the Hunter River estuary, the second largest estuarine mangrove area in NSW.

Mangroves play an important role in estuarine ecology. They provide organic matter to estuaries through the decomposition of leaf litter, (according to West (1995) up to 6 tonnes/ha of leaf litter are produced annually). Mangroves provide habitat for fish, birds, molluscs, crustacea, butterflies and other insects, and worms. Grazing of mangroves by cattle sometimes occurs; mangroves provide a source of pollen for apiarist's bees. Mangroves protect and stabilise the shoreline; maintain water quality by filtering land based runoff; and provide recreational and educational opportunities.

Unconsolidated Sediments of Sand or Mud

There are approximately 0.6 sq.km of intertidal mudflats in the Hunter River estuary. Intertidal mud and sand flats are important feeding areas for birds, especially waders. Common food items include molluscs, barnacles, polychaete and nematode worms, crabs and shrimps. As the rising tide covers the mudflats, fish and other aquatic animals move into the area to feed. As the tide recedes, birds move out onto sand and mudflats from their high tide roosts. Different species of birds employ different feeding strategies and forage over varying periods of time within the ebb-flood cycle. In general, the smaller species of wader feed for a longer time. Different species of wader are quite selective in their choice of feeding areas on the exposed flats.



Legend

- Study Area
- Kooragang Nature Reserve
- Hexham Swamp
- Shortland Wetlands
- Land Subject To Inundation
- Mangrove
- Reef
- Sand
- Swamp-Wet

Data Sources
Aerial Photograph - AUSIMAGE
Hydrology data - LPI 2008
Habitat data - LPI 2008

0 2
A4 1:85,000 Kilometres

Figure 5-2 Location of aquatic features and water quality modelling sites

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Saltmarsh/Saltflats

There is approximately 5.0km^2 of saltmarsh in Hunter River estuary, the third largest estuarine saltmarsh area in NSW. Saltmarshes provide organic matter to estuarine food chains, but are not as productive as seagrass or mangrove areas. They also help maintain estuarine water quality by filtering sediment from land based runoff. Saltmarshes may harbour important insect communities. Some rare butterfly species depend on saltmarshes and associated vegetation for completion of certain life phases, e.g. the larvae of the Saltpan Blue and Painted Skipper butterflies.

Fauna

Hunter River estuary provide one of the most important bird study areas in NSW and is a very important migratory bird feeding and roosting site. It supports between 2% and 5% of the East Asian-Australasian Flyway population of Eastern Curlew (*Numenius madagascariensis*) and 1% of the world's population of Bar-tailed Godwits (DECCW 2008). At least 38 species of migratory birds recorded at Kooragang and 21 species of migratory birds at Shortland Wetlands are listed under international treaties including the Japan-Australia and China-Australia Migratory Bird Agreements (JAMBA and CAMBA). Reedy margins of the Hunter Estuary Wetlands provide breeding areas for native waterfowl and shallow pond margins support foraging sites for shorebirds (Aussie Heritage 2007). The wetlands also support a large number of bird species at a critical seasonal stage of their breeding cycle as well as provide refuge for a number of species during periods of critical inland drought (DECCW 2008). These species include:

- Freckled Duck (*Stictonetta naevosa*);
- Pink-eared duck (*Malacorhynchus membranaceus*);
- Australian Pelican (*Pelecanus conspicillatus*); and
- Glossy Ibis (*Plegadis falcinellus*).

The Hunter Estuary Wetlands are important for local resident ducks, herons and other waterbirds (DECCW 2008). The Hunter River Estuary supports 15 species of commercial, and many species of recreational, fish and decapod crustaceans (e.g. the Hunter school prawn) (Aussie Heritage 2007; Hunter-Central Rivers CMA 2004). In summary, the types of fauna in the study area include:

- 185 birds, (28 are migratory species);
- 45 fish and decapod crustaceans, (14 are listed as commercial and recreational species);
- 15 frogs, including the endangered Green and Golden Bell Frog; and
- 17 non-marine molluscs.

Macroinvertebrate surveys have routinely recorded molluscs, bloodworms, caddis fly larvae, gastropods, beetles, bugs, water fleas, seed shrimps, copepods and nymph forms of dragonfly, damselfly, stonefly and mayfly in the wider Hunter River Estuary (Aussie Heritage 2007).

5.3.2. Construction Impacts

Construction impacts on aquatic environments are discussed in the terrestrial ecology (**Section 5.4.2**).

5.3.3. Operational Impacts

The major potential impacts on aquatic ecology from the operation of the KIWS would be associated with changes in water quality. This includes changes in eutrophication potential due to nutrients in the RO reject water and the direct toxic impacts of other key pollutants. As discussed in **Section 5.2**, water quality in the Hunter River estuary is expected to improve, especially in dry weather, due to a reduction in loads of key pollutants discharged into the estuary compared to the existing situation.

In relation to eutrophication, there would be a reduction in the potential for algal blooms, the growth of nuisance aquatic plants, in the Hunter River estuary. It should be noted that because other sources of nutrients may still dominate nutrient loads in the estuary, there may be no measureable reduction in eutrophication impacts from the KIWS despite the decrease in nutrients loads discharged. A similar reduction in the potential toxicity of estuarine waters would be expected due to a decrease in metal loads discharged in the estuary. Again it would be difficult to measure any reduction in toxic impacts on estuarine flora and fauna because of the influence of other sources of toxicity.

As detailed in **Section 5.2**, the estimated future loads discharged from Burwood Beach WWTW will remain within the existing EPL load limits for most pollutants with the operation of KIWS. The exception is total nitrogen, which is expected to increase to 15-20% above the EPL load limit by 2020. A comprehensive two-year Marine Environmental Assessment Program is underway to assess potential impacts from future effluent and biosolids discharges from Burwood Beach WWTW as part of the Stage 3 Upgrade project. This assessment is scheduled to be completed in 2013.

5.3.4. Mitigation Measures

Aquatic ecology impacts from construction & operation of the KIWS are either related to land based activities (construction) or reject water discharge (operation) and relevant mitigation measure are addressed under others sections. See Terrestrial Ecology **Section 5.4.4** and Water Quality **Section 5.2.4**

5.4. Terrestrial Ecology

5.4.1. Existing Environment

Most of the study where the proposed works for the KIWS and pipelines would be undertaken are highly disturbed and modified by development. Exceptions include the north side of the Hunter River crossing and parts of Cormorant Rd. A detailed terrestrial flora and fauna study was undertaken for the proposed IWS and pipelines (refer to **Appendix D**). The following section provides a summary of this assessment.

Terrestrial Flora

From the relevant database search, a total of 13 threatened flora species have been identified in a 10 kilometre radius of the study area. A review of the habitat requirements of these species suggests that *Zannichellia palustris* may potentially occur in the study area and *Rutidosis heterogama* is known to occur in disturbed areas and therefore has a low potential of occurring in the study area. The remaining 11 species have either very marginal or have no habitat elements present in the works area and are therefore highly unlikely to occur. No further assessment has been conducted on these species.

A number of Endangered Ecological Communities (EECs) listed under the TSC Act which occurs on coastal floodplains are present in the local area including: Coastal Saltmarsh, Freshwater Wetlands, Swamp Oak Floodplain Forest, Swamp Sclerophyll Forest and River-flat Eucalypt Forest. However, within the bounds of the project area, Coastal Saltmarsh is the only EEC present. A flora survey was conducted at seven separate locations. Each separate survey concentrated on land approximately 30 metres either side of the proposed pipelines, except at the proposed KIWS plant location where the whole site was surveyed. The seven separate surveys included:

- Steel River Industrial Park;
- Stevenson Park;
- Tourle Street – Hunter River;
- Kooragang Island;
- Sandgate Road;
- MacClure Reserve and Heaton Park; and
- Blue Gum Road.

Terrestrial Fauna

From the relevant database search, a total of 56 threatened fauna species have previously been recorded in the greater Newcastle area (See **Figure 5-3**). The review of the known habitat requirements indicates that at least 9 of these species have marginal habitat elements present within the study area. This is associated with habitat along the fringes of the Hunter River. These species include the Painted Snipe (*Rostratula benghalensis australis*), Little Tern (*Sterna albifrons*), Osprey (*Pandion haliaetus*), Great Knot (*Calidris tenuirostris*), Broad-billed Sandpiper (*Limicola falcinellus*), Black-tailed Godwit (*Limosa limosa*), Terek Sandpiper (*Xenus cinereus*), Greater Sand-plover (*Charadrius leschenaultia)* and Lesser Sand-plover (*Charadrius mongolus*).

Despite the presence of estuarine and freshwater wetland communities in the wider area, the majority of the proposed pipeline routes would be located in cleared disturbed lands which are generally devoid of habitat value for threatened fauna species. Field surveys were carried out and based on precautionary habitat assessment and the adoption of protective strategies for features deemed likely to be critical habitat for threatened fauna species known from the area. Targeted surveys were conducted for the nationally endangered Green and Golden Bell Frog (*Litoria aurea*) which is known from 21 locations on Kooragang Island (Hammer *et al* 2002). However neither the species nor potential habitat for this species was identified within the proposed works areas associated with the Proposal. During the survey, all opportunistic sightings of fauna species were recorded. Based on these initial field survey results it was determined that a more detailed investigation of threatened fauna was not necessary.

5.4.2. Construction Impacts

The conservation value of remnant vegetation in the study area was considered in the initial planning phases of the project and therefore the pipelines were located to avoid impacts on native vegetation and fauna habitat including threatened flora, fauna and ecological communities. The majority of the pipelines would be located on already developed land including residential property easements, road verges, maintained parkland and vacant cleared lands. Therefore, minimal native vegetation clearing would be required.

Areas of native vegetation that may be potentially impacted by the pipelines include:

- Planted native vegetation along the western edge of Tourle Street. This includes several Broad-leaved Paperbark and Swamp Mahogany trees and several understorey plants associated with the listed Swamp Sclerophyll Forest EEC. However as this native vegetation is planted it does not constitute an EEC, although it does provide foraging habitat for fauna. This area supports a moderate-high abundance of *Lantana camera.* Considering the potential small area of this community to be removed, the highly modified nature of the area and the relatively widespread occurrence of the community in the local area, the local occurrence of the community is not at risk of extinction.

Legend

- Recycled Water Pipeline
- Reject Discharge
- Effluent Main Route B
- SEPP Wetlands
- Threatened fauna
- Threatened flora

Data Sources
AUSIMAGE
DECC Sightings from January to October

Sinclair Knight Merz does not warrant that this document is definitive nor free of error and does not accept liability for any loss caused or arising from reliance upon information provided herein.

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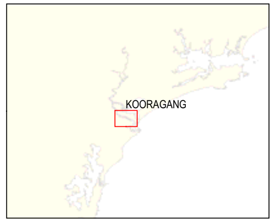

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Figure Threatened Flora and Fauna

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- Areas of listed Coastal Saltmarsh EEC and Mangroves on the northern bank of the Hunter River. The areas of Coastal Saltmarsh species are relatively disturbed with invasive weed species. However, these areas support several native Saltmarsh species and provide potential habitat for listed migratory bird species. This area has been identified as high conservation value, and directional drilling for the river crossing should avoid impacts on the EECs.

Endangered Ecological Communities

One EEC was recorded in the study area and is recognised as Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions under the TSC Act. A thin strip of this EEC is present on the landward side of the mangrove vegetation found on the northern bank of the Hunter River. This area is in moderate condition supporting a high density of exotic species (Sharp Rush).

An assessment of significance was undertaken for the EEC (provided in **Appendix A**) under the guidelines of the TSC Act (7-part test) for the Coastal Saltmarsh. Only a very small area of Coastal Saltmarsh would be potentially impacted by the proposed recycled water pipeline. The location of the area of EEC that has the potential to be affected is on the edge of the saltmarsh that extends west from the existing Tourle Street Bridge. However, direct impacts to the EEC would be minimised by the placement of the pipeline along the existing raised trail and the proposed development would not fragment any area of EEC saltmarsh. This area has already been disturbed by weed invasion and the construction of a raised trail. However, there is potential for further weed invasions into adjacent areas of saltmarsh following construction of the pipeline along the trail which are caused by soil disturbance. With appropriate management during and post construction of the pipeline, any such indirect impacts would be avoided.

Threatened Flora

No threatened flora species were recorded during the field surveys. Based on the modified condition of the habitats within the proposed development area it is considered unlikely that the project would negatively impact on a threatened flora species or potential habitat. While potential habitat such as estuarine wetland areas exists for the threatened species *Zannichellia palustris*, possible impacts on the potential habitat of this species can be adequately managed during construction.

Introduced Flora

Of the 105 flora species recorded at the study area, 72 of these are introduced species. Of these introduced species, 6 are declared noxious species under the *Noxious Weeds Act 1993* (NW Act) for the Newcastle local government area (LGA). These are listed in **Table 5-10.**

- **Table 5-10: Noxious weed species present in the study area**

Species	Prevalence on Site	Noxious Class
Bitou Bush *Chrysanthemoides monilifera* subsp. *rotunda*	Present in vacant industrial lands at Steel River Industrial Park (Area 1).	Class 4: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Crofton Weed *Ageratina adenophora*	Present in disturbed riparian areas dominated by exotic vegetation, in (Areas 5 & 6)	
Green Cestrum *Cestrum parquai*	Present in disturbed riparian areas dominated by exotic vegetation, in (Areas 5 & 6)	Class 3: The plant must be fully and continuously suppressed and destroyed
Lantana *Lantana camara*	Main occurrence on the western side of Tourle Street (Area 3)	Class 5: The requirements in the NW Act for a notifiable weed must be complied with
Privet (Broad-leaf) *Ligustrum lucidum*	Present in disturbed riparian areas dominated by exotic vegetation, in (Areas 5 & 6)	Class 4: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Privet (Narrow-leaf) *Ligustrum sinense*		

Threatened Fauna

Habitat for fauna within the works areas consist predominantly of cleared and modified land that includes open areas, vegetated road verges, parkland with planted trees. These habitats are characterised by isolated small patches of disturbed and modified habitat with little value for native fauna and dominated by urban dwelling species. No threatened fauna or potential habitat for threatened fauna species was identified in the study area. Targeted surveys were conducted for the Green and Golden Bell Frog (*Litoria aurea*). Neither the species nor potential habitat was identified in, or in the vicinity of, the proposed development area.

Migratory Birds

Tidal areas along the fringes of the Hunter River provide marginal and low-quality habitat for wader birds which may include a number of threatened and migratory species. These include:

- Black-trailed Godwit;
- Terek Sandpiper;
- Red-necked Stint;

- Eastern Curlew;
- Curlew Sandpiper;
- Common Sandpiper;
- Grey-tailed Tattler;
- Wandering Tattler;
- Ruddy Turnstone;
- Ruff;
- Pectoral Sandpiper; and
- Little Curlew.

The proposed development will not directly or indirectly impact on potential habitat for these species.

No threatened flora or fauna species or potential habitat would be directly impacted by the works, apart from minor impacts along the edge of the threatened saltmarsh EEC habitat found west of the existing Tourle Street Bridge. The assessment of significance found that the proposed development is unlikely to have a 'significant impact' on the identified endangered communities or their habitats as listed under the TSC Act and the EPBC Act, provided the mitigation measures are adequately implemented.

Targeted surveys were conducted for the nationally endangered Green and Golden Bell Frog (*Litorea aurea*). No species or potential habitat for this species was identified in the proposed development area. The proposed development will not significantly impact on identified local populations of *Litorea aurea*.

A number of listed migratory bird species have been recorded from the Hunter River estuary. The proposed development will not impact any potential habitat for these species. Potential habitat identified near Tourle Street Bridge will be avoided through the use of directional drilling.

5.4.3. Operational Impacts

There would be no new impacts on terrestrial and aquatic ecology from the operation of the IWP. Wet weather discharge of reject water to the Hunter River would continue.

5.4.4. Mitigation Measures

Recommended mitigation measures for the protection of flora and fauna during construction of proposed pipelines include measures for the protection of natural vegetation and fauna habitat, water quality drainage, minimising the spread of invasive weed species and protecting local fauna species.

- No heavy machinery shall traverse saltmarsh areas. Where construction activities are undertaken adjacent to remnant vegetation or where vegetation will be cleared, visual barriers or fencing shall be used to prevent access to these areas. Disturbance limits in these areas will be identified on plans attached to the Construction Environmental Management Plan (CEMP) and clearly marked on ground;
- Direct avoidance and lopping shall be used to minimise disturbance of vegetation where possible. Where this is not possible, smaller equipment shall be used to minimise the width of disturbance corridor to protect natural habitats;
- Best-practice sediment and erosion controls implemented to prevent impacts to water quality and minimise run-off into adjacent ecologically sensitive areas such as saltmarsh, mangrove and wetland habitats shall be implemented;
- Weed management strategies shall be identified in the CEMP;
- Wherever possible, trenches shall not be left open overnight. If this is not possible, inspections of the trench shall be conducted each morning for captured fauna. All fauna captured shall be removed and released to adjacent natural habitats; and
- If possible, trenches shall be dug with shallow sloping ends to allow natural fauna escape; and
- Construction personnel shall be made aware of the importance of ecological values in the area, particularly the mangroves and coastal saltmarsh in proximity to the Hunter River. All construction personnel shall be inducted and made aware of their environmental responsibilities.
- A map of the construction zone showing sensitive ecological features/locations, disturbance limits and management controls shall be prepared to accompany the CEMP.

5.5. Cultural Heritage

5.5.1. Existing Environment

Environment Resources Management (Australia) Pty Ltd (ERM) undertook a cultural heritage assessment of potential impacts of the proposed KIWS. The full assessment is presented in **Appendix E**.

The environmental context of the greater study area suggests that the area was likely used as an area of resource exploitation by Aboriginal people. It is suggested that:

- Rock outcrops of the type suitable for axe grinding grooves, shelter sites or artwork are found south and west of the study area, thus there is a possibility that these site types may occur in the area;
- The geology to the south and west of the study area suggests that rock types such as tuff and mudstone which are suitable for stone tool making, are present in the area. It is possible that quarries and stone artefacts will occur in these areas, although are unlikely within the study area;
- The majority of tree species in the area tend to be low trees and shrubs, which are unlikely to support culturally created scars; and
- The proximity of the Hunter River and the diverse range of fauna and flora in the river would have been a good resource for food such as fish, birds and shellfish. It is possible that Aboriginal heritage sites such as middens and stone artefact scatters would occur in the study area.

The level of disturbance in the study area reduces the potential for Aboriginal heritage sites to occur in the area. This is particularly true for the areas of pipeline which run along the southern bank of Kooragang Island, through the Steel River precinct and the northern area of Mayfield West, as these areas have been modified by reclamation. Numerous middens and artefact scatters have been recorded in Stockton Bight, north-west of the study area, although the study area itself has had far fewer number of sites recorded, the majority being either middens or artefact scatters.

Heritage Register Searches

A search of the Newcastle Local Environmental Plan (LEP) 2003 was undertaken for Aboriginal and historic heritage items around the study area. The search revealed no registered Aboriginal heritage items. There were a number of historic heritage items on the Newcastle LEP located within 500m of the proposed pipeline routes. However, only one remnant historic garden located on McIntosh Drive in Mayfield West is located on a street where the proposed pipeline would run.

A review of the Department of Environment, Water, Heritage and the Arts (DEWHA) (now SEPWaC) database was undertaken which includes the Commonwealth Heritage List (CHL), Register of the National Estate (RNE), and National Heritage List (NHL). No Aboriginal or historic heritage items on the NHL, RNE or CHL are located within the study area.

A search of the OEH Aboriginal Heritage Information Management System (AHIMS) database was undertaken in the study area. The AHIMS search results revealed only one site within 100m of the proposed pipeline routes. Site 38-4-0041 is listed in the AHIMS database as an artefact scatter, and is recorded on the site cards as 'midden by new bridge is almost complete bulldozed'. The site is located on the southern bank of Kooragang Island, immediately east of the Tourle Street Bridge. The site is outside the project area and won't be impacted.

5.5.2. Construction Impacts

The remnant historic garden listed under the Newcastle LEP located on McIntosh Drive in Mayfield West is set back from Murray Dwyer Circuit and is separated from the proposed pipeline by a retaining wall. Therefore, if the area bounded by the retaining wall is avoided, then the proposed works are unlikely to impact any items listed on the Newcastle LEP.

None of the heritage items listed on the DEWHA's heritage database are located along the path of the proposed works and thus KIWS will not impact upon any of the listed items.

For archaeological heritage sites, the site types most likely to occur in the study area are stone artefact scatters and isolated finds. Although axe grinding grooves have been recorded in the greater study area, the lack of suitable stone outcrops and previously recorded sites close to the proposed pipeline routes suggest they are unlikely to occur in the study area. No scarred trees were recorded in the study area and the extent of clearing and shrubby nature of the remnant wetlands suggests a low likelihood of existence in the study area.

Although no middens have been recorded in the study area, numerous middens have been registered near Stockton Bight, several kilometres east of the study area. Aboriginal sites have also been recorded on Kooragang Island, in Mayfield North and along the Hunter River where there would have been an abundant source of edible shellfish. However given the high level of disturbance in the project area there is a low potential that Aboriginal heritage sites are present and would be impacted.

Extensive residential construction also exists in the southern portion of the study area, and industrial construction and reclamation of land has occurred on the southern coast of Kooragang Island. Therefore, it is likely that these developments would have previously impacted any Aboriginal sites and there is a low potential that heritage sites will occur within the Proposal's footprint.

5.5.3. Operational Impacts

There would be no impact on cultural heritage from the operation of the KIWS.

5.5.4. Mitigation Measures

The following mitigation measures would be implemented:

- Should any previously unrecorded Aboriginal or heritage objects be discovered during construction activities then disturbance shall cease in the area of the discovery. No further construction activities shall occur in the area of the find until the OEH and/or NSW Heritage Branch has been contacted and the site has been assessed by the project archaeologist.
- All construction work staff (including sub-contractors) shall go through a site induction concerning Aboriginal and Non-Aboriginal heritage issues prior to commencing work on site. This induction shall inform workers of the locations of the known sites potentially impacted by construction works.

5.6. Noise and Vibration

5.6.1. Existing Environment

The KIWS consists of an IWP to produce recycled water and a number of pipelines. The existing noise land use impacted by the proposed development is discussed below:

- Industrial Water Plant (IWP) – This is located in the Steel River industrial area along Industrial Drive, Mayfield. The near vicinity is dominated by commercial and light industrial activities. Potentially sensitive receivers in the vicinity are generally residential in nature, and predominantly located to the south west along Decora and Olearia Crescents, Warabrook and to a lesser extent along Terry Street and Stevenson Avenue Mayfield. The noise environment at both these locations is dominated by traffic noise from Maitland Road and Industrial Drive. In addition residents in Mayfield would be impacted by industrial noise from businesses along Industrial Drive, and daytime impacts from recreational activities in Stevenson Park. Commercial and light industrial land uses on Industrial Drive are unlikely to be impacted from noise generated by the KIWS, given the influence of local noise sources such as local industrial activities and traffic on Industrial Drive.
- Treated Effluent Pipeline – This pipeline will extend from the existing treated effluent pipeline near the rail line to the north west, to the IWP. Sensitive receivers in the vicinity of these works are located to the south along Decora Crescent Warabrook. The noise environment in this area is dominated by traffic noise from Maitland Road, in addition to daytime industrial noise from both Shortland and Warabrook Industrial areas. Engine and track noise from coal trains passing along the railway line to the Kooragang Coal Loading Facility also impact the noise environment, particularly during the night time hours.
- RO Reject Water Pipeline –This pipeline runs south east through the Steel River Industrial Area, then turns south, under Industrial Drive and across Stevenson Park. It will then pass along Purdue Avenue, pass under Maitland Road and finally join the existing wastewater system close to Casuarina Circuit Warabrook. The noise environment along this route is again dominated by traffic noise from both Maitland Road and Industrial Drive, in conjunction with noise generated by commercial land uses within Warabrook, although the route passes by several residential properties.
- Recycled Water Pipeline – This pipeline would run south east, within the Steel River Industrial Area until it reaches Tourle Street, it will then run approximately north, under the Hunter River, and then onwards to the eastern areas of Kooragang Island. Noise sensitive receivers are located along Gregson Avenue and Groongal Street Mayfield, however Industrial Drive passes between the route and these residences and this dominates the local noise environment. No sensitive receivers would be near the pipeline after it has crossed the Hunter River.

- Pipeline diverting flows from the Burwood Beach wastewater system to the Shortland wastewater system – The pipeline route starts at the existing Newcastle 10 Waste Water Pumping Station (WWPS) located at the corner of Janet Road and Blue Gum Road and ends near Sandgate Road. Construction associated with the pipeline would in close proximity to residential areas. No detailed construction noise assessment has been undertaken for the construction of this pipeline, however, background noise levels are likely to similar to other residential areas and noise levels generated by construction would be likely to exceed noise goals.

Noise Monitoring Results

Existing, ambient noise levels were monitored during December 2008. The monitoring locations are detailed in **Table 5-11** and were chosen to be representative of all residences where potential noise impacts may be experienced. The results of this background noise monitoring are included in **Table 5-12.**

- **Table 5-11: Sensitive Receiver Locations**

Reference	Address	Distance from IWP (m)
Location 1	3 Stevenson Avenue, Mayfield	770m
Location 2	Cnr Purdue and Thornton Avenues, Mayfield	840m
Location 3	18 Olearia Crescent, Warabrook	320m
Location 4	59 Decora Crescent, Warabrook	585m

Overall, the results of ambient noise monitoring indicate that the area surrounding the IWP is generally a noisy environment, with typical night time background (LA_{90}) noise levels of approximately 40 - 45 dB(A). Both day and night time noise levels are impacted by noise from Industrial Drive and Maitland Road, in addition to coal trains. Noise sources such as crickets and frogs were audible during night time hours in the absence of traffic noise sources.

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- **Table 5-12: Background Attended Noise Monitoring Results, 6 – 16 December 2008**

	LA_{eq} - dB(A)	LA_{10} - dB(A)	LA_{90} - dB(A)
Location 1 (Unattended Results)			
Day	62	66	54
Evening	59	63	47
Night	60	62	42
Location 2 (Attended Results)			
Day	58	60	48
Evening	53	53	44
Night	46	49	42
Location 3 (Attended Results)			
Day	53	56	46
Evening	51	53	42
Night	48	52	41
Location 4 (Unattended Results)			
Day	56	58	52
Evening	53	56	49
Night	54	55	49

Refer to for the complete monitoring data

Noise Criteria

Operational Noise Criteria

There have been a number of noise studies undertaken specific to the Steel River industrial area including the Steel River Strategic Impact Assessment Studies (SIAS). These studies have derived noise criteria for specific lots in the industrial area based upon noise criteria determined for the whole industrial area using the Industrial Noise Policy. Further discussion of these studies and outcomes is contained in **Appendix F**.

In 2002, Hatch Engineering prepared *A Review of Noise Amenity Criteria to Industrial Noise Policy Guidelines for the Steel River Site*. This report was commissioned to overlay the SIAS, and to set project site criteria that complied with the NSW Industrial Noise Policy (NSW INP). The calculated noise criteria contained in this report have been shown below in **Table 5-13**.

- **Table 5-13: Hatch Report Steel River Site Noise Criteria**

Location	LA_{eq} Criteria – dB(A)			Sleep Disturbance Criteria – LA_1 dB(A)
	Day	Evening	Night	
Mayfield West Church - cnr Werribi St and Gregson Avenue, Mayfield	54	44	43	57
Kennards Hire - Ayrshire Crescent Warabrook	64	58	48	58
42 Travers Avenue, Mayfield	55	51	47	57
Cnr Stevenson Ave and Stevenson Park, Mayfield West	52	44	40	50
85 Decora Crescent, Warabrook	51	50	47	58
27 Groongal Street, Mayfield	55	52	48	58
20 Norris Street, Mayfield	48	44	41	52

It should be noted that these noise levels apply to overall noise from the Steel River Site, and not just from the IWP.

Noise Allotments

EMA were commissioned to prepare a noise model for the Steel River industrial area, and determine noise allotments for each development lot that would allow noise emissions from the entire industrial area to comply with the INP criteria for the whole Steel River Industrial area. The allocated noise emissions for the development lots where the IWP would be located are detailed below in **Table 5-14** to **Table 5-16.** These noise criteria would be used for assessing the operational noise emissions from the IWP.

- **Table 5-14: Day Time Noise Allocation for Lots 87 & 88 – dB(A)**

Frequency (Hz)	31.5	63	125	250	500	1k	2k	4k	8k	L / A
LWA	107	105	104	99	95	94	93	88	86	111 / 99.8

- **Table 5-15: Evening Noise Allocation for Lots 87 & 88 – dB(A)**

Frequency (Hz)	31.5	63	125	250	500	1k	2k	4k	8k	L / A
LWA	103	101	100	96	93	92	91	86	84	107 / 97.5

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Table 5-16: Night Time Noise Allocation for Lots 87 & 88 – dB(A)

Frequency (Hz)	31.5	63	125	250	500	1k	2k	4k	8k	L / A
LWA	92	90	89	86	81	79	78	75	73	96 / 85.5

5.6.2. Interim Construction Noise Guidelines (ICNG)

The risk of adverse impact of construction noise within a community is determined by the extent of its emergence above the existing background noise level, the duration of the event and the characteristics of the noise. Impacts can then be exacerbated by the proximity of construction to residences or other sensitive land uses and the times of occurrence.

The NSW DECC (2009) has prepared an Interim Construction Noise Guideline. The guideline has been developed to assist with the management of noise impacts, rather than to present strict numeric noise criteria for construction activities.

Although not mandatory, the ICNG recommends standard hours for construction work as summarised in **Table 5-17.** Categories of work that may be undertaken outside these hours include:

- Delivery of oversized plant or structures
- Emergency work
- Work on essential services and / or considerations of worker safety do not allow work within standard hours
- Work where the proponent demonstrates and justifies a need to operate outside the recommended standard hours. In this case approval must be explicitly given by the approval authority.

Table 5-17: Recommended standard hours for construction work.

Work type	Recommended standard hours of work
Normal construction	Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays

The ICNG describes two methods of assessing noise impacts from construction activities: the quantitative method, which is suited to major and complex construction projects; and the qualitative method, suited to short-term (less than three weeks) works undertaken during standard construction hours.

Construction of the project would last for a period of greater than three weeks, and will involve several periods where construction activities outside the recommended hours are necessary. As such a quantitative assessment has been carried out.

The ICNG states that the noise management level applies at the property boundary that is most exposed to the construction noise, at a height of 1.5 m above ground level. In cases where the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence.

Table 5-18 outlines management levels for noise at sensitive receivers and how they should be applied. Restrictions to the hours of construction may apply to activities that generate noise at sensitive receivers above the 'highly noise affected' noise management level. The rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours).

For other relevant land uses within the area of the proposal, noise guidelines are set out as follows:

- Industrial premises: external $L_{Aeq(15min)}$ 75 dB(A)
- Offices, retail outlets: external $L_{Aeq(15min)}$ 70 dB(A)
- Classrooms: internal $L_{Aeq(15min)}$ 45 dB(A)
- Places of Worship: internal $L_{Aeq(15min)}$ 45 dB(A)
- Passive Recreational Areas: external $L_{Aeq(15min)}$ 60 dB(A)

Given these guidelines, the following LA_{eq} construction noise goals have been calculated:

- Location 1 (Stevenson Avenue) 64dB(A)
- Location 2 (Purdue Avenue) 58dB(A)
- Location 3 (Olearia Crescent) 56dB(A)
- Location 4 (Decora Crescent) 62dB(A)

- **Table 5-18: General Construction Noise Management Levels (NML's)**

Recommended Standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected (RBL + 10 dB)	▪ The noise affected level represents the point above which there may be some community reaction to noise. ▪ Where the predicted or measured LAeq (15 min) is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. ▪ The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected (>75 dB(A))	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences 2. If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected (RBL + 5 dB)	▪ A strong justification would typically be required for works outside the recommended standard hours. ▪ The proponent should apply all feasible and reasonable work practices to meet the noise affected level. ▪ Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. ▪ For guidance on negotiating agreements see section 7.2.2.

Vibration Guidelines

The effects of vibration can be divided into three main categories:

- Where occupants or users of the building are disturbed or inconvenienced;
- Those in which the building contents may be affected; and
- Circumstances in which the integrity of the building or the structure itself may be prejudiced.

Vibration may be transmitted through the ground or as low frequency pressure waves through the air. There are two types of vibration criteria that are used when assessing impacts. The first is the human comfort criteria, which as the name suggests is designed to minimise impacts that may disrupt day to day activities of humans. The other form of vibration criteria is designed to avoid damage to buildings and structures. Vibration criteria are prescribed and discussed in detail in **Appendix F.**

5.6.3. Construction Impacts

5.6.3.1. Hours of Work

Construction works would generally be limited to the following hours.

- Monday to Friday: 7am to 6pm;
- Saturday: 8am to 1pm; and
- No audible construction work to take place on Sundays or public holidays.

However some construction work may be required to be undertaken outside of these hours. This especially involves works that may have significant impacts on traffic (e.g. some road crossings) – and therefore the work may be required to be undertaken during low traffic periods (e.g. at night). Similarly, connections to existing operational wastewater pipelines would generally be undertaken in periods when flows in the pipelines are at their lowest – and this occurs at night.

Also work that is inaudible at sensitive receivers (e.g. residences) may be undertaken outside these hours. This includes low impact activities such as electrical installation at the IWP – but may also include more noisy activities which are at a significant distance from residential receivers and are therefore inaudible.

5.6.3.2. Construction Impact Assessment

The following section provides an assessment of likely noise levels that may be encountered during the construction of the IWP and the associated pipelines. In the preparation of each construction noise assessment, calculations have been based on the equipment noise levels contained in **Table 5-19**. This data has been sourced using internal and government databases, in addition to manufacturer provided noise specifications.

- **Table 5-19: Estimated Equipment Noise Levels**

Equipment	Sound Power Level – dB(A)
Truck - Product 15 t	109
Concrete Pump + Truck - low load on pump	129
Hand Tools Air Wrench	101
Hand Tools Metal Cut off Saw	97
Hand Tools Metal Grinder	107
Hand Tools Ratchet Gun (Air)	101
Hand Tools TIG Welder	98
Generator - Diesel	107
Excavator Cat 245	104
Crane Mobile 100-200kW	105
Air Compressor	100
Piling Rig - Hydraulic Hammer (tubular steel, 4T hammer)	115
Rockbreaker Cat - 240E	120
Micro Tunnelling Equipment	107

The noise levels have been used in conjunction with standard noise attenuation methods to calculate likely construction noise levels at the nominated locations. These calculations are based on basic attenuation methods, and do not consider the absorption of noise by local geography or vegetation. However it is noted that the IWP site is separated from Warabrook by a substantial hill and it is unlikely that construction activities would be audible at residential receivers. In addition, it has been assumed that all equipment described below would be operating at the same time at the nearest point to the receiver. As such these calculations should be seen as possible maximum noise levels, and may not be reached in reality.

Pipelines – Open Trench Excavation

Open trench excavation is the preferred method of pipe installation. For the purposes of noise assessment, the open trench excavation for the installation of pipes has been divided into two work stages. The first stage includes the initial excavation, requiring the use of an excavator, trucks, rockbreaker and generator. Although the use of a rockbreaker has not been confirmed, it is assumed that concrete will need to be demolished to allow for crossings of paths, driveways and similar structures. Furthermore the geotechnical report by RCA (2008) identified rock in the corelog for borehole SR29 at 0.5 metres – 5.2 metres. Stage two would involve the pipe installation and subsequent back filling. This work is expected to require equipment such as a concrete truck and pump, metal saws, ratchet guns, grinders, welders, excavators and compactors.

Noise criteria for each pipeline have been based on the nearest background noise monitoring locations, and these are detailed below.

- **Table 5-20: Open Trench Excavation – Initial Excavation, Noise Criteria and Separation Distances**

Pipeline	Noise Criteria L_{Aeq} dB(A)	Nearest Sensitive Receiver (m) / Land Use	Maximum Estimated Construction Noise Level dB(A)
Effluent	56	220m to Residential	59
Reject Water	58	20m to Residential	71
Recycled Water	75 (industrial) 64 (residential)	20m to Industrial / Offices 175m to Residential	71 / 62

- **Table 5-21: Open Trench Excavation – Installation and Filling, Noise Criteria and Separation Distances**

Pipeline	Noise Criteria L_{Aeq} dB(A)	Nearest Sensitive Receiver (m) / Land Use	Maximum Estimated Construction Noise Level dB(A)
Effluent	56	220m to Residential	66
Reject Water	58	20m to Residential	78
Recycled Water	75 (industrial) 64 (residential)	20m to Industrial / Offices 175m to Residential	78 / 69

The noise level calculations contained in **Table 5-20** and **Table 5-21** show that exceedances of the construction noise guidelines may be experienced at times during pipeline construction. However, it should be noted that:

- It has been assumed that all plant and equipment would be operational at once– this is unlikely to occur for any significant periods of time (in particular, rockbreaking is unlikely to be required for extended periods);
- The effects of the intervening geography, buildings and roads have not been included. As there are a number of major roads (with > 20000 traffic movements every day) between the construction sites and residents, the impact of short term construction noise is likely to be reduced; and
- Pipeline construction would occur progressively along the pipeline routes, and as such each location would be exposed to construction noise for short time periods.

Noise impact assessment identified that Purdue Ave Mayfield will likely be the most sensitive location for noise impacts during open trench construction. Targeted residential consultation should be undertaken at the most potentially impacted locations prior to the construction of the Reject Water pipeline, and in response to community complaints during other construction stages.

Pipelines - Boring

Underboring for pipelines would be required where open trenching is not possible, such as the crossings of Maitland Road and the Hunter River. Where underboring is required, potential boring techniques may include Horizontal Directional Drilling (HDD) or micro tunnelling. Where micro tunnelling is required, two work stages would be necessary. The first stage would involve excavation of a drill pit, and would utilise equipment such as an excavator, compactor and possibly rock hammer. The second stage involves actual tunnelling activities, which would use saw cutters, hand tools, compressors and generators and the drilling rigs themselves. Where HDD is used, the drill rig sits on the surface or in a shallow pit, and as such less excavation is required, however noise impacts from the drill rig would typically be higher.

Noise criteria for each potential underboring site have been based on the nearest background noise monitoring locations, and these have been set out below in conjunction with an estimated separation distance where compliance with the construction noise criteria would be expected. Therefore where construction works are separated from sensitive receivers by distance less than this estimated separation distance, construction noise levels may potentially exceed the nominated criteria.

- **Table 5-22: Pipeline Boring – Drill Pit Excavation, Noise Criteria and Separation Distances**

Boring Location	Noise Criteria L_{Aeq} dB(A)	Nearest Sensitive Receiver (m) / Land Use	Drill Pit Excavation Estimated Compliance Separation Distance (m)
Industrial Drive	58	165m Residential	200 m
Maitland Road	58	10m Residential	200 m
Tourle Street Bridge	64	165m Industrial / Offices 830m Residential	120 m

- **Table 5-23: Pipeline Boring – Micro Tunnelling and HDD, Noise Criteria and Separation Distances**

Boring Location	Noise Criteria L_{Aeq} dB(A)	Nearest Sensitive Receiver (m) / Land Use	Micro Tunnelling/HDD Estimated Compliance Separation Distance (m)
Industrial Drive	58	165m Residential	190 m
Maitland Road	58	10m Residential	190 m
Tourle Street Bridge	64	165m Industrial / Offices 830m Residential	110 m

The noise level calculations in **Table 5-22** and **Table 5-23** show that exceedances of construction noise guidelines may be experienced during underboring works at Industrial Drive and Maitland Road. However it should be noted that the effects of the intervening geography, buildings and roads have not been included. As there are a number of major roads (with > 20000 traffic movements every day) between the construction sites and residents, the impact of short term construction noise is likely to be substantially reduced.

Attended noise monitoring associated with directional drilling would only be undertaken in response to community complaints and if directional drilling was to be undertaken at night.

IWP

For the purposes of this noise assessment, construction of the IWP was divided into two main stages. The first stage was earthworks, civil works and general site preparation. This would require equipment such as a piling rig, excavators, concrete trucks and pumps, delivery trucks and hand tools. The second stage was the installation of the building structures and internal pipes and equipment. It is expected that these works will require a large crane, delivery trucks, assorted hand tools and an excavator.

Estimated noise levels during each stage of the construction process have been calculated and included in **Table 5-24.**

- **Table 5-24: IWP Construction – Estimated Noise Levels at Sensitive Receivers**

Location	Construction Noise Criteria – LA_{eq} dB(A)	Estimated Noise Level Site Preparation – LA_{eq} dB(A)	Estimated Noise Level Construction – LA_{eq} dB(A)
Location 1	64	51	36
Location 2	58	50	35
Location 3	56	**62**	47
Location 4	62	55	40

With the exception of properties on Olearia Crescent, during stage one works the calculated construction noise levels contained in **Table 5-22** show that construction of the IWP would not result in noise impacts at nearby receiver locations. It should be noted however that these calculations do not take into account losses due to local geography, and significant screening of construction noise would be provided by the ridge between the construction site and Warabrook residential properties. As a consequence, exceedances of construction noise guidelines are considered unlikely, and it is considered that monitoring should only be necessary when complaints are received.

Traffic Noise Assessment

Construction traffic site access routes would be predominately along Industrial Drive, Tourle Street and Cormorant Road. These three roads are designated heavy vehicle transport routes, and as such already have high levels of traffic noise. The expected increase in heavy vehicle traffic generated by construction of this development would be negligible. However it is recommended that most deliveries of construction materials occur during normal business hours where possible. Additionally where trucks are required to wait for site access, they should be parked away from residential properties.

Vibration

The prediction of vibration impacts from construction activities is not straight forward as the type and size of equipment, the proximity to a sensitive receiver and the local geology all play a significant role the in the actual vibration levels experienced at a residence. Estimates of vibration levels may be made, however these are based on typical conditions and equipment types. The primary method of ensuring no adverse vibration impacts are encountered is by setting vibration limits and carrying out monitoring during construction at potentially affected receiver locations.

An indication of generally accepted minimum buffer distances is presented in **Table 5-25**. This table identifies distances where the more stringent human comfort criteria are likely to be met. These levels are for reference only and are not to be applied as project specific limits.

- **Table 5-25: Recommended Buffer Distances for Human Comfort Impacts from Ground Vibration**

Equipment Type	Buffer Distances from Sensitive Receiver
Hydraulic rock breaker	15 m
Vibratory Roller	25 m
Truck movements	10 m

It should be noted that this discussion is based on ground borne vibration. Vibration may also be air borne and transmitted in the form of low frequency sound waves. This type of vibration may travel much further distances from the construction area than ground borne vibration, and its magnitude is difficult to predict.

A qualitative assessment of potential vibration impacts during each construction stage have been outline below in **Table 5-26**:

- **Table 5-26: Potential Construction Vibration Impacts**

Construction Activity	Potential Vibration Impacts
Effluent Pipeline	Considering the type of construction activities and the distances to nearest receivers, no vibration impacts upon either human comfort or building integrity are anticipated. However, where construction activities which have the potential to cause vibration, such as hammering or dynamic compaction, take place within 10m of buildings or structures, vibration levels may approach building damage limits, and consideration should be given to the monitoring of vibration levels.
Reject Water Pipeline	The proposed route for the reject water pipeline passes within 10m of residential properties. Some construction activities involved with open trench excavation (eg. rock breaking, and compacting) have the potential to result in result in vibration impacts at nearby receivers. Vibration levels may exceed human comfort levels where vibratory roller and rock breaking works are carried out within 25m of a building. All potentially impacted receivers would be informed of the works and potential impacts. If required, vibration monitoring should be carried out at these locations at the commencement of work and where vibration impacts are considered possible. Where construction works are undertaken at distances of more than 10m from residential receivers, any risk of building structural damage is considered low, however where rock breaking or compacting works are undertaken within 10m, building inspections or vibration monitoring should be considered.
Recycled Water Pipeline	The majority of the route for the recycled water pipeline is more than 400m from any building structures. However within the Steel River industrial area, some buildings are located approximately 20 - 40m from the pipeline route. Given the nature of these industries, and the short term nature of pipe installation works, particularly vibration inducing activities, vibration impacts on human comfort levels are considered unlikely, however should works be undertaken within 10m of building structures, building inspections or vibration monitoring should be considered.
IWP	Given the construction methodology for the IWP plant the distances to nearest receivers, no vibration impacts are anticipated.

5.6.4. Operational Impacts

Modelling Methodology

When calculating industrial noise emissions to the broader environment, the CONCAWE prediction algorithm provides the most appropriate form of assessment and was used during modelling. The noise model was constructed using terrain contours and aerial photography to accurately identify the locations of sensitive receivers. The model has been run under assumed ‘worst case’ meteorological conditions for the transmission of noise. This assumes a wind speed of $3ms^{-1}$ towards receivers, and a Pasquil Stability class of ‘F’.

The proposed layout was obtained from Hunter Water in AutoCAD format, and directly imported into the SoundPlan model. The results of the operational noise modelling are contained in **Figure 5-4** and **Table 5-27**.

- **Table 5-27: Point Calculated Noise Results**

Location	Steel River SIAS Noise Criteria – LA_{10}		Calculated Noise Level LA_{eq} (15min)
	Daytime	Night time	
Location 1	48	30	7 dB(A) - 1.8m 10 dB(A) - 2nd Floor
Location 2	48	30	7 dB(A) – 1.8m
Location 3	48	30	8 dB(A) – 1.8m 10 dB(A) – 2nd Floor
Location 4	48	30	10 dB(A) – 1.8m 12 dB(A) – 2nd Floor

As can be seen from the results above, noise generated from the operation of the IWP would be within the Steel River LA_{10} noise criteria at all times, and would be inaudible at all sensitive receiver locations.

Legend

Calculated Noise Levels

- dB A
- dB A
- dB A
- dB A

Data Sources

AUSIMAGE

Sinclair Knight Merz does not warrant that this document is definitive nor free of error and does not accept liability for any loss caused or arising from reliance upon information provided herein

Metres

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Figure Operational Noise

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Assessment of Noise Allocation

Noise emission allocations for each lot in the Steel River Industrial area have been derived. Under these guidelines, sound power levels have been outlined for each lot; and where these allocated noise levels are met at all sites within Steel River Industrial area, total noise levels at sensitive receiver locations should also be met.

Calculation of the sound power levels from the IWP has been carried out in accordance with the ISO8297.1994, *Acoustics – Determination of Sound Power Levels of Multisource Industrial Plants for Evaluation of Sound Pressure Levels in the Environment – Engineering Method*.

It should be noted that available data for both facade and roof noise attenuation covered the spectral band between 63 Hz and 4kHz, whereas criteria require assessment against the range of 31.5Hz to 8kHz. Attenuation levels for these frequencies were estimated using the available data.

As the IWP would be operational 24 hours a day, noise levels have been assessed against the night time noise criteria, as these are the most conservative limits. The relevant criteria and calculated sound power levels have been given below in **Table 5-28.**

- **Table 5-28: EMA Noise Allocation and Estimated Noise Emissions at Building Facade**

Frequency (Hz)	31.5	63	125	250	500	1k	2k	4k	8k	Lin / Awt
LWA - Criteria	**92**	**90**	**89**	**86**	**81**	**79**	**78**	**75**	**73**	**96.1 / 85.5**
Calculated LWA – IWP	97	84	72	64	57	54	58	53	47	97/65

The results outlined above show that compliance with the total A weighted Lot Noise Allocation would be easily achieved. A minor exceedance of the linear noise allocation for 31.5 Hz was estimated however, and this is due to minor inaccuracies involved in the estimation of attenuation values for building facades and roof materials in 31.5Hz frequency band. The overall exceedance is considered minor, particularly when considering the ease of compliance in the A weighted noise level.

Vibration

Given the distances to nearby structures and the equipment proposed for use during the operation of the IWP, no operational vibration impacts to either human comfort or building integrity would occur.

5.6.5. Mitigation Measures

The following mitigation measures would be implemented to minimise noise impacts from construction and operation:

Construction

- Noise mitigation measures that may be considered during the laying of pipes and underboring would include:
  - *Community notification:*
    - Contact potentially noise affected neighbours at the earliest possible time before any site work begins;
    - Inform potentially noise affected neighbours about the nature of the construction stages and the duration of noisier activities – for example, excavation and rock-breaking;
    - Describe any noise controls, such as walls to be built first that will reduce noise, temporary noise walls, or use of silenced equipment;
    - Keep potentially noise affected neighbours up to date on progress;
    - Ask about any concerns that potentially noise affected neighbours may have and discuss possible solutions;
    - Provide a copy of the noise management plan, if available, to potentially noise affected neighbours.
  - *Operation of plant in a quiet and efficient manner:*
    - Where practical, undertake the noisiest works during the recommended standard hours;
    - Turn off plant that is not being used.
    - Examine, and implement where feasible and reasonable, alternative work practices which generate less noise – for example, use hydraulic rock splitters instead of rock breakers, electric equipment instead of diesel or petrol powered equipment, or rubber wheeled plant instead of steel tracked equipment;
    - Examine, and implement where feasible and reasonable, the use of silenced equipment and noise shielding around stationary plant (such as generators), subject to manufacturers' design requirements;
    - Ensure plant is regularly maintained, and repair or replace equipment that becomes noisy;
    - Ensure road plates (if used) are properly installed and maintained;

- Arrange the work site to minimise the use of movement alarms on vehicles and mobile plant;
- Locate noisy plant away from potentially noise affected neighbours or behind barriers, such as sheds or walls.

- *Involve workers in minimising noise:*
  - Avoid dropping materials from a height, dropping or dragging road plates;
  - Talk to workers about noise from the works at the identified land uses and how it can be reduced;
  - Avoid the use of radios or stereos outdoors where neighbours can be affected.
- *Handle complaints:*
  - Keep staff who receive complaints informed regarding current and upcoming works and the relevant contacts for these works;
  - Handle complaints in a prompt and responsive manner;
  - Where there are complaints about noise from an identified work activity, review and implement, where feasible and reasonable, actions additional to those described above to minimise noise output.
- *Additional work practices at night:*
  - Avoid the use of equipment which generates impulsive noise;
  - Minimise the need for reversing or movement alarms
  - Avoid dropping materials from a height;
  - Avoid metal-to-metal contact on equipment;
  - Schedule truck routes to avoid residential streets where possible;
  - Ensure periods of respite are provided in the case of unavoidable maximum noise level events;
  - Examine and implement, where feasible and reasonable, alternatives to transporting excavated material from tunnelling activities at night. For example, stockpile material and load out the following day.

- A Construction Noise Management Plan (or a relevant section in a CEMP) shall be developed and implemented. The Construction Noise Management Plans shall detail:
  - The location and types of construction activities;
  - Expected noise and vibration levels from specific activities;
  - The location of sensitive receivers marked on a plan attached to the CEMP;
  - Noise mitigation measures, such as those outlined above;

  - Procedure for notification of potentially impacted land users, including consultation with sensitive receivers;
  - Noise and vibration monitoring plan;
  - Procedure to respond to noise and vibration complaints.
- Where possible construction activities audible at sensitive receivers shall be restricted to the hours of:
  - 7 am and 6 pm Monday to Friday; and
  - 8 am to 1 pm on Saturday.
- If audible construction activities occur outside these hours:
  - Sensitive receivers shall be advised of the work at least 24 hours before it commences;
  - An activity-specific noise management plan detailing mitigation measures to reduce noise impacts shall be developed.

Operation

- The detailed design of the IWP shall comply with the lot emissions criteria and include noise modelling to demonstrate compliance.
- Once the IWP is operational, noise monitoring shall be undertaken to confirm the results of the modelling.

5.7. Air Quality

5.7.1. Existing Environment

Air quality in Newcastle is good and generally complies with the Ambient Air Quality NEPM goals for all key pollutants (NCC 2005). The only pollutants which sometimes approach or exceed the Ambient Air Quality are fine particulates and ozone. High concentrations of fine particulates are generally related to extreme natural events such as bush fires and dust storms associated with droughts. High ozone levels generally occur in areas where vehicular traffic is significant. Overall there has been an improvement in air quality over the past 10 years due to improved pollution control technology and the closure of industries which have been high emitters of air pollutes (e.g. steel works).

5.7.2. Construction Impacts

The main potential impact on air quality during the construction phase is the generation of dust. This would be caused by the disturbance of soils during excavation activities. The construction of the KIWS would result in the disturbance of soils. If not properly managed, these disturbed soils may result in the generation of dust, especially in windy conditions. However provided appropriate mitigation measures are implemented during construction and the disturbed areas are rehabilitated as soon as practical, dust generation from construction is unlikely to have a significant impact.

Exhaust emission from the intermittent operation of work machinery during construction also has the potential to impact local air quality. Exhaust emissions would mainly be generated by trucks, excavation equipment, and cranes. However, provided vehicles and machinery are properly maintained and operated, emissions from these sources would have negligible impact. Any impacts would be localised, intermittent and limited to the construction period.

5.7.3. Operational Impacts

The KIWS would not generate any odours or other air quality impacts during operation. Although the IWP uses effluent as feed water, the effluent is largely odourless as it has already been treated at Shortland WWTW. The industrial water produced by the IWP would have no odour.

5.7.4. Mitigation Measures

The following mitigation measures shall be implemented to minimise air quality impacts:

Construction

- Appropriate measures to minimise dust generation during construction shall be developed and implemented via the CEMP;
- Disturbed areas shall be rehabilitated as soon as practical; and
- Work vehicles/machinery shall not be left running or idling when not in use.

Operation

- No specific mitigation measures would be required.

5.8. Energy and Greenhouse

5.8.1. Existing Environment

Climate change is a global issue which is increasingly threatening the sustainability of natural resources in Australia. Climate change is a natural process but is accelerated by greenhouse gases (GHGs). GHGs are gases found in the atmosphere that absorb outgoing heat that is reflected from the sun. One of the primary GHGs is carbon dioxide (CO_2). The absorption of the heat energy warms the air, enabling life to survive, and is known as the Greenhouse Effect. Human activities, such as the combustion of carbon-based fuels, increase the amount of GHGs in the atmosphere. This leads to greater absorption of heat and increases in atmospheric temperature, known as the Enhanced Greenhouse Effect. Overall, the total net greenhouse gas emissions in Australia increased 2.2% between 1990 and 2005. Most of the increases resulted from energy generation and industrial processes.

The proposed IWP would process up to 12.6 ML of treated effluent from Shortland WWTW per day to generate up to 9 ML/day of high quality industrial water and approximately 3.6 ML per day of reject water. Hunter Water is a medium-level consumer of electricity. Generally, energy consumption is a major source of GHGs for Hunter Water, with the majority (approximately 80 %) of the GHG emissions from Hunter Water's operations due to electricity use. Desalination of the treated effluent at the IWP is an energy intensive process which would mainly involve electricity consumption.

5.8.2. Construction Impacts

The assessment of greenhouse gas emissions was constrained to emissions resulting from the operation of the KIWS only and therefore construction emissions were not included because of their relatively minor contribution. Activities associated with the construction of the IWP, including vehicle transport, would be temporary in nature and therefore would not have a long term effect on Hunter Water's emissions.

5.8.3. Operational Impacts

The main impact on Hunter Water's greenhouse gas emissions would derive from the operation of the IWP. The two main processes involved with the processing of effluent at the IWP include membrane filtration (MF) and reverse osmosis (RO). RO is the preferred method of treating recycled water at the IWP but it also requires a large amount of power to operate it and therefore produces more greenhouse gas emissions.

Prediction of the greenhouse gas emissions likely to be generated by operation of the proposed IWP was undertaken (see **Appendix G**) by using three types of assessment categories in accordance with the *National Greenhouse Accounts (NGA) Factors (2008)*. These three categories include:

- **Scope 1 -** covers direct emissions from sources within the boundary of an organisation such as fuel combustion and manufacturing processes;
- **Scope 2 -** covers indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation;
- **Scope 3 -** includes all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned or controlled by the organisation; that is, emissions from offsite waste disposal, emissions associated with the production of fuels, and emissions from the generation of purchased electricity.

Electricity Consumption

Hunter Water calculated the specific power consumption for the MF/RO process to be 1.14 kWh/kL of product water pumped into the distribution system. Applying a 30 % contingency to ensure emissions are evaluated conservatively and accommodate any changes in design which result increased electricity use, the transfer of effluent from Shortland WWTW and the pumping of RO reject water, resulted in a power consumption of 1.48 kWh/kL. This estimate was based on the production of 9 ML per day of treated water from the reverse osmosis plant with pre-treatment with micro/ultra filtration and de-gassing, and only included power used by the IWP and the distribution of treated water to customers. As such, transport of the effluent to the IWP and of the backwash/brine reject from the plant was not included, nor was the embodied energy of chemicals used in the process.

The power consumption values were used to determine the GHG emissions on a daily and yearly basis using the emission factors for purchased electricity for NSW from the NGA Factors published in November 2008. As shown in **Table 5-29**, the IWP plant is expected to generate approximately 4000 tCO_2-e per year, or over 5000 tCO_2-e when allowing for a 30 % contingency (**Table 5-30)**.

- **Table 5-29: Greenhouse Gas Emissions from Electricity Consumption**

Emissions Type	Emission Factor (kg CO_2-e/kWh)	GHG Emissions (t CO_2-e)	
		Per day	Per year
Scope 2	0.89	9.1	3333
Scope 3	0.17	1.7	636.6
Full Fuel Cycle (Total)	1.06	10.9	3969.6

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- **Table 5-30: Greenhouse Gas Emissions from Electricity Consumption – 30 % Contingency**

Emissions Type	Emission Factor (kg CO_2-e/kWh)	GHG Emissions (t CO_2-e)	
		Per day	Per year
Scope 2	0.89	11.9	4327.0
Scope 3	0.17	2.3	826.5
Full Fuel Cycle (Total)	1.06	14.1	5153.5

Comparison of Emissions

Desalination is an energy intensive process, and can use more than twice the energy required to pump and distribute water from rivers or reservoirs. Desalination of treated effluent, however, is much less energy-intensive than desalination of saltwater (1.48 kWh/kL compared to more than 4 kWh/kL).

A total of 73,543 tCO_2-e were emitted by Hunter Water's operations in 2007/08 (Hunter Water, 2008a). Energy consumption associated with the Kooragang IWP would increase Hunter Water's GHG emissions by 3969.6 tCO_2-e per year as a base case, or 5153.5 tCO_2-e per year with a 30% contingency. For the 30 % contingency scenario, the additional emissions constitute a 7 % increase over existing GHG emissions.

A total of 160.0 MtCO_2-e of GHG were emitted NSW in 2006. The GHG emissions calculated above represent approximately 0.003 % of the total NSW emissions.

As some industrial processes require high quality, low salinity water for operational processes, some form of water purification is necessary. RO plants have a number of environmental advantages over alternative processes such as distillation. These include lower energy requirements, higher recovery rates, and smaller surface area plants for the same amount of water production. Based on existing technologies, the IWP was considered by Hunter Water to be the most cost effective and energy efficient desalination technology for this application. Further to this, use of recycled water saves significant amounts of potable water for other users. Australia has experienced significant periods of drought, and such periods are expected to increase in the coming years due to climate change. As such, saving potable water supplies will become increasingly important.

5.8.4. Mitigation Measures

To ensure that the effect of Hunter Water’s greenhouse emissions is mitigated a ‘continuous improvement approach’ would be adopted. Mitigation measures that shall be implemented on an annual basis include:

- Electricity use shall be monitored to identify areas where energy use can be reduced;
- Appropriate maintenance and replacement of redundant equipment shall be undertaken to maintain or improve greenhouse efficiency;
- Up to date technology (with a focus on greenhouse efficiency) shall be considered when sourcing components for maintenance and overhaul activities;

In addition to these measures Hunter Water would also:

- Calculate electricity consumption from the KIWS in order to calculate and report greenhouse gas emissions over the lifespan of the project. Emissions would be reported in Hunter Water’s Annual and Environmental Performance Indicators Reports, and used in state and national greenhouse inventories as required by the National Greenhouse and Energy Reporting (NGER) System; and
- Develop and implement a 'renewable or carbon offset strategy' for the Project’s operations to ensure that all of the energy used is from renewable sources or that the carbon emissions are fully offset.

5.9. Waste

5.9.1. Existing Environment

Due to past industrial development, some areas around the Hunter River have a legacy of contaminated soils and groundwater. Also some shoreline areas along the Hunter River have been reclaimed and in some cases the fill used for reclamation has been contaminated. This includes the Steel River industrial area which was originally owned by BHP and used as part of their steel making operations in Newcastle. However, once BHP's steel making operations in Newcastle ceased, the site was remediated to appropriate NSW industrial standards. This generally involved capping the contaminated material with an impervious layer and covering with capped areas with a layer of clean fill. The type of contaminated material was generally steel stag (which is largely inert), wastes from the coke ovens, and coal washery reject material. In some areas elevated levels of poly-aromatic hydrocarbons were noted. Contamination cells were specifically located during development of the Steel River industrial area and will not be impacted by the project.

5.9.2. Construction Impacts

The largest volume of waste generated by the construction works would be excess spoil from the excavation for pipelines and other infrastructure. Wherever possible, suitable excavated spoil would be reused on site for backfilling, landscaping and other uses. If suitable spoil was unable to be reused on-site, opportunities for off-site reuse would be investigated. Some of the excess spoil may not be suitable for reuse due to its geotechnical or contaminated condition (see **Section 5.1**). Also, spoil generated by directional drilling or micro-tunnelling is not suitable for reuse. Spoil not suitable for reuse would require classification and disposal at an appropriate landfill.

A soil contamination assessment was carried out by *Coffey Environments* and *RCA Australia* in December 2008 and January 2009, respectively. It was found that all samples for contaminants were below the relevant guidelines, except for sample SR32 which was in excess of the conservative guidelines for Total Petroleum Hydrocarbons (TPH). All other samples analysed for TPH were below the relevant guidelines. Chromium was also identified at concentrations >500mg/kg in two test holes but was not considered to pose an environmental or human health risk.

Other solid wastes produced during construction would include:

- Green-waste from clearing of vegetation;
- Packaging waste;
- Off-cuts and disused construction materials; and

- General waste from construction works.

No significant volumes of liquid wastes, including oils or fuels would be generated on site during construction.

Laboratory results undertaken by Coffey (2008) also revealed that 16 samples (TL01, TL05, TL06, TL11, TL13, TL 14, Tl21, TL22, TL23, TL25, TL30, TL37, TL42, TL43, TL44 and TL47) all exceeded the NSW Waste Classification Guidance (CT1) criteria for benzo(a)pyrene. Exceedances under these criteria were also observed for lead contamination in 11 samples (TL06, TL07, TL33, TL34, TL36, TL42, TL43, TL44, TL45, TL 46 and TL47) and five samples (TL11, TL13, TL22, TL37 and TL42) exceeded the NEPM (1999) guidelines for lead. It is recommended that the soils excavated in these areas be disposed of as **General Solid Waste** at an approved landfill, or as suitably validated backfill placed in the pipeline trench following construction of the pipeline.

5.9.3. Operational Impacts

Minor volumes of waste would be generated by maintenance activities associated with the recycled water and wastewater systems. Also some solid wastes may be generated at the IWP such as packaging and used MF/UF and RO membranes that cannot be reused or recycled by the manufacturers. Hunter Water's standard operating procedures and policies would be used as a basis for the management and disposal of this waste.

5.9.4. Mitigation Measures

Mitigation measures aim to ensure that where waste is produced during the construction and the operation of the KIWS that they have the least adverse impact on the environment as possible. These measures include:

- Detailed measures to manage, reduce, reuse, recycle and dispose of construction waste shall be contained in the Construction Environmental Management Plan. Any additional waste management strategies developed for the IWP shall consider and comply with the objectives of the *Waste Avoidance and Resource Recovery Act 2001*;
- If reuse opportunities for the spoil was unable to be identified or the spoil was unsuitable for reuse due to its geotechnical or contamination characteristics, spoil shall be classified according to *Waste Classification Guidelines* (DECCW 2009) and disposed of at an appropriately licensed facility;
- Organic wastes produced through vegetation clearing shall be minimised where possible and opportunities for mulching and composting would be investigated;
- Wherever possible construction wastes shall be recycled or reused, however, it is likely that they would require disposal after being classified according to *Waste Classification Guidelines* (DECCW 2008); and
- Liquid and non-liquid waste would be classified and managed in accordance with DECCW's *Waste Classification Guidelines* (DECCW 2009).

5.10. Traffic and Access

5.10.1. Existing Environment

Components of the KIWS are located in industrial, residential and transport land use areas. Traffic type and numbers generally reflect the impacted land use.

While the IWP (located in the Steel River Industrial Area) would generate the most traffic at a single location during construction and operation, its potential impacts on the road network would be relatively minor because of its location and the low number of associated traffic movements.

The construction of the reject water and recycled water pipelines would have the potential to have the most significant impact on the road network – especially as the pipelines would cross four major arterial roads.

Presented in **Table 5-31** is a list of the roads, the relevant road authority, average annual daily traffic volumes (if available) and the potential impact of the pipelines.

- **Table 5-31: Roads Potentially Impacted by Pipelines**

Road	Significance	Road Authority	2001 AADT	Potential Impact
Industrial Water Pipeline				
Channel Road	2 lane road within industrial park	NCC	NA	Pipeline in road reserve for 0.5 km
Murray Dwyer Circuit	2 lane road servicing light industrial area	NCC	NA	Pipeline in road reserve for 0.7 km
McIntosh Drive	2 lane road servicing light industrial area	NCC	NA	Pipeline in road reserve for 0.06 km
Tourle Street	Major arterial road connecting Newcastle City to port and Kooragang Island	RTA	23650	Pipeline in road reserve for 0.4 km Pipeline crossing of road required
Cormorant Road	Major arterial road connecting Newcastle City to port and Kooragang Island	RTA	NA	Pipeline in road reserve for 3.5 km Pipeline in median for 0.4 km Pipeline crossing of road required
Heron Road	Secondary road servicing major industrial area	NCC	NA	Pipeline in road reserve for 1.1 km
Reject Water Pipeline				
Channel Road	2 lane road within industrial park		NA	Pipeline in road reserve for 0.5 km

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Road	Significance	Road Authority	2001 AADT	Potential Impact
Industrial Drive	Major arterial road connecting Newcastle West to port and Kooragang Island	NCC	21559	Pipeline crossing of road required
Steel River Boulevard	1 lane road servicing light industrial area	NCC	NA	Pipeline in road reserve for 0.1 km
Purdue Avenue	Low traffic residential street	NCC	NA	Pipeline in road reserve for 0.1 km
Maitland Road	Major arterial road	RTA	18840	Pipeline crossing of road required Pipeline in road reserve for 0.05 km

NA = Not Available

5.10.2. Construction Impacts

Construction of the proposed development would result in the following potential impacts on traffic, transportation and access:

- Temporary increases in road traffic during the construction period due to the movements of construction vehicles;
- Temporary road lane closures during the installation of pipelines in road reserves;
- Temporary disruption of pedestrian pathways during the construction of pipelines;
- Temporary loss of or disruption to property access during the construction of pipelines in road reserves.

The above-listed impacts are described in detail in the following sections. In summary, impacts on traffic, transportation and access as a result of construction would be minor and can be readily managed with standard mitigation and management controls. These controls would be prepared in consultation with relevant stakeholders, including NCC, RTA and ARTC (if required).

Temporary increases in road traffic during construction

During construction, an increase in traffic along the affected roads would be generated by:

- Construction site establishment activities, including establishment of site offices and storage areas;
- Movement of work crews to and from the construction sites; and
- Delivery of the construction materials and removal of waste materials such as excess spoil.

For the pipeline construction, the increase in traffic movements would be relatively minor as the pipe laying crews generally consist of about 10 people, the construction site moves as the pipeline installation progresses (that is, construction activities are not centred on one location for the entire construction period), deliveries occur on an as needs basis, and the daily volumes of spoil requiring removal are small. Given the existing capacities of the affected roads and the existing average daily traffic volumes, the minor increase in traffic associated with pipeline construction is not expected to affect the capacity or waiting times on any roads.

The construction of the IWP is likely to generate moderate volumes of construction-related traffic, especially during earthworks and civil works. The average number of vehicles accessing the site would be approximately 20 vehicles a day, with an additional 5 trucks a day during bulk earthworks. Nevertheless, the capacity of the roads in the area would be sufficient to cater for the likely temporary increase in construction traffic. Further assessment would be undertaken before construction commences, however, so that appropriate traffic management controls can be developed and incorporated into a Traffic Management Plan for the site.

Temporary lane closures during pipeline installation

Pipelines would generally be constructed within the existing road reserves. The majority of roads that would be affected are wide with a footpath or substantial road reserve along each side, which would allow construction of the pipelines to be carried out without lane closures. Temporary lane closures would, however, be required along some roads.

The majority of the roads that would be affected by pipeline installation are minor local roads, however a number of main roads and principal traffic routes with major intersections would be potentially impacted including Tourle Street, Cormorant Road, Industrial Drive and Maitland Road.

Lane closures would typically involve the closure of one lane of traffic adjacent to the pipeline construction to accommodate equipment, removal of spoil and delivery of bulk materials. This may result in traffic delays and/ or traffic diversions depending on the number of lanes available. Generally these temporary partial closures would only occur when trenching works are in progress. Road closures would be developed and implemented in consultation with the relevant roads authorities (Council and/or RTA).

Where pipelines cross roads, they would be constructed by one of the following approaches:

- Open trenching and temporary partial road closures during normal construction hours (generally for roads with low traffic volumes);
- Open trenching and temporary partial road closures outside normal construction hours (generally for roads with moderate traffic volumes);

- Underboring techniques, such as thrust boring or microtunnelling (generally for roads with high traffic volumes), which would avoid the need for road closures; and
- Underboring techniques would be used where pipelines cross major intersections to avoid traffic diversions and delays in these areas.

Appropriate construction methodologies for road crossings would be developed and implemented in consultation with the NCC and/ or RTA.

Temporary disruption of pedestrian pathways during pipeline installation

Access to and use of some pedestrian pathways would be temporarily impacted during the construction of pipelines. This impact would most commonly occur where footpaths are located adjacent to the roads affected by pipeline construction. Some of pipelines would also be laid directly within existing footpaths, rather than in road reserves. This would require temporary diversion of pedestrian traffic.

Generally the access to, and use of, pedestrian pathways would only occur when pipe trenching works are in progress. Councils and local community members would be informed of any potential loss of access and appropriate measures to either provide alternative pedestrian access ways or reinstate access at the end of each work day would be negotiated. Measures to manage closures and diversions of pedestrian pathways would be carried out in consultation with NCC. The overall impacts on pedestrian pathways as a result of construction of the KIWS would be low.

Temporary loss of or disruption to property access

During the construction of the pipelines, access to properties may be temporarily affected. Due to the rapid rate of pipeline construction, however, the time period for which properties are affected would be relatively low (generally less than 1-2 days). Property owners would be informed of any potential loss of access and appropriate measures to either provide an alternative access or reinstate access at the end of the day would be negotiated. Any access ways affected by construction would be reinstated to their original condition. The overall impacts on property access from the construction of the Project would be low.

5.10.3. Operational Impacts

During operation of the KIWS, the pipelines would require inspections and maintenance. The volume of traffic associated with these activities would be negligible in comparison to existing traffic movements and road capacities and would not affect the capacity of any regional or local roads.

Where maintenance or emergency activities require a road closure or the temporary loss of access to a property, Hunter Water's standard operational procedures in managing these activities would be implemented.

The new IWP to be constructed as part of the KIWS would generate about 3 additional truck movements every week for chemical deliveries, approximately three additional light vehicle movements per day for operation and maintenance and 4 additional bus movements per week accessing the educational facility. The impact of these additional vehicle movements on surrounding roads would be negligible. Likewise, the impact of additional vehicles parked in existing kerbside parking near the IWP would be negligible.

5.10.4. Mitigation Measures

The following mitigation measures would be implemented to minimise the impact of the proposed development on traffic and access:

Construction

- During further development of the design and construction planning, the RTA and/or Newcastle City would be consulted to determine the most appropriate construction methodologies for construction of the pipelines in road reserves and for road crossings of the pipelines. Generally for all major road crossings underboring would be used to minimise road disturbance.
- Construction Traffic Management Plans would be prepared and implemented in consultation with the appropriate road authority;
- Property access would be maintained wherever possible. Consultation with land users whose access is impacted would be undertaken;
- Potentially impacted users would be informed of temporary changes in traffic management during construction; and
- Roads and road reserves would be reinstated as near as practicable to their original condition after construction.

Operation

No additional mitigation measures would be required to minimise the impact of the operation of the IWS on traffic.

5.11. Hazardous Chemicals and Dangerous Goods

5.11.1. Existing Environment

State Environmental Planning Policy 33 – Hazardous and Offensive Development (SEPP 33) defines potential hazardous and offensive developments and specifies the requirements for the assessment of hazards and the granting of development applications. SEPP 33 normally only applies to developments requiring development consent under Part 4 of the EP&A Act. As the KIWS would be considered under Part 5 of the EP&A Act, the requirements of the SEPP normally would not apply.

However, to provide a comprehensive environment assessment of all potential impacts a hazard assessment using the SEPP 33 guidelines *(Applying SEPP 33: Hazardous and Offensive Development Application Guidelines (DUAP 1994))* has been undertaken to examine the potential hazards relating to the Project.

5.11.2. Construction Impacts

During construction, fuel (diesel and petrol) and oil would be used by construction vehicles and equipment. At each construction area, small volumes of fuel (generally about 200 L) would be stored and used to refuel generators, saw cutters and other similar types of construction equipment.

There may be small quantities of chemicals used during construction (generally in containers of less than 20 L). Any fuel or chemicals would be stored to meet relevant standards in bunded or contained areas. The presence of these substances provides potential for fire or explosion. The quantity of these substances on site would be only that contained within vehicles, construction equipment and mini tankers and as such, these fuels would not represent a significant hazard.

The storage of fuels on or around the site would generally be avoided and vehicles and equipment would be refuelled off site. Where on-site refuelling is unavoidable, mini-tankers would be used. Mini-tankers would be required to follow standard procedures to minimise the risk of explosion or fire.

5.11.3. Operational Impacts

The production of industrial water at the IWP would require the use of chemicals, primarily to keep the membranes clean and operating efficiently. For chemicals that are used at a high rate, bulk storages would be provided and these chemicals would be delivered by tanker. For chemicals that are used at a lower rate, palecons (1000 L plastic containers) would be the method of delivery and storage.

The bulk chemical storages have been sized to ensure that they would not require refilling more than once a month. An external chemical storage area is proposed separate from the main building and would be designed in accordance with AS 3780-1994. The volume and type of chemicals that would be stored at the IWP are presented in **Table 5-32**.

- **Table 5-32: Types and Quantities of Dangerous Goods Stored at the IWP**

Name	Dangerous Good Class	Maximum Stored on site	Packaging Class
sodium hypochlorite	8	22 kL	III
sodium hydroxide	8	5 kL	III
aqueous ammonia	8	2.5 kL	III
sulphuric acid	8	1 kL	III
antiscalant	NA	1 kL	NA
sodium bisulfite	NA	1 kL	NA

NA = Not considered a Dangerous Good

All of the chemicals used at the IWP are either Class 8 or not classified as dangerous goods. Class 8 dangerous goods are corrosive and generally do not pose risks of explosion or fire. Therefore their major potential risks to surrounding land uses would be predominately environmental impacts and damage to infrastructure if they escaped from site.

The SEPP33 guidelines consist of a multi-level risk assessment. Initially a screening level assessment is undertaken based upon the type and quantity of dangerous goods stored on site. If the screening level threshold is exceeded for a specific class of dangerous good, a more detailed hazard assessment is triggered. For Class 8 dangerous goods with a packaging class of III (bulk storage), the screening level threshold is 50 kL. Based upon the volumes in **Table 5-32**, 30.5 kL of Class 8 substances would be stored on site – which is below the screening level threshold and therefore the development is not classed as hazardous and no further assessment is required.

It should be noted that the size of storages and types of chemicals may change once the detailed design of the IWP has been completed. When the final types and quantities of chemicals are known, a reassessment of potential hazards would be undertaken.

5.11.4. Mitigation Measures

The following mitigation measures would be implemented to minimise hazards associated with construction and operation of the KIWS:

Construction

- Appropriate storage, transport and use measures for fuel and chemicals used during construction shall be developed and implemented.

Operation

- All chemical storages shall be designed and operated in accordance with the appropriate Australian and NSW standards;
- Once the detailed design has been completed and the location, type and quantity of chemicals are known, a SEPP33 hazard assessment shall be undertaken.

5.12. Human Health

5.12.1. Existing Environment

The KIWS would involve supply of recycled water to industries on Kooragang Island and in the future, potentially other users in the region. The recycled water would be produced using effluent from Shortland WWTW. While treatment at Shortland WWTW would remove the majority of human pathogens from the wastewater, some would still remain in the effluent. Therefore, it is important that Hunter Water ensures that the treatment process at the IWP further remove pathogens to levels that are acceptable for its intended use.

Industries on Kooragang Island intend to utilise the recycled water for industrial uses such as cleaning, washdown and cooling tower water. If pathogens in the recycled water are at unacceptable levels, exposure to the recycled water could potentially have an effect on the staff working at industrial areas on Kooragang Island, the family of staff and to a lesser extent, the surrounding community.

5.12.2. Construction Impacts

Construction of the KIWS would have no direct impact on human health. As such, no construction impact mitigation measures are required in relation to human health.

5.12.3. Operational Impacts

The following discussion is based on human health risks of recycled water use at surrounding industries on Kooragang Island. Once other users are identified an identical risk assessment process would need to be undertaken. The main potential human exposure to recycled water is inadvertent physical contact or inhalation of mist, droplets and splashes. Contractors, staff and their families, as well as surrounding community members are all considered to be potentially affected both indirectly and directly. Direct contact with recycled water can occur through activities such as cleaning equipment, maintenance of machinery, undertaking inspections, and testing of vessels. An example of indirect contact is of bike riders and fishermen offsite inhaling spray drift from the cooling tower.

The main human health risk associated with the non-drinking use of recycled water is from the presence of residual pathogens after treatment. Ingestion of recycled water may cause gastrointestinal illness whilst inhalation of recycled water may cause respiratory illness. The recycled water that would be provided by Hunter Water would be to the standard of urban non-drinking reuse as defined by the *Natural Resource Management Ministerial Council, Environmental Protection and Heritage Council, Australian Health Ministers Conference – National Guidelines for Water Recycling: Managing Health and Environmental Risks* (2006) that identify acceptable levels for index pathogens, representing viruses, bacteria and protozoa, such that risks to human health are reduced to acceptable levels. Index pathogens are used to define the necessary removal requirements during treatment to achieve acceptable health risk targets. It would not be possible to define these for all pathogens given the wide range of pathogens that may be potentially found in wastewater.

The necessary removal requirements are defined as "log reduction" of the index pathogens in the recycled water. Log reduction is used to define the ability of a treatment process to remove, kill or inactivate pathogens (90 per cent reduction is equivalent to 1-log reduction, 99 per cent reduction is equivalent to 2-log reduction, 99.9 per cent reduction is equivalent to 3-log reduction etc). The higher the log reduction, the higher the percentage reduction in pathogen and the less risk to humans exposed to recycled water.

An exposure workshop was held with Hunter Water, Hunter Water Australia and Orica staff in May 2008 to determine the proposed and unintended end uses of recycled water and from this estimate the likely exposure volumes. From these exposure volumes the log reductions of index pathogens can be derived. The higher the exposure volume the larger the log reduction in pathogens required. The exposure assessment summary from this workshop is outlined in **Table 5-33.**

- **Table 5-33: Exposure Assessment Summary (log reductions reported in base 10)**

Rank order of exposure	Location	Group	Exposure volume (ml/yr)	Virus log reductions required	Protozoa log reductions required	Bacteria log reductions required
1	Nitrate Plant	Operators	35.72	5.1	3.6	3.8
2	Ammonia Plant	Operators	11.30	4.6	3.2	3.8
3	Cooling Towers	Contractors	9.36	2.5	1.1	1.2
4	Nitrate Plant	Contractors	8.00	4.4	3.0	3.2
5	Ammonia Plant	Mechanical	6.06	4.3	2.9	3.0
6	General	Lab Staff	1.39	3.6	2.2	2.4
7	General	General Staff	0.87	2.4	1.0	1.2
8	Ammonia Plant	Contractors	0.53	3.2	1.8	2.0

To assess the log reduction in pathogens all treatment process used to produce recycled water from untreated wastewater are considered. This includes both the treatment processes at Shortland WWTW and at the IWP. The treatment process that would be used at Shortland WWTW and the IWP and the log reduction credits for each unit treatment process are provided in **Table 5-34**. Using index pathogens *E. coli* (bacteria), MS-2 bacteriophage (viruses) and *C. perfringens* spores (protozoa), **Table 5-34** shows that the total pathogen log reduction is higher than what is required by the *National Guidelines for Water Recycling: Managing Health and Environmental Risks* (2006). Also presented in the table are log reductions for pathogens which are known to be difficult to remove from wastewater due to their specific biological characteristics. For these worst case pathogens the log reductions from the proposed treatment process are higher than the required log reduction indicating that recycled water does not pose an unacceptable risk to users.

It should be noted the log reductions assigned to specific treatment processes are based upon results from other facilities and from scientific literature and generally are conservative. The actual log removal may be higher. Once the KIWS is operational sampling of the wastewater after it undergoes each treatment process would be required to verify the predicted log reductions. This would be part of a design verification and commissioning validation plan that would be provided to appropriate regulatory authorities such as NSW Health.

The log reductions in **Table 5-34** also indicate that the RO treatment process results in the highest log reduction in pathogens. If this treatment process was to fail it suggests that some of the required log reduction targets would not be achieved (e.g. Viruses) and unacceptable risks to human health from the recycled water may occur. While this theoretically may occur there are a number of mitigating characteristics of the IWS which make this unlikely such as:

- Failure of the RO membranes would be rapidly detected due to a decrease in pressure across the membranes and a deterioration in the quality of the recycled water. For example, the salinity of the recycled water would increase and this would be able to be detected immediately; and
- The recycled water at the IWP and the recycled water pipeline combined hold a significant volume of water. Therefore, if there was a failure there would be a considerable time period to stop the RO process before the recycled water reaches the user.

- **Table 5-34: Current pathogen log reduction summary table (log reductions reported in base 10)**

Treatment Process Step	Virus (nominal)	Bacteria (nominal)	Protozoa (nominal)	Adeno (validated worst-case)	Hep A (Validated worst-case)	Bacteria (Validated worst-case)	Protozoa (validated worst-case)
IDEA (Shortland)	2	3	1.5	1.5	1.5	2.5	1
Chlorination (Shortland)	1.0-3.0	2.0-6.0	0 -2.0	2	2	2	0
MF/UF (IWP)	0.5	4	4	1	0.5	4	4
RO (IWP)	6	6	6	2	2	2	2
Total	**9.5 – 11.5**	**15 – 19**	**11.5–13.5**	**6.5**	**6**	**10.5**	**7**
Required	**5**	**4**	**4**	**5**	**5**	**4**	**4**

5.12.4. Mitigation Measures

The following mitigation measures shall be implemented to limit exposures to recycled water:

- Materials codes and regulations that easily discriminate between potable and recycled water pipes shall be developed and existing standards, such as pipe colours for recycled water pipelines, would be used;
- Education of users on the risks of recycled water use shall be undertaken;
- Backflow prevention systems shall be installed to reduce the extent of hydraulic influence from any cross-connections that do occur; and
- Operational checking and connection auditing shall be undertaken.

Other mitigation measures would include:

- A validation study conforming with the requirements of the National Guidelines for Water Recycling: Managing Health and Environmental Risks (2006) shall be undertaken to confirm the efficiency of treatment processes.
- Ongoing monitoring of recycled water shall be undertaken to ensure the quality of the recycled water meets customer requirements.

5.13. Cumulative Impacts

There are two types of cumulative impacts to consider for the proposed development namely:

- The cumulative impacts of the proposed development on sensitive receivers and the environment; and
- The cumulative impacts of proposed development and other developments.

Impacts on sensitive receivers (i.e. residential and commercial areas) would mainly occur during the construction of the proposed development and would be specifically related to the construction of the pipelines, rather than the IWP. A small length of the reject water pipeline and pipeline diverting water from the Burwood Beach wastewater system to the Shortland wastewater system would be located in residential areas (including a park and residential street) and minor impacts from dust, noise and loss of access would be expected. Measures to minimise these impacts would be implemented and the impact would only be temporary during the relatively short construction period. The cumulative impacts of the construction of the pipeline in these areas would not be significant. There are not expected to be any cumulative impacts on the environment from the proposed development.

There are not expected to be any significant cumulative impacts of the proposed development and any other known developments. The operational noise levels for the whole Steel River Industrial Area have been derived from the Industrial Noise Policy and noise emissions levels have been determined for individual lots in the Steel River Industrial Area to meet the overall INP criteria. Noise emissions from IWP would be below the individual lot noise allotment. As there would be no change or a reduction in overall loads of water-borne pollutants discharged into the environment there would be no additional cumulative impacts on the environment.

Construction of other developments in the Steel River Industrial Area may occur at the same time as construction of the IWS, however, because the Industrial Area is located away from residential areas there is not expected to be any cumulative impact on residential areas from construction.

5.14. Construction Environmental Management Plan (CEMP)

A CEMP will be prepared by the construction contractor. The CEMP will include the mitigation measures described within this REF, and would be prepared in accordance with the relevant statutory and policy requirements. The CEMP will define environmental objectives, controls to mitigate adverse impacts, corrective actions to manage impacts and auditing and reporting requirements.

The implementation of the CEMP will be audited by Hunter Water representatives during the construction contract. Any corrective action requests arising from audits will be followed up (through re-inspection) within a timeframe agreed between the Hunter Water representative and construction contractor.

Table 5-35 provides a summary of the proposed environmental management to be implemented during the construction phase.

- **Table 5-35: Summary of Proposed Construction Environmental Safeguards**

Issue	Safeguards
Topography, geology and soils	▪ For the tar contamination, it may be possible to apply a surface capping to render the tar area a low human health exposure risk. If this is not practical, the tar contaminated material shall be removed from the development site for appropriate disposal elsewhere; ▪ Hunter Water shall liaise with Newcastle City Council during the design and construction of the pipeline through Stevenson Park to ensure that the works do not impact upon the effectiveness of the previous remediation works; ▪ A Soil and Water Management Plan which complies with the Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom 2004) shall be prepared and implemented during construction; ▪ During excavation works, the presence of Acid Sulphate Soil (ASS) shall be monitored via observation of soil colour and odour. Should any indication of ASS be discovered, the Project Manager will be notified and action taken to test and implement appropriate ASS controls; ▪ All excess spoil shall be classified using the Waste Classification Guidelines (DECC 2009) and disposed of at an appropriately licensed landfill; ▪ Appropriate measures for the safe storage and handling of fuels, chemicals and other substances shall be employed in accordance with AS1940; ▪ Emergency response procedures for spills (e.g. chemicals and hydrocarbons) and other emergencies potentially causing soil contamination shall be implemented; and ▪ Further investigations in the likelihood of encountering groundwater shall be made during construction planning to determine appropriate construction methodologies and the need to obtain a licence for dewatering activities.
Water quality	▪ Soil and water management plans complying with Managing Urban Stormwater: Soils and Construction (Landcom 2004) shall be prepared and implemented

Issue	Safeguards
Terrestrial Ecology	▪ No heavy machinery shall traverse saltmarsh areas. Where construction activities are undertaken adjacent to remnant vegetation or where vegetation will be cleared, visual barriers or fencing shall be used to prevent access to these areas. Disturbance limits in these areas will be identified on plans attached to the Construction Environmental Management Plan (CEMP) and clearly marked on ground; ▪ Direct avoidance and lopping shall be used to minimise disturbance of vegetation where possible. Where this is not possible, smaller equipment shall be used to minimise the width of disturbance corridor to protect natural habitats; ▪ Best-practice sediment and erosion controls implemented to prevent impacts to water quality and minimise run-off into adjacent ecologically sensitive areas such as saltmarsh, mangrove and wetland habitats shall be implemented; ▪ Weed management strategies shall be identified in the CEMP; ▪ Wherever possible, trenches shall not be left open overnight. If this is not possible, inspections of the trench shall be conducted each morning for captured fauna. All fauna captured shall be removed and released to adjacent natural habitats; and ▪ If possible, trenches shall be dug with shallow sloping ends to allow natural fauna escape; and ▪ Construction personnel shall be made aware of the importance of ecological values in the area, particularly the mangroves and coastal saltmarsh in proximity to the Hunter River. All construction personnel shall be inducted and made aware of their environmental responsibilities. ▪ A map of the construction zone showing sensitive ecological features/locations, disturbance limits and management controls shall be prepared to accompany the CEMP.
Aquatic Ecology	▪ See Terrestrial Ecology and Water Quality
Cultural Heritage	▪ Should any previously unrecorded Aboriginal or heritage objects be discovered during construction activities then disturbance shall cease in the area of the discovery. No further construction activities shall occur in the area of the find until the OEH and/or NSW Heritage Branch has been contacted and the site has been assessed by the project archaeologist. ▪ All construction work staff (including sub-contractors) shall go through a site induction concerning Aboriginal and Non-Aboriginal heritage issues prior to commencing work on site. This induction shall inform workers of the locations of the known sites potentially impacted by construction works.

Noise and Vibration	▪ Noise mitigation measures that may be considered during the laying of pipes and underboring would include:
	  ▪ *Community notification:*
	    – Contact potentially noise affected neighbours at the earliest possible time before any site work begins;
	    – Inform potentially noise affected neighbours about the nature of the construction stages and the duration of noisier activities – for example, excavation and rock-breaking;
	    – Describe any noise controls, such as walls to be built first that will reduce noise, temporary noise walls, or use of silenced equipment;
	    – Keep potentially noise affected neighbours up to date on progress;
	    – Ask about any concerns that potentially noise affected neighbours may have and discuss possible solutions;
	    – Provide a copy of the noise management plan, if available, to potentially noise affected neighbours.
	  ▪ *Operation of plant in a quiet and efficient manner:*
	    – Where practical, undertake the noisiest works during the recommended standard hours;
	    – Turn off plant that is not being used.
	    – Examine, and implement where feasible and reasonable, alternative work

Issue	Safeguards
	practices which generate less noise – for example, use hydraulic rock splitters instead of rock breakers, electric equipment instead of diesel or petrol powered equipment, or rubber wheeled plant instead of steel tracked equipment; – Examine, and implement where feasible and reasonable, the use of silenced equipment and noise shielding around stationary plant (such as generators), subject to manufacturers' design requirements; – Ensure plant is regularly maintained, and repair or replace equipment that becomes noisy; – Ensure road plates (if used) are properly installed and maintained; – Arrange the work site to minimise the use of movement alarms on vehicles and mobile plant; – Locate noisy plant away from potentially noise affected neighbours or behind barriers, such as sheds or walls. ▪ *Involve workers in minimising noise:* – Avoid dropping materials from a height, dropping or dragging road plates; – Talk to workers about noise from the works at the identified land uses and how it can be reduced; – Avoid the use of radios or stereos outdoors where neighbours can be affected. ▪ *Handle complaints:* – Keep staff who receive complaints informed regarding current and upcoming works and the relevant contacts for these works; – Handle complaints in a prompt and responsive manner; – Where there are complaints about noise from an identified work activity, review and implement, where feasible and reasonable, actions additional to those described above to minimise noise output. ▪ *Additional work practices at night:* – Avoid the use of equipment which generates impulsive noise; – Minimise the need for reversing or movement alarms – Avoid dropping materials from a height; – Avoid metal-to-metal contact on equipment; – Schedule truck routes to avoid residential streets where possible; – Ensure periods of respite are provided in the case of unavoidable maximum noise level events; – Examine and implement, where feasible and reasonable, alternatives to transporting excavated material from tunnelling activities at night. For example, stockpile material and load out the following day. ▪ A Construction Noise Management Plan (or a relevant section in a CEMP) shall be developed and implemented. The Construction Noise Management Plans shall detail: ▪ The location and types of construction activities; ▪ Expected noise and vibration levels from specific activities; ▪ The location of sensitive receivers marked on a plan attached to the CEMP; ▪ Noise mitigation measures, such as those outlined above; ▪ Procedure for notification of potentially impacted land users, including consultation with sensitive receivers; ▪ Noise and vibration monitoring plan; ▪ Procedure to respond to noise and vibration complaints. ▪ Where possible construction activities audible at sensitive receivers shall be restricted to the hours of: ▪ 7 am and 6 pm Monday to Friday; and ▪ 8 am to 1 pm on Saturday. ▪ If audible construction activities occur outside these hours:

Issue	Safeguards
	▪ Sensitive receivers shall be advised of the work at least 24 hours before it commences; ▪ An activity-specific noise management plan detailing mitigation measures to reduce noise impacts shall be developed.
Air quality	▪ Appropriate measures to minimise dust generation during construction shall be developed and implemented via the CEMP; ▪ Disturbed areas shall be rehabilitated as soon as practical; and ▪ Work vehicles/machinery shall not be left running or idling when not in use.
Waste	▪ Detailed measures to manage, reduce, reuse, recycle and dispose of construction waste shall be contained in the Construction Environmental Management Plan. Any additional waste management strategies developed for the IWP shall consider and comply with the objectives of the Waste Avoidance and Resource Recovery Act 2001; ▪ If reuse opportunities for the spoil was unable to be identified or the spoil was unsuitable for reuse due to its geotechnical or contamination characteristics, spoil shall be classified according to Waste Classification Guidelines (DECCW 2008) and disposed of at an appropriately licensed facility; ▪ Organic wastes produced through vegetation clearing shall be minimised where possible and opportunities for mulching and composting would be investigated; ▪ Wherever possible construction wastes shall be recycled or reused, however, it is likely that they would require disposal after being classified according to Waste Classification Guidelines (DECCW 2008); and ▪ Liquid and non-liquid waste would be classified and managed in accordance with DECCW's Waste Classification Guidelines (DECCW 2008).

Traffic and access	▪ During further development of the design and construction planning, the RTA and/or Newcastle City would be consulted:
	  ▪ to determine the most appropriate construction methodologies for construction of the pipelines in road reserves and for road crossings of the pipelines. Generally for all major road crossings underboring would be used to minimise road disturbance;
	  ▪ to determine the suitable location of scour and air valves – and other associated infrastructure in relation to roads; and
	  ▪ on the design of the access road to the IWP.
	▪ Construction Traffic Management Plans would be prepared and implemented in consultation with the appropriate road authority;
	▪ Property access would be maintained wherever possible. Consultation with land users whose access is impacted would be undertaken;
	▪ Potentially impacted users would be informed of temporary changes in traffic management during construction; and
	▪ Roads and road reserves would be reinstated to their original condition after construction.

Hazards and Dangerous Goods	▪ Appropriate storage, transport and use measures for fuel and chemicals used during construction shall be developed and implemented.

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5.15. Operational Environmental Management Plan

An Operational Environmental Management Plan would be prepared before commissioning of the KIWS. The mitigation measures from the REF are presented in **Table 5-36** and would be included in the Operational Environmental Management Plan.

- **Table 5-36: Summary of Proposed Operational Environmental Safeguards**

Issue	Safeguards
Topography, geology and soils	▪ Appropriate measures for the safe storage and handling of fuels, chemicals and other substances shall be employed in accordance with AS1940; ▪ Emergency response procedures for spills (e.g. chemicals and hydrocarbons) and other emergencies potentially causing soil contamination shall be implemented;
Hydrology and water quality	▪ RO reject water shall be only be discharged into the Hunter River estuary if the Burwood Beach wastewater system was not able to receive flows; ▪ The toxicity of other chemicals in the RO reject water (e.g. anti-scalents) shall be assessed once the detailed design has been completed and the membrane manufacturer identified. The potential toxicity of any chemicals used in the process shall be a factor in deciding on the preferred supplier of the membranes; ▪ Routine monitoring of receiving waters and discharge water shall be undertaken for compliance reporting and to validate water quality monitoring. A monitoring program shall be developed and implemented before operation of the KIWS commences. ▪ Nitrogen load limits and treatment options for the Burwood Beach WWTW shall be reviewed once the outcomes of the Marine Environmental Assessment Program are available.
Terrestrial Ecology	▪ No mitigation measures required
Aquatic Ecology	▪ See Water Quality Section 5.2
Cultural Heritage	▪ No mitigation measures required
Noise and Vibration	▪ The detailed design of the IWP shall comply with the lot emissions criteria and include noise modelling to demonstrate compliance. ▪ Once the IWP is operational, noise monitoring shall be undertaken to confirm the results of the modelling.
Air quality	▪ No specific mitigation measures would be required.
Traffic and access	▪ No additional mitigation measures would be required to minimise the impact of the operation of the IWS on traffic.
Waste Generation	Liquid and non-liquid waste would be classified and managed in accordance with OEH's Waste Classification Guidelines (DECCW 2009).
Hazards and Dangerous Goods	▪ All chemical storages shall be designed and operated in accordance with the appropriate Australian and NSW standards; ▪ Once the detailed design has been completed and the location, type and quantity of chemicals are known, a SEPP33 hazard assessment shall be undertaken.
Human Health	▪ Materials codes and regulations that easily discriminate between potable and recycled water pipes shall be developed and existing standards, such as pipe colours for recycled water pipelines, would be used; ▪ Education of users on the risks of recycled water use shall be undertaken; ▪ Backflow prevention systems shall be installed to reduce the extent of hydraulic influence from any cross-connections that do occur; and ▪ Operational checking and connection auditing shall be undertaken. ▪ A validation study conforming with the requirements of the National Guidelines for Water Recycling: Managing Health and Environmental Risks (2006) shall be undertaken to confirm the efficiency of treatment processes. ▪ Ongoing monitoring of recycled water shall be undertaken to ensure the quality of the recycled water meets customer requirements.

Issue	Safeguards
Energy and Greenhouse	▪ Electricity use shall be monitored to identify areas where energy use can be reduced; ▪ Appropriate maintenance and replacement of redundant equipment shall be undertaken to maintain or improve greenhouse efficiency; ▪ Up to date technology (with a focus on greenhouse efficiency) shall be considered when sourcing components for maintenance and overhaul activities; ▪ Calculate electricity consumption from the KIWS in order to calculate and report greenhouse gas emissions over the lifespan of the project. Emissions would be reported in Hunter Water's Annual and Environmental Performance Indicators Reports, and used in state and national greenhouse inventories as required by the National Greenhouse and Energy Reporting (NGER) System; and ▪ Evaluate the future options to reduce GHG emissions produced by the operation of the IWP. Future options include use of renewable energy, on-site power generation, and GHG offsets. The cost and feasibility of these options would be evaluated against the cost of grid power electricity and would likely be undertaken as a corporate program to manage GHG generations across the whole of Hunter Water operations.

5.16. Licences and Approvals

The following licences and approvals would be required:

- Approval under the Protection of Environment Operations Act for water discharge from the KIWS;
- Road Occupancy Licences for construction in roadways;
- If dewatering of construction sites is required during construction, a licence under the Water Act or Water Management Act may be required.

It is envisaged that KIWS would be incorporated into the existing EPL No. 1683 for Newcastle Sewerage Scheme, which currently includes both Shortland and Burwood Beach WWTWs. The changes likely to be required to incorporate KIWS in the EPL include addition of a licensed discharge to the Hunter River Estuary for wet weather discharge of the RO reject water from the IWP, as well as a review of existing EPL load limits.

6. Conclusion

Hunter Water proposes to develop the Kooragang Industrial Water Scheme (KIWS) to provide high quality low salinity recycled water to industrial users. Hunter Water plans to divert 12.6 ML/day of treated effluent from their Shortland Waste Water Treatment Works (WWTW), which normally discharges to the Hunter River estuary, for further treatment at an Industrial Water Plant (IWP) before distribution to customers. The IWP would be located in the Steel River Industrial Area and would use membrane filtration (pre-treatment) and reverse osmosis to produce industrial quality recycled water. The reject water from the membrane pre-treatment stage would be returned to Shortland WWTW and the reject water from the reverse osmosis treatment stage would be discharged from the IWP to Burwood Beach wastewater system the majority of time and to the Hunter River estuary in extreme wet weather.

This Review of Environmental Factors (REF) has outlined the justification for the project and the options considered for developing the KIWS; the statutory and legal requirements to carry out the KIWS; consultation with key stakeholders; and a detailed environmental impact assessment on all aspects of the construction and operation of the KIWS. Mitigation measures are also outlined to offset adverse effects. The following outlines the conclusions made about each environmental factor affected by the construction and operation of the KIWS:

Topography, Geology and Soils

The proposed development is predominantly located in areas that have been reclaimed from the Hunter River estuary. Often fill with unknown characteristics has been used to reclaim areas in Newcastle and therefore the contamination status of areas affected by the development was assessed. It was found that in most areas contaminants levels in the soils were below the relevant guidelines however, TPH, chromium, lead and benzopyrene concentrations marginally above the guidelines were found at some borehole locations. Disposal of the soil from these locations would be at an appropriately licensed waste facility. The design and construction of the pipeline in Stevenson Park (a remediated landfill) will be undertaken in consultation with Newcastle City Council to ensure that remediation measures are not comprised.

Groundwater was observed at depths of 5.5 and 6.5 meters on the IWP site (RCA 2008), however it is unlikely that groundwater will be encountered during shallow excavations associated with the construction of the IWP.

No free groundwater was encountered along any of the proposed pipeline routes, however wet soil was observed in 16 borehole sites by Coffey (2009) and two borehole sites by RCA (2008) at a depth of 0.75 and 2.5 metres below the ground's surface. As wet soil is an indicator of proximal groundwater tables the construction of all the pipelines will therefore need to consider shallow and potentially fluctuating groundwater levels, especially as 1.5 m deep excavations are required for the installation of the pipelines

Mitigation measures during the construction phase of the development have been put in place to avoid further detriments to human health and contamination of the surrounding natural environment. There are also further mitigation measures in place for construction activities in the vicinity of the Hunter River.

Water Quality

Construction of the KIWS would require the disturbance of soils, which may result in impacts on water quality after rainfall during to sediment-laden runoff from construction areas. A Soil and Water Management Plan complying with appropriate guidelines would be prepared and implemented.

The major potential impact on water quality from the KIWS would be during operation. The RO reject water would contain most of the dissolved pollutants in the effluent from Shortland WWTW in a concentrated form and therefore the disposal of this waste stream has the largest potential impact. In most weather conditions, the RO reject water would be discharged into the Burwood Beach wastewater system, where it would eventually be discharged into the Pacific Ocean. In extreme wet weather, the RO reject water would be discharged into Hunter River estuary as there would be insufficient capacity in the Burwood Beach wastewater system to receive the flows because of infiltration and inflow of stormwater into the system. When Shortland WWTW produces greater than 12 ML/day of effluent, the excess would be discharged into the Hunter River estuary. There may however be periods during commissioning and maintenance of KIWS when all effluent produced by Shortland WWTW is discharged in the Hunter River estuary.

Loads of pollutants discharged in the Hunter River estuary and Pacific Ocean were calculated, and modelling of the Hunter River estuary discharge was undertaken to estimate the impact of the scheme. Also the future conditions, where the catchment of Shortland wastewater system was fully developed, were assessed.

Overall, there would be significant reduction in the loads of pollutants discharged into the Hunter River estuary, with a 39% reduction in nitrogen loads and a 51% reduction in phosphorus loads in an average rainfall year and full development of catchment. The loads of pollutants would be below the current estuarine EPL load limits.

For most key pollutants there would be no or little change in overall annual loads discharged from Burwood Beach WWTW with the operation of KIWS. With the exception of total nitrogen, loads of key pollutants would not exceed the existing EPL load limits.

As part of the Burwood Beach WWTW Stage 3 Upgrade project, a comprehensive two-year Marine Environmental Assessment Program was commenced in May 2011 to address potential impacts from future effluent and biosolids discharges from Burwood Beach WWTW. The outcomes of this program, which has been developed in close consultation with the OEH and other key stakeholders, will help to establish whether increasing the total nitrogen loads discharged from the plant would impact on marine ecology. In parallel with the Marine Environmental Assessment Program, a range of upgrade options for the Burwood Beach WWTW are being developed, including nitrogen removal process options as well as options for ceasing the discharge of biosolids to ocean (which currently contributes around 20% of the total nitrogen load discharged). The results of these investigations will feed into a sustainable decision-making process in 2014 to determine the scope of future upgrade works required at Burwood Beach WWTW. The preferred upgrade strategy for Burwood Beach WWTW would then be the subject of a separate concept design and EIA process.

Modelling of the discharge of RO reject water in wet weather into the Hunter River estuary was undertaken. The modelling indicated that there would be a decrease in the levels of most nutrients at all sites, however, generally the decrease would be small and would have minor or negligible impacts.

Modelling of key toxicants during worst case RO reject water discharge in dry weather indicate that the increase in toxicant levels would be minor and are unlikely to have any impact.

More testing of RO reject water once the final design is completed would be needed to determine any other potential toxicity issues associated with chemicals used in the treatment process.

Aquatic Ecology

The aquatic ecology of the potentially impacted areas contains many important flora and fauna species including threatened species and ecologically important habitats such as seagrasses, salt marshes and mangroves. However, in the Hunter River estuary especially, there are significant pressures on the ecological health of aquatic communities due to land reclamation, stormwater runoff, point source pollution discharges, fishing, shipping and catchment development.

The main potential impact on aquatic ecology from the KIWS is from changes in water quality due the disposal of the RO reject water. As noted in **Section 5.2**, there would be a significant reduction in the load of pollutants discharged into the Hunter River estuary. Although there may be no measureable improvement in the health of the aquatic environment in the Hunter River estuary because other sources of impact are likely to be more significant, the KIWS would result in less potential for impacts compared with the existing situation.

At Burwood Beach, the pollutant loads would remain similar and would be below the current EPL load limits, except for nitrogen – and this is being addressed through the Marine Environmental Assessment Program and a review of treatment options. Therefore apart from potential impacts from increased nitrogen discharge, aquatic ecological impacts would not be greater that already assessed for relevant development and licensing approvals.

Terrestrial Ecology

There study area has been highly modified by industrial and urban development and consequently there are only small areas of remnant vegetation remaining. One EEC was identified as being potentially impacted by the Recycled Water Pipeline however it is isolated and small and has already been disturbed. With the careful location of the pipeline, further disturbance of this EEC would be avoided. No threatened flora, fauna and or migratory birds or their potential habitat would be impacted by the KIWS.

Cultural Heritage

The cultural heritage assessment found that there is only one remnant historic garden potentially impacted by the proposed development. This historic garden is separated from the proposed pipeline by a retaining wall and therefore no mitigation is required. Only one registered indigenous heritage site within 100 meters of the proposed pipeline was identified and this site has already been destroyed by the construction of the Tourle Street Bridge. Overall the KIWS does not pose any risk to the heritage.

Noise and Vibration

The majority of noise and vibration impacts would occur during construction of the KIWS. It was predicted that there would be exceedances of noise levels at times during the construction of the pipelines, however, these noise impacts would be temporary and mitigated by the intervening terrain and other noise sources e.g. major roads. Mitigation measures would be implemented to offset the adverse impacts of noise on the surrounding environment during construction.

Overall, the noise impacts from the operation of the KIWS would be minimal. Noise modelling indicates that IWP and associated infrastructure would comply with the individual noise allotments specified in the Steel River Strategic Impact Assessment Study and the overall noise limits from Industrial Noise Policy. Consequently the KIWS would be largely inaudible at the nearest sensitive receivers.

Air Quality

It was found that during construction disturbed soils may result in the generation of dust, especially in windy conditions. However, by ensuring that mitigation measures are followed during and after the construction there would be no significant impacts on the surrounding environment. There would be no air quality issues with the operation of the KIWS.

Energy and Greenhouse

The main impact on Hunter Water's greenhouse gas emissions would be from the operation of the Kooragang IWP. Allowing for a 30 % contingency in expected electricity use, operation of the proposed plant would increase Hunter Water's existing GHG emissions by 7% (i.e. an additional 5153.5 tCO_2-e per year). These emissions could be reduced or removed through the purchase of renewable energy, energy efficient building design and equipment selection, on-site power generation or through the purchase of carbon offsets. These management options would need to be explored during the detailed design phase. The MF/RO process is considered to be the most energy efficient and environmentally sustainable option for generating high quality water for the identified customers. Additionally, the proposal would avoid greenhouse gas generation associated with the production of 9 ML/day of potable water.

Soil Contamination and Waste

Small volumes of waste may be generated during the construction and operation of the KIWS. Where possible waste would minimised, recycled or reused. Waste requiring disposal would be classified using the Waste Classification Guidelines before being disposed off at an appropriately licensed facility.

Traffic and Access

The main impacts on traffic and access would be caused by activities associated with the construction of the pipelines especially as some pipelines would cross major arterial roads. Where pipeline crossings of major roads are proposed, underboring would be used to minimise traffic impacts. Other impacts caused during construction are temporary in nature and include increases in road traffic, road lane closures, disruption of pedestrian pathways, and loss of or disruption to property access.

Activities involved with the operation of the IWP and pipelines, including inspections and maintenance, would cause minimal disturbance to traffic and access. The IWP would only generate four additional trucks movement every week for chemical deliveries and approximately three additional light vehicle movements per day for operation and maintenance.

Mitigation measures would be implemented to minimise the impact of the proposed development on traffic and access during the construction including preparation and implementation of traffic management plans, consulting with property owners and the public on access being blocked or road closures in advance, and working with the RTA and NCC on the design and construction planning.

Hazardous Chemical and Dangerous Goods

An assessment using the SEPP 33 Guidelines was used to identify potential hazards during the operation of the KIWS. The production of industrial water at the IWP would require the use of chemicals, primarily to keep the membranes clean and operating efficiently. All of the chemicals used at the IWP are either Class 8 or not classified as dangerous goods and thus do not pose a major risk to explosion or fire. The volumes of chemicals stored would be below the SEPP33 screening level threshold and would be stored in facilities complying with Australian standards.

Human Health

The use of recycled water may pose a potential health risk to the users in the customers' facilities. The main human health risk associated with the non-drinking use of recycled water is from the presence of residual pathogens after treatment. An exposure and treatment risk assessment was undertaken to determine whether the proposed uses and treatment processes reduced the pathogens levels in the recycled water to acceptable levels. The risk assessment process was based upon *National Guidelines for Water Recycling: Managing Health and Environmental Risks* (2006). The risk assessment found the treatment process was sufficient to reduce the risk (based on it intended uses) to acceptable levels for indictor and persistent pathogens. Further validation of the treatment process is required once the scheme becomes operational.

Conclusion

Overall the construction and operation of the KIWS would not result in any significant long term environmental impacts on the cultural and natural environment. There may be some short term adverse effects from noise, dust, disturbance of soils and traffic impacts, however, these can be minimised through design, construction planning and standard construction management measures.

The impacts from the operation of the KIWS would be mostly be negligible with environmental aspects such as noise, traffic, waste, terrestrial flora and fauna, air quality and soils largely unaffected. However, operation of the KIWS would have some positive environmental benefits including:

- Saving up to 9ML/day of potable water; and
- Significant reduction in the load of pollutants discharged into the Hunter River estuary.

7. References

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DECCW (2008b) http://www.naturalresources.nsw.gov.au/estuaries/inventory/index_ns.shtml

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Matthei L. E. (1995) *Soil Landscapes of the Newcastle 1:100,000 Sheet: Allworth, Stockton, Maitland, Paterson*. Department of Land and Water Conservation, Sydney.

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NSW EPA (1994) *Service station sites: assessment & remediation*

RCA Australia (2008) *Geotechnical and Environmental Investigation Steel River Industrial Estate Mayfield West,* Prepared for Hunter Water Australia

Appendix A Clause 228 Factors

Clause 228 Factors	Description
a) any environmental impact on a community	The three main environmental impacts on the surrounding community are the noise created during construction, change in traffic and access patterns during construction, and the loss of amenity in the park. Noise, traffic and access impacts will be short term and temporary in nature.
b) any transformation of a locality	The IWP will transform the site by it construction however this is an existing commercial/ light industrial precinct
c) any environmental impact on the ecosystems of the locality	The majority of proposed pipeline routes will traverse along cleared disturbed lands which are generally devoid of habitat value for threatened flora and fauna species and estuarine and freshwater wetland communities. The pipeline routes will also avoid the fragmentation of vegetation and thus decrease the environmental impact. The reduction in discharge of pollutants into the Hunter River estuary would have a positive impact
d) any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality	There would be no long term reduction in the quality of the local environment. A small length of the reject water pipeline would be located in residential areas (including Stevenson Park and a residential street) and therefore there will be temporary loss of amenity for the local residents.
e) any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations	There are no items of aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance on or near the proposed site for the proposed IWP and pipeline systems.
f) any impact on the habitat or protected or endangered fauna (within the meaning of the *National Parks and Wildlife Act 1974*).	A very small area of Coastal Saltmarsh has the potential to be directly impacted from the proposed pipeline, west from the existing Tourle Street Bridge. However direct impacts to the threatened community have been minimised, as the pipeline would be placed along the existing raised trail. Indirect impacts such as increased weed growth would be avoided by appropriate management during and post construction of the pipeline.
g) any endangering of any species of animal, plant or other form of life whether living on land, in water or in the air	No threatened fauna or potential habitat for threatened fauna species was identified in the study area. Targeted surveys were conducted for the Green and Golden Bell Frog (*Litoria aurea*), however neither the species nor potential habitat was identified in or in the vicinity of the proposed development area.
h) any long-term effects on the environment	No long term detrimental effects on the environment are envisaged from the construction of KIWS. Some improvement in estuarine water quality is expected with the reduction in pollutant loads discharged into the Hunter River estuary

Clause 228 Factors	Description
i) any degradation of the quality of the environment	The operation of KIWS would not result in the degradation of the environment. There would be some minor temporary impacts associated with construction
j) any risk to the safety of the environment	The project does not pose a risk to the safety of the environment.
k) any reduction in the range of beneficial uses of the environment	There will be an improvement in the beneficial uses of the Hunter River estuary. Shortland WWTW has a higher level of treatment and more suspended pollutants will be captured before entering the Hunter River or the ocean.
l) any pollution of the environment	There would be a reduction in the pollution of the environment with the operation of the KIWS
m) any environmental problems associated with the disposal of waste	There are no environmental problems associated with the disposal of waste.
n) any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply	Once the IWP and pipeline system have been constructed there will be no increase in demand for resources. The only major resource that the Industrial Water Plant will require is the effluent from Shortland WWTW which is not likely to become short in supply.
o) any cumulative environmental effect with other or existing or likely future activities	There are not expected to be any significant cumulative impacts of the proposed development and any other known developments on the environment.
p) any impact on coastal processes and coastal hazards, including those under projected climate change conditions	The KIWS would not impact upon coastal processes or cause any additional coastal hazards

Appendix B Agency Consultation

SP&D
DW: 2286900
Phone 4974 2768

17 December 2008

D Cleary
Hunter Water Corporation
PO Box 5171
HRMC NSW 2310

Dear Mr Cleary

PROPOSAL: PROPOSED KOORAGANG INDUSTRIAL WATER SCHEME

I refer to the abovementioned proposal and your letter dated 26 August 2008 and apologise for the delaying in responding.

It is noted that Hunter Water Corporation are using the '*without development consent*' provisions under State Environmental Planning Policy (Infrastructure) and, as such, will undertake a Review of Environmental Factors (REF). In that context the following brief comments are made:

1. **Water Quality/Salt loads –** The discharging of the waste waters (i.e. with increased salt loads) would need to be addressed within the assessment.
2. **Amenity Impacts (Odour, Noise & Air Quality) –** The assessment needs to address the potential odour, noise and air quality impacts on both the nearby commercial/industrial receivers and also the residential areas.
3. **Strategic Impact Assessment Study (SIAS) –** The SIAS should be addressed including the noise, air and contamination reporting criteria. The Steel River estate has specific environmental control regimes which need to be considered.
4. **System Fail safes –** The assessment need to address what fail safe mechanisms will be included in the event that the system has a malfunction.

If you have any further enquiries please contact myself on 4974 2768.

Yours sincerely

Damian Jaeger
SENIOR DEVELOPMENT OFFICER – Newcastle City Council
CITY WEST

HW2006-3189|16|46

NSW MARITIME

Our Ref: **08/101**
Your Ref: HW2006-3189
Simon W Lawton – Manager Commercial Property & Assets
E-mail: slawton@maritime.nsw.gov.au
Direct: (02) 9364 2351
Mobile: 0418 55 4414
Fax: (02) 9364 2444

RECEIVED SEP 2008

26 September, 2008

Hunter Water Corporation
PO Box 5171
HRMC NSW 2310

Att: Mr Mark Gebhard

Dear Mr Gebhard,

Subject: Kooragang Industrial Water Scheme
Premises: Hunter River South Arm

I refer to your introduction letter dated 5th September 2008, regarding proposed works associated with the Kooragang Industrial Water Scheme, in particular the stage involving works crossing the Hunter River South Arm.

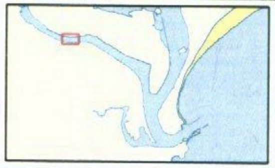
NSW Maritime wishes to advise that its boundary of landownership concludes just east of the vehicle bridge crossing Hunter River South Arm, as illustrated on the attached plan. Therefore we suggest that you refer this matter to the Department of Lands as the appropriate landowner.

I also wish to advise, that a copy of your letter has also been forwarded to NSW Maritime's Carrington office; Mr Charlie Dunkley – Regional Manager Hunter Inland, to consider what requirements need to be considered to ensure safe navigation is maintained during construction of the proposed Hunter River crossing. Mr Dunkley can be contacted on 4962 8517 should you wish to discuss further.

Please do not hesitate to contact me direct 9364-2351, if you have any query in relation to this letter or any other aspect regarding NSW Maritime's interests in this project.

Yours sincerely

Simon W Lawton
Manager,
Commercial Property & Assets
Maritime Property Division



NSW Maritime title boundary
Proposal

0 20 40 60 80 m

Plan compiled from information held in the Domestic Property & Geospatial Services Branch

Allan Gordon
Surveyor registered under the Surveying Act 2002

NSW MARITIME

CUSTOM PLAN

Hunter River South Arm

Date Produced: 24 September 2008

PLAN N^{0}:

HW2006-3189/5

Your reference : HW2006-3189/5
Our reference : DOC08/40681; LIC 07/1773
Contact : Rebecca Scrivener, 4908 6830

SCANNED 30 SEP 2008

Hunter Water Corporation
PO Box 5171
HRMC NSW 2310

Attn: Mr Mark Gebhardt

RECEIVED 19 SEP 2008

Dear Mr Gebhardt

RE: KOORAGANG INDUSTRIAL WATER SCHEME AND UPGRADE OF SHORTLAND WASTE WATER TREATMENT WORKS

I refer to your letter dated 26 August 2008 seeking the Department of Environment and Climate Change's (**DECC**) comments on, and requirements for, the preparation of a Review of Environmental Factors (**REF**) for the above proposal.

DECC attended a Risk Assessment workshop for this proposal on 5 August 2008. From this workshop and your letter, DECC understands the proposal to comprise:

- Installation of a UV disinfection system at Shortland Waste Water Treatment Works (**WWTW**);
- Establishment of an Industrial Water Treatment Plant (**IWTP**) at the Steel River Industrial Park, utilising chemical treatment, dual membrane treatment and reverse osmosis to produce water quality suitable for industrial processes;
- In dry weather, the transfer of a maximum of 12ML/day of treated effluent from Shortland WWTW (and initially the Burwood Beach catchment) to the IWTP and supply of 9ML/day of recycled water to Orica on Kooragang Island;
- During wet weather, the transfer of 12ML/day of treated effluent from Shortland WWTW to the IWTP. Any effluent in excess of 12ML/day, will be discharged to the Hunter River from Shortland WWTW (as is the current practice);
- The discharge of 3ML/day from the IWTP to the Hunter River, subject to detailed impact assessment. Discharge water will essentially be concentrated brine from the recycled osmosis plant; and
- The use of recycled water by Orica, principally in the cooling towers. DECC notes there will be no human consumption of the recycled water.

PO Box 488G, Newcastle NSW 2300
117 Bull Street, Newcastle West, NSW 2302
Tel: (02) 4908 6800 Fax: (02) 4908 6810
ABN 30 841 387 271
www.environment.nsw.gov.au

Department of **Environment and Climate Change** NSW

Key issues of concern identified by DECC at the Risk Assessment workshop included:

- The quality of water discharged to the Hunter River from both the IWTP and the end user(s), including Orica;
- The proposed pipeline route, in particular the potential to encounter contaminated material and impact habitat for *Litoria aurea* (Green and Golden Bell Frog – GGBF); and
- The construction of the IWTP at the 'Steel River' industrial subdivision, and the requirement to comply with planning and construction guidelines developed to avoid disturbance to contaminated material.

Accordingly, DECC advises these issues, together with matters identified below, be addressed in the REF.

1. Environment Protection Licences

The Shortland WWTW is regulated by DECC through conditions imposed on environment protection licence 1683, with discharges to the Hunter River occurring through licensed discharge point 19. Licence limits for discharge point 19 include pH, total suspended solids, biological oxygen demand and total volume.

Given the IWTP will be connected via pipeline to the Shortland WWTW and will be providing additional treatment to effluent, it is possible that the IWTP could be included as part of the premises within environment protection licence 1683. Alternatively HWC may choose to apply for a separate water discharge licence for the IWTP.

The REF should ensure that the proposed works will comply with the conditions of licence 1683 and/or identify any licence variations or additional licences required to permit the proposed upgrade works at Shortland WWTW and construction of the IWTP.

2. Air Quality

Sections 124-129 of the *Protection of the Environment Operations Act 1997* (**POEO Act**) prohibits air pollution. The REF should identify any works with the potential to produce air pollution, including dust and odour, and document measures that will be implemented to control identified impacts.

3. Noise Amenity

The potential noise impacts during the construction and operational phases of the proposal should be assessed in accordance with, and conform to, the *NSW Industrial Noise Policy* (EPA, 2000). HWC should also ensure appropriate community consultation processes are adopted where noise impacts may be experienced by the surrounding community.

4. Water and Land Pollution

Sections 120 and 142A of the POEO Act prohibit the pollution of waters and land respectively. The REF should provide sufficient information to demonstrate that the proposal can be undertaken in compliance with these requirements.

In particular, the REF should analyse the impacts of any discharge from the Shortland WWTW, the IWRP and end users (including Orica) on the receiving environment. Any analysis should take into consideration the guidance provided in the *Australian and New Zealand Fresh and Marine Water Quality Guidelines* (ANZECC 2000).

An issue raised at the Risk Assessment workshop was the concentration of nitrogen in the recycled water supplied to Orica. It is understood the recycled water will become concentrated in the cooling towers, increasing the concentration of nitrogen in the discharged water from the Orica site.

The REF should also consider if there is likely to be an impact on areas of native vegetation in accordance with the provisions of the *Native Vegetation Act 2003.*

The REF should consider in particular any impacts on habitat for the threatened species *Litoria aurea* (Green and Golden Bell Frog – GGBF) with respect to the proposed route for the recycled watermain across the Hunter River. If it is determined the proposed route will impact GGBF habitat, the REF should provide details on measures to avoid, mitigate or, where impacts are unavoidable, offset the potential loss or impacts on the GGBF at the site.

8. Areas of Significant Conservation Value

Where relevant, the REF should consider the potential direct and indirect impacts of the proposal on the protected area estate and/or areas of recognised high conservation value. The REF should describe mitigation measures that will be used to prevent, control or minimise any identified impacts on areas of high conservation significance.

If you require any further information regarding this matter please contact Rebecca Scrivener on 4908 6830.

Yours sincerely

12/09/08

JOSH GIBSON
Head Major Industry Unit
North East Branch
<u>Environment Protection and Regulation</u>

Our ref: CF08-165
Your Ref:EN02380

21 October 2008

Jonas Ball
SKM PO Box 164
St Leonards NSW 1590

Dear Sir

Re: New Kooragang Industrial Water Scheme and Upgrade to Shortland WTWW

Thank you for your letter of 23 September in relation to the upgrade and treatment scheme.

The Department has reviewed the information supplied and in addition to the information attached, would require the following information to be incorporated in the REF.

- The makeup of the discharged "saline Water" raises concerns as basically it's concentrated sewage effluent. Nutrient issues are probably of a lesser concern in relation to ecological impacts on the river, but the presence of toxicants in the effluent must be addressed.
- The potential impact of discharging higher salinity water in the estuary and its effect on the downstream migration of prawns. The balance between existing discharge and future discharge salinities needs to be addressed in relation to any potential to interrupt the migration of prawns and larval fish between the Hexham Swamp and the lower estuary.

For further information please contact me on 02 4916 3931.

Yours faithfully

Scott Carter
Senior Conservation Manager – Central

Matters to be Addressed

Definitions

The definitions given below are relevant to these requirements:

Fish means any part of marine, estuarine or freshwater fish or other aquatic animal life at any stage of their life history (whether alive or dead). This includes aquatic molluscs, crustaceans, echinoderms, worms, aquatic insect larvae and other macroinvertebrates .

Marine vegetation means any species of plant that at any time in its life must inhabit water (other than fresh water).

Waters refers to all waters including tidal waters as well as flowing streams, irregularly flowing streams, gullies, rivers, lakes, coastal lagoons, wetlands and other forms of natural or man made water bodies on both private and public land.

GENERAL REQUIREMENTS

- Area which may be affected either directly or indirectly by the development or activity should be identified and shown on an appropriately scaled map (1:25000) and aerial photographs.
- All waterbodies and waterways within the proposed area of development are to be identified.
- Description and maps of aquatic vegetation, snags, gravel beds and any other protected, threatened or dominant habitats should be presented. Description should include area, density and species composition.
- A survey of fish species should be carried out and results included. Existing data should be used only if collected less than 5 years previously.
- Identification of recognised recreational and commercial fishing grounds, aquaculture farms and/or other waterways users.
- Details of the location of all component parts of the proposal, including any auxiliary infrastructure, timetable for construction of the proposal with details of various phases of construction
- Aspects of the management of the proposal, both during construction and after completion, which relate to impact minimisation and site rehabilitation eg Environment Management Plans, Rehabilitation Plans, Compensatory offsets
- For each freshwater body identified on the plan, the plan should include, either by annotation or by an accompanying table, hydrological and stream morphology information such as: flow characteristics, including any seasonal variations, bed substrate, and bed width
- For each marine or estuarine area identified on the plan, the plan should include, either by annotation or by an accompanying table, hydrological and stream morphology information such as: tidal characteristics, bed substrate, and depth contours

DREDGING AND RECLAMATION ACTIVITIES

- Purpose of works
- Type(s) and distribution of marine vegetation in the vicinity of the proposed works
- Method of dredging to be used
- Timing and Duration of works
- Dimension of area of works including levels and volume of material to be extracted or placed as fill

Aquatic Habitat Protection
NSW Department of Primary Industries
Locked Bag 1
NELSON BAY NSW 2315

ABN 51 734 124 190
www.dpi.nsw.gov.au
Tel: 02 4982 1232
Fax: 02 4982 2306

- Nature of sediment to be dredged, including Acid Sulphate Soil, contaminated soils etc
- Method of marking area subject to works
- Environmental safeguards to be used during and after works
- Measures for minimising harm to fish habitat under the proposal
- Spoil type and source location for reclamation activities
- Method of disposal of dredge material
- Location and duration of spoil stockpiling, if planned

ACTIVITIES THAT DAMAGE MARINE VEGETATION
- Type of marine vegetation to be harmed
- Map and density distribution of marine vegetation
- Reasons for harming marine vegetation
- Methods of harming marine vegetation
- Construction details
- Duration of works/activities
- Measures for minimising harm to marine vegetation under the proposal and details of compensatory habitat development to replace lost vegetation.
- Method and location of transplanting activities or disposal of marine vegetation

ACTIVITIES THAT BLOCK FISH PASSAGE
- Type of activity eg works in a stream that change flow or morphological characteristics of the stream, including culvert and causeway construction, sediment and erosion control measures, stormwater diversion structures.
- Length of time fish passage is to be restricted, whether permanent or temporary
- Timing of proposed restriction. Should be timed to avoid interfering with migratory movements of fish.
- Remediation or compensatory works to offset any impacts

THREATENED SPECIES
- Threatened aquatic species assessment (Section 5c, EP&A Act 1979). This must be addressed even if there are no Threatened Species present on the site.
- Eight Part Test

FISHING AND AQUACULTURE
- Outline and document commercial, recreational and indigenous fishing activities that may be affected by the activity, including regular commercial fishing grounds, popular recreational fishing sites, recognised indigenous harvesting sites.
- Will the activity interfere with or cause an impact on the continuing operation and viability of nearby aquaculture or mariculture ventures.

2. Initial Assessment

A list of threatened species, endangered populations and endangered ecological communities must be provided. In determining these species, consideration must be given to the habitat types present within the study area, recent records of threatened species in the locality and the known distributions of these species.

In describing the locality in the vicinity of the proposal, discussion must be provided in regard to the previous land and water uses and the effect of these on the proposed site. Relevant historical events may include land clearing, agricultural activities, water abstraction/diversion, dredging, de-snagging, reclamation, siltation, commercial and recreational activities.

A description of habitat including such components as stream morphology, in-stream and riparian vegetation, water quality and flow characteristics, bed morphology, vegetation (both aquatic and adjacent terrestrial), water quality and tide/flow characteristics must be given. The condition of the habitat within the area must be described and discussed, including the presence and prevalence of introduced species. A description of the habitat requirements of threatened species likely to occur in the study area must be provided.

In defining the proposal area, discussion must be provided in regard to possible indirect effects of the proposal on species/habitats in the area surrounding the subject site: for example, through altered hydrological regimes, soil erosion or pollution. The study area must extend downstream and/or upstream as far as is necessary to take all potential impacts into account.

Please Note: Persons undertaking aquatic surveys may be required to hold or obtain appropriate permits or licences under relevant legislation. For example:

Fisheries Management Act 1994
- Permit to take fish or marine vegetation for research or other authorised purposes (Section 37)
- Licence to harm threatened (aquatic) species, and/or damage the habitat of a threatened species (Section 220ZW).

Animal Research Act 1985:
- Animal Research Authority to undertake fauna surveys.

It is recommend that, prior to any field survey activities taking place, those persons proposing to undertake those activities give consideration to their obligation to obtain appropriate permits or licences which may be required in the specific context of the proposed survey activities.

3. Assessment of Likely Impacts

The EIS must:
- describe and discuss significant habitat areas within the study area;
- outline the habitat requirements of threatened species likely to occur in the study area;
- indicate the location, nature and extent of habitat removal or modification which may result from the proposed action;
- discuss the potential impact of the modification or removal of habitat;
- identify and discuss any potential for the proposal to introduce barriers to the movement of fish species; and
- describe and discuss any other potential impacts of the proposal on fish species or their habitat.

For all species likely to have their lifecycle patterns disrupted by the proposal to the extent that individuals will cease to occupy any location within the subject site, the EIS must describe and discuss other locally occurring populations of such species. The relative significance of this location for these species in the general locality must be discussed in terms of the extent, security and viability of remaining habitat in the locality.

4. Ameliorative Measures

The EIS must consider how the proposal has been or may be modified and managed to conserve fisheries habitat on the subject site and in the study area.

In discussing alternatives to the proposal, and the measures proposed to mitigate any effects of the proposal, consideration must be given to developing long term management strategies to protect areas within the study area which are of particular importance for fish species. This may include proposals to restore or improve habitat.

Any proposed pre-construction monitoring plans or on-going monitoring of the effectiveness of the mitigation measures must be outlined in detail, including the objectives of the monitoring program, method of monitoring, reporting framework, duration and frequency.

In the event of a request for concurrence or consultation of the Director of NSW Department of Primary Industries, one (1) copy of the EIS should be provided to NSW Department of Primary Industries in order for the request to be processed.

It should be noted that the NSW Department of Primary Industries has no regulatory or statutory role to review draft EISs unless they are accompanied by or are requested as part of a licence application under Part 7A of the FM Act. However, NSW Department of Primary Industries is available to provide advice to consent and determining authorities regarding Fisheries' opinion as to whether the requirements have been met if requested, pending the availability of resources and other statutory priorities.

Useful Information
To help you in the preparation of an EIS, the publication "*Guidelines for the Assessment of Aquatic Ecology in EIA*" (Draft 1998) produced by the Department for Urban Affairs and Planning may prove useful in outlining appropriate procedures and methodologies for conducting aquatic surveys.

Appendix C Water Quality Modelling

Revised Hunter River Water Quality Modelling for the KIWS Project

Prepared For:	Hunter Water Corporation
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

Offices

Brisbane
Denver
Mackay
Melbourne
Newcastle
Perth
Sydney
Vancouver

DOCUMENT CONTROL SHEET

<table>
<tr><td rowspan="2">BMT WBM Pty Ltd
BMT WBM Pty Ltd
126 Belford Street
BROADMEADOW NSW 2292
Australia
PO Box 266
Broadmeadow NSW 2292

Tel: +61 2 4940 8882
Fax: +61 2 4940 8887

ABN 54 010 830 421

www.wbmpl.com.au</td><td>Document : R.N1419.002.00.docx
Project Manager : Luke Kidd</td></tr>
<tr><td>Client : Hunter Water Corporation
Client Contact: Rahul Chhillar
Client Reference</td></tr>
</table>

Title :	Revised Hunter River Water Quality Modelling for the KIWS Project
Author :	Luke Kidd / Emma Gale
Synopsis :	This report describes numerical modelling results obtained using the existing ELCOM-CAEDYM hydrodynamic and water quality model prepared by BMT WBM. Additional scenario modelling was undertaken to investigate potential water quality impacts of the proposed KIWS Project on receiving water quality within the Lower Hunter River Estuary.

REVISION/CHECKING HISTORY

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1 INTRODUCTION

Modelling investigations of receiving water quality were undertaken for the Kooragang Recycled Water Plant (KRWP) by BMT WBM in December 2008. The previous modelling assessment considered a dry weather period (October 1995) and wet weather period (May 2003) to model potential water quality impacts from discharge of treated wastewater from Shortland WWTW and reject water from the proposed KRWP into the Hunter River Estuary. Since then, HWC have revisited modelling investigations, reassessed available information and revised wastewater models to better define the quantity and quality of wet weather discharges that would occur from Shortland Waste Water Treatment Works (WWTW).

Although wet weather conditions during May 2003 were originally selected to represent the worst case scenario (occurring from significant coastal rainfall) within the Hunter River Estuary, these conditions modelled as modelled by Hunter Water Corporation (HWC), revealed that rainfall during May 2003 was insufficient to trigger diversion of reject water into the Hunter River. Based on the revised wastewater system modelling undertaken by HWC, only larger rainfall events are likely to trigger the diversion of reject water rather than periods of localised coastal rainfall. Furthermore, the revised wastewater modelling found that previous model inputs provided to BMT WBM significantly overestimate discharge volumes to the Hunter River during such wet weather conditions and that the Burwood Beach wastewater system would have sufficient capacity to receive reject water from the KIWS a large proportion of the time including most wet weather events.

Reassessment of previous modelling scenarios by HWC also found that discharge of reject water under dry weather conditions reflected potential operating conditions and provided an adequate estimate of potential water quality impacts on the Estuary. Consequently, any further consideration of dry weather impacts would not be required. The reassessment of potential worst case scenarios found that both the coastal rainfall scenario (i.e. May 2003) and another larger more significant rainfall event occurring during February 1990 should be further investigated to incorporate revised wastewater model and wet weather effluent quality data. Revision of water quality data was undertaken by SKM to provide improved estimates of wet weather treated wastewater quality to reflect expected water quality from the WWTW and proposed KIWS.

2 SUMMARY OF MODELLING APPROACH

2.1 Scope of Investigations

A hydrodynamic and water quality model of the Lower Hunter River Estuary was previously developed (please note that documentation of previous modelling investigations including details of model development, calibration and validation are presented within BMT WBM (2008)) using the Estuary Lake and Coastal Ocean Model (ELCOM) and the Computational Aquatics Ecosystem Dynamics Model (CAEDYM).

Using the existing numerical model and revised modelling data provided by HWC, a number of additional model scenarios (refer Section 2.2) were prepared to investigate potential impacts of the proposed KIWS. Based on the above background information and re-modelling of the proposed KIWS, a number of changes have been incorporated into the numerical model used to investigate receiving water quality. Noteworthy changes made to the ELCOM-CAEDYM include:

1. *Revised estimate of discharge volumes from Shortland and the KRWP*. Previously, the ELCOM-CAEDYM adopted flow data that overestimated discharge volumes directed to the Hunter River. Recent wastewater system modelling undertaken by HWC incorporates Burwood Beach wastewater treatment works to receive reject water from the KRWP for a large proportion of time. Improved estimate of flow data from Shortland WWTW and the KIWS have been incorporated within the additional model scenarios;
2. *Reassessment of a possible worst case scenario.* The previous wet weather period selected to represent a worst case discharge scenario within the Hunter River Estuary was based on significant coastal rainfall conditions, i.e. no rainfall within upper Hunter River catchment. The results of revised wastewater system modelling carried out by HWC, determined that a larger rainfall event (than that originally adopted) would be required to trigger diversion of KIWS reject water into the Hunter River Estuary. Accordingly, a separate additional rainfall period during February 1990 was identified by HWC which has been investigated as part of the revised water quality impact modelling assessment; and
3. *Improved estimate of wet weather treated wastewater quality* from Shortland WWTW based on review of water quality data undertaken by SKM.

2.2 Model Scenarios

Model scenarios were prepared to represent an existing base case condition and two future discharge scenarios for selected rainfall periods that correspond to ‘coastal rainfall’ occurring in May 2003 and substantial rainfall (moderate flood event) that occurred within the Hunter River Catchment during February 1990.

A total of six model scenarios were prepared using the existing ELCOM-CAEDYM for these two wet weather periods. A summary of the model scenarios considered by the investigation are summarised in Table 2-1.

Table 2-1 Wet Weather Model Scenarios

Wet Weather Period	Scenario	Discharge Condition	Discharge to Hunter River?	Reject Stream Operational?
May 2003 No major river inflows Mean tidal range Catchment Runoff	1	Base case (max 13.2 ML/day)	Yes	No
	2	Future Case (with no KIWS operational)	Yes	No
	3	Future Case (with KIWS operational)	Yes	No
February 1990 3 Major river inflows Mean tidal range Catchment runoff	4	Base case (max 13.2 ML/day)	Yes	No
	5	Future Case (with no KIWS operational)	Yes	No
	6	Future Case (with KIWS operational)	Yes	Yes

2.3 Model Configuration

Using the existing ELCOM-CAEDYM receiving water quality model, additional modelling was undertaken to investigate the impact of the Shortland WWTW and proposed KIWS adopting revised estimates of effluent discharge and wet weather water quality. A number of changes to model configuration were required to incorporate revised boundary condition data (e.g. daily WWTW discharge volumes and wet weather water quality). Additional timeseries data were also required to reflect meteorological conditions, river flow and contribution from local catchment runoff during the separate modelling periods.

A summary of boundary condition data applied to the ELCOM-CAEDYM model is provided in the following sections.

2.3.1 Meteorological data

Meteorological conditions for the selected time periods (i.e. February 1990 and May 2003) are applied to the full extent of the model to account for variations of air temperature, relative humidity, wind speed and direction, and solar radiation. Modelling previously undertaken by BMT WBM (2008) includes meteorological timeseries data for May 2003 and as such required no adjustment. However, historical timeseries data measured at Williamtown were obtained and incorporated within the model to reflect meteorological conditions for the additional wet weather period during February 1990.

2.3.2 Ocean tide

A representative mean ocean tide (i.e. without fortnightly spring / neap cycles) previously adopted by BMT (2008) was applied at the downstream extent of the model (i.e. Newcastle Harbour entrance) for both wet weather modelling periods. No change to downstream boundary conditions was required for the additional modelling scenarios.

2.3.3 Initial water quality conditions

Previous modelling by BMT WBM (2008) assigned initial water quality conditions using median concentrations reported by Sanderson and Redden (2001) for key water quality constituents (e.g. nitrate, ammonia, orthophosphate, and Total Kjeldahl Nitrogen) based on historical data collected within the Hunter River Estuary. Median concentrations for key parameters within these zones were again used to define initial (background) conditions within various parts of the Estuary for additional modelling scenarios.

2.3.4 River flow

River inflows provide a significant source of freshwater that act to transport constituents downstream through advection and dispersion processes. The nature of major river inflows is therefore an important process that influences water quality conditions within the Lower Hunter River Estuary. For the purposes of revised scenario modelling, wet weather conditions as a result of coastal rainfall conditions (i.e. Scenarios 1, 2 and 3) are likely to be associated with low flow conditions within the Hunter, Paterson or Williams River and as such river flow was excluded from the model. For the larger rainfall event occurring in February 1990 (i.e. Scenarios 4, 5 and 6) substantial river flow contribution from all three major rivers were applied to ELCOM-CAEDYM which are shown in Figure 2-1.

2.3.5 Local catchment runoff

Local contributing catchment runoff was estimated using the existing catchment model (WaterCAST) prepared for the Lower Hunter River catchment (see BMT WBM (2008)). The extents of the catchment model incorporate areas downstream of tidal extents on the three major rivers and was used to estimate local catchment runoff at a number of key locations including Ironbark Creek, Cottage Creek, Styx Creek, Purgatory Creek, Fullerton Cove, Fourteen Foot drain, Wallis Creek and Windeyers Creek. Results obtained from the catchment model including estimates of daily runoff volume, Total Suspended Solids (TSS), Total Nitrogen (TN) and Total Phosphorus (TP) were incorporated within the receiving water quality model for May 2003 and February 1990 in accordance with previous modelling assumptions outlined within BMT WBM (2008).

2.3.6 Treated wastewater discharge

Discharge from the WWTW at Raymond Terrace and Morpeth were included using outflow volumes measured by HWC during periods of higher discharge (indicative of wet weather conditions). In accordance with previous modelling assumptions contained in BMT WBM (2008), daily discharge volumes for the period 15 June to 15 July and 1 June to 1 July 2007 were adopted for the Raymond Terrace and Morpeth discharge locations respectively.

For the Shortland WWTW, timeseries of discharge at 15 minute intervals was provided by HWC to represent future discharge scenarios. Discharge data adopted for the existing (base case) scenarios included daily timeseries data for Shortland WWTW, which were previously adopted by BMT WBM (2008). Inflow data applied to the receiving water model consisted of the following:

- Existing (base case) flow conditions (adopted for Scenario 1 and 4);
- Modelled future flow conditions without proposed KIWS (Scenario 2 and 5);
- Modelled future flow conditions with the proposed KIWS operational without reject stream discharge (Scenario 3); and
- Modelled future flows with proposed KIWS and reject stream operational (Scenario 6).

A comparison of the daily discharges from Shortland WWTW is presented in Figure 2-2, and the daily KIWS reject stream discharge shown in Figure 2-3.

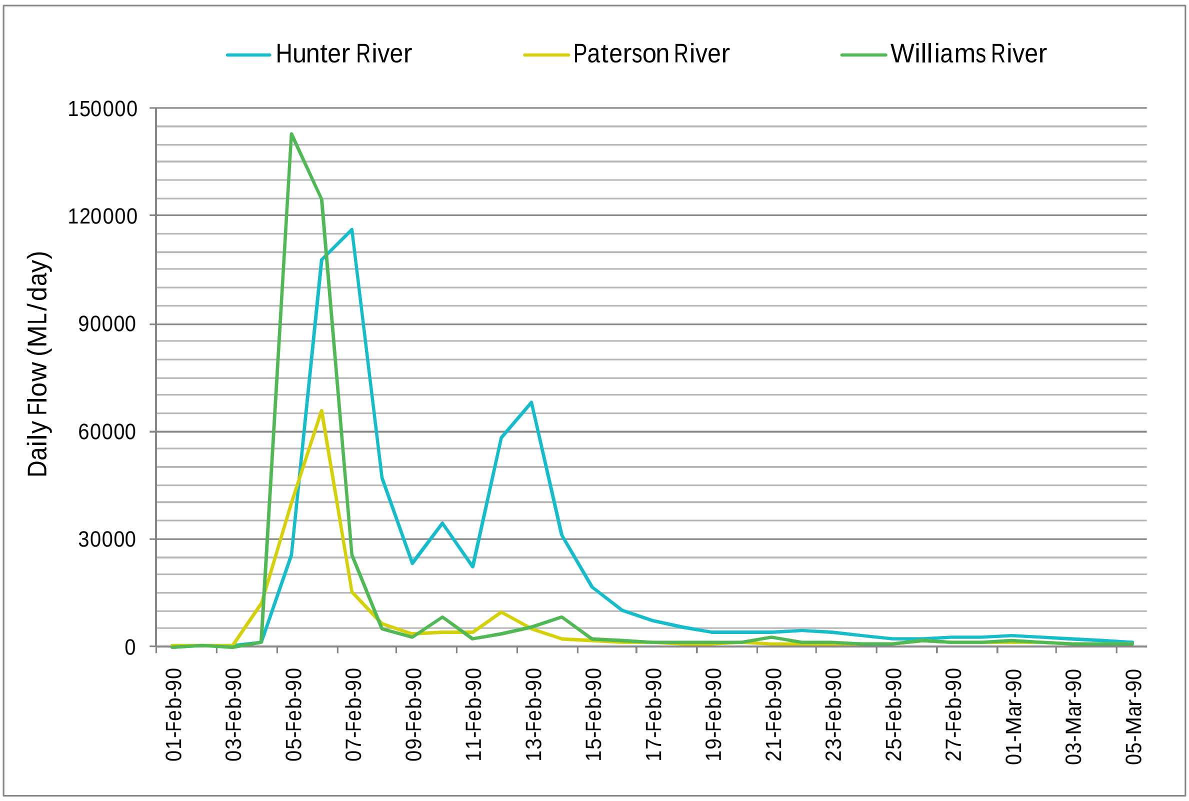

Figure 2-1 Daily River Flows During February 1990

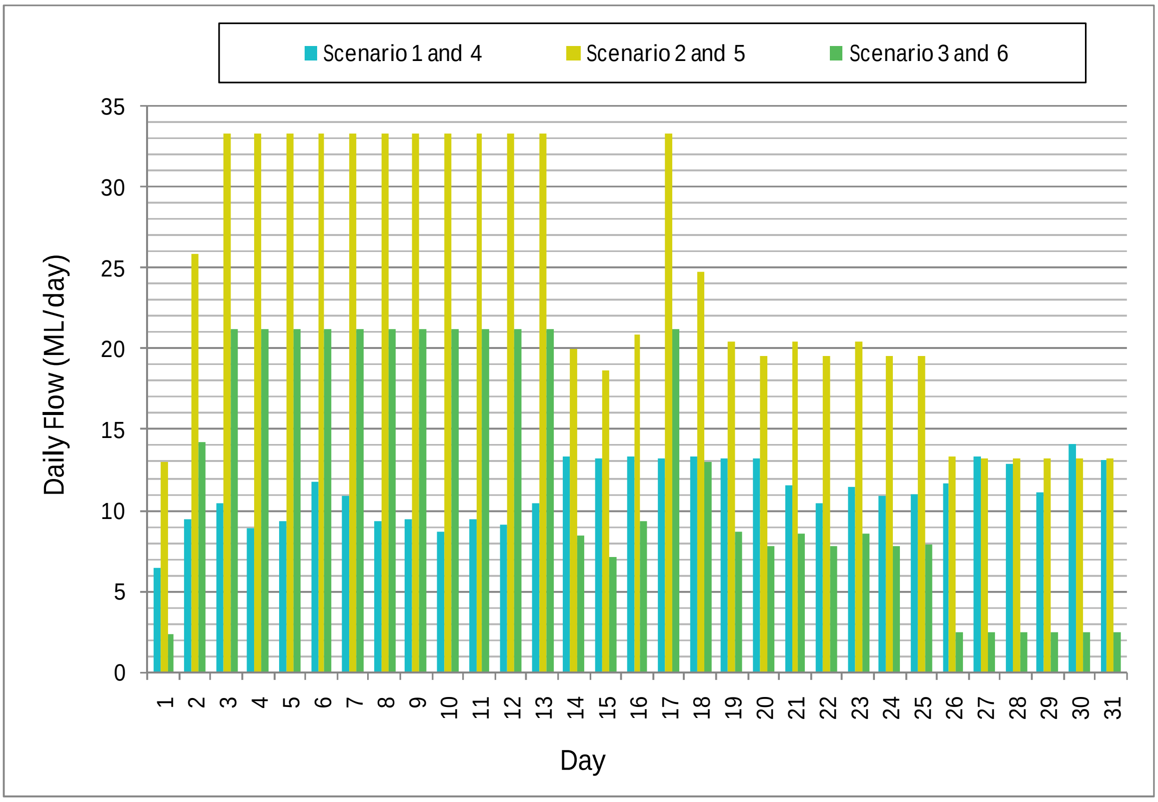

Figure 2-2 Shortland WWTW Discharge to Hunter River

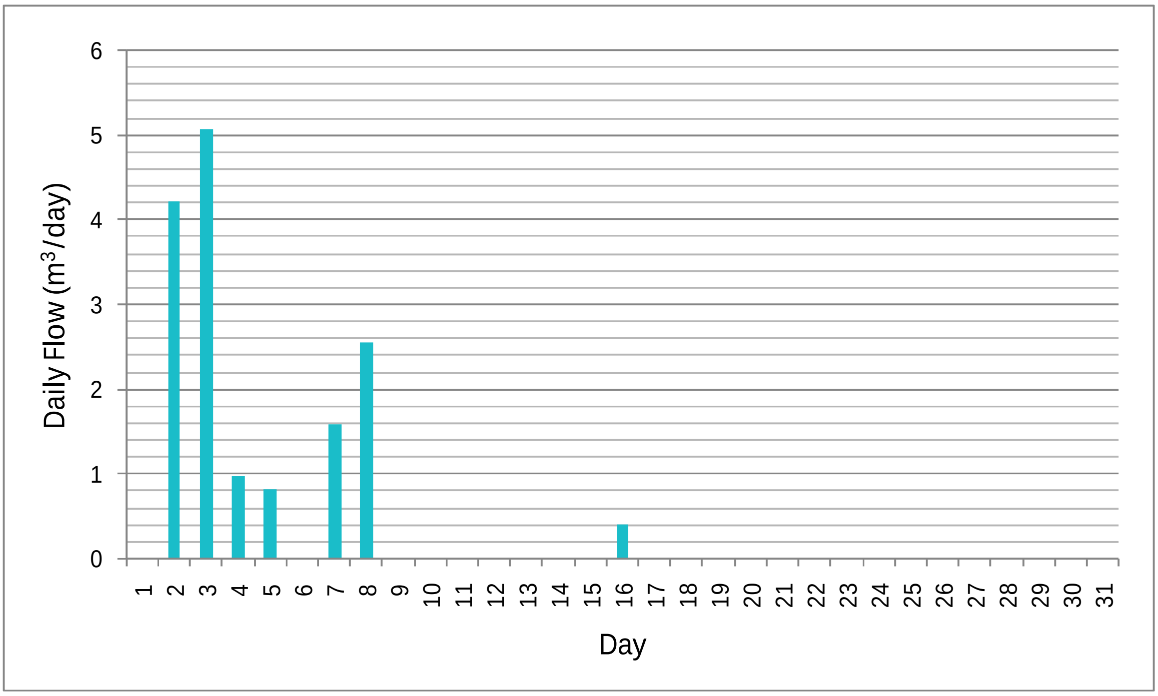

Figure 2-3 KIWS Reject Discharge to Hunter River (Scenario 6 only)

2.3.7 Treated wastewater quality

Disaggregation of TN and TP into various forms (e.g. nitrate, orthophosphate etc) is required for input to the CAEDYM model. Nutrient species modelled by CAEDYM including ammonia, nitrate and orthophosphate represent the most common forms of N and P present within a receiving waterbody. Revised estimates of wet weather treated wastewater quality provided by SKM were used to update expected operating conditions of the Shortland WWTW and KIWS reject stream. Revised wet weather treated wastewater quality estimates provided by SKM are presented in Table 2-2.

Table 2-2 Revised Wet Weather Treated Wastewater Quality

Discharge Stream	Total Phosphorous (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Total Oxidised Nitrogen (mg/L)	Ammonia (mg/L)	Total Nitrogen (mg/L)
Shortland WWTW	2.75	2.45	4.15	0.75	6.6
KIWS Reject[1]	11.0	27.0	45.7	3.0	26.4

[1] KIWS reject stream assumed to be 4 times more concentrated than Shortland WWTW discharge

In order to define the concentration of water quality constituents required for input to CAEDYM, a number of assumptions relating to the disaggregation of TP and TKN into sub species were required, which include:

- Total Phosphorus assumed to comprise 90% orthophosphate (PO4) and 10% organic phosphorus (DOPL);
- Total Oxidised Nitrogen assumed to be entirely present as nitrate (NO3); and
- Dissolved Organic Nitrogen (DONL) assumed to account for the difference between TKN and Ammonia (NH4).

The final discharge water quality (based on data provided by SKM and the assumed disaggregation of nutrients) for Shortland WWTW and KIWS reject streams as used by the CAEDYM are summarised in Table 2-3.

Table 2-3 Summary of Discharge Quality Adopted by CAEDYM

Discharge Stream	PO4	DOPL	TP	DONL	NH4	NO3	TN
Shortland WWTW	2.48	0.28	2.75	1.7	0.75	4.15	6.6
KIWS Reject	9.9	1.10	11.0	6.8	3.0	16.6	26.4

3 MODELLING RESULTS

3.1 Overview

Results of scenario modelling for the coastal rainfall event (May 2003) and flood rainfall event (February 1990) are presented within Section 3.2 and Section 3.3 respectively. Model results include prediction of Total Nitrogen (TN), nitrate (NO3), ammonium (NH4), Total Kjeldahl Nitrogen (TKN), Total Phosphorous (TP), orthophosphate (PO4) and marine diatoms (MDIAT).

The results for wet weather scenarios focus on presentation of timeseries for NO3, TKN, TN, PO4, TP and MDIAT at Railway Bridge to assess the immediate impact of WWTW discharges within the Hunter River South Arm. Model results were extracted at six reporting locations (refer Figure 3-1) as previously adopted by BMT WBM (2008). Results averaged over the last day of each simulation were used to provide an indication of relative difference between existing and future discharge scenarios at reporting locations.

3.2 Coastal Rainfall Event, May 2003

Model scenarios for May 2003 represent coastal dominated rainfall conditions within the lower Hunter River Estuary that include freshwater runoff contribution from local catchments. As summarised in Table 2-1, existing (base case) and future discharge scenarios (with and without the KIWS operational) are represented by Scenarios 1, Scenario 2 and Scenario 3 respectively.

Using modelled timeseries results extracted in the vicinity of the proposed point source discharge location (i.e. Railway Bridge), the overall trend predicted shows clear diurnal variation of nutrient concentrations associated with tidal exchange and flushing from the downstream marine dominated environment. Timeseries results for water quality constituents predicted at Railway Bridge are discussed further below.

TN concentrations (refer Figure 3-2) were highest for Scenario 2 (i.e. future case without KIWS), with a maximum of 0.6 mg/L around the 16 and 27 May. Maximum values for Scenario 3 (i.e. future case with KIWS operational) were approximately 0.5 mg/L, and consistently lower over the modelling period.

NO3 concentrations (refer Figure 3-3) were greatest for Scenario 2, with maximum values reaching 0.21 mg/L again around the 16 and 27 May. Nitrate concentrations predicted during the same period were less for Scenario 3 reaching a maximum concentration of approximately 0.16 mg/L.

TKN concentrations (refer Figure 3-4) show an overall decrease throughout the model simulation, for all three scenarios, with relatively minor increases occurring around the 16 and 27 May.

TP concentrations (refer Figure 3-5) include maximum concentrations of 0.14 mg/L for Scenario 2, while for Scenario 3 (i.e. with KIWS operational), TP concentrations are marginally lower than the existing scenario and future case scenario (i.e. without KIWS) with maximum concentration of approximately 0.10 mg/L.

Title:
Reporting Sites

Figure: **3-1**

Rev: **A**

N

0 3.75 7.5km

Approx. Scale

BMT WBM

www.wbmpl.com.au

Filepath : K:\N1651 Ramsar Wetland Modelling Investigations for Tillegra Dam\MI\Workspaces\DRG_018_100820 Reporting Sites.WOR

PO4 concentrations (refer Figure 3-6) follow a similar trend as TP concentrations noted above, with Scenario 2 producing higher concentrations than the base case and future case (i.e. with KIWS operational) discharge scenarios. A maximum concentration of approximately 0.10 mg/L was predicted for Scenario 2 and approximately 0.06 mg/L for Scenario 1 and Scenario 3.

The concentration of marine diatoms (refer Figure 3-7) did not vary considerably between scenarios. Sustained and rapid growth of marine diatoms was not predicted for any of the scenarios during the modelled period. Marginally higher concentrations of marine diatoms were predicted for Scenario 2 when compared to Scenario 1 and Scenario 3 results.

Results of water quality modelling results after 31 days of continuous model simulation are summarised in Table 3-1. The results show that the concentration of modelled constituents would increase under Scenario 2 conditions (i.e. future without KIWS) and decrease under Scenario 3 conditions (i.e. future with KIWS operational) relative to baseline conditions (i.e. Scenario 1). Overall, results indicate that the concentration of constituents within the South Arm were considerably less than other reporting locations within the North Arm and upstream of Hexham Bridge.

Results for TN show increases of up to 5% (relative to the base case existing scenario) for the majority of locations (except the South Arm reporting location) under Scenario 2 (without KIWS) discharge conditions. Under Scenario 3 (with KIWS) discharge conditions, results show a decrease for all reporting locations with a maximum of difference of 6% at Railway Bridge relative to the base case scenario.

Results for NO3 show the largest increase (approximately 10%) relative to the base case scenario would occur under Scenario 2 (without KIWS) discharge conditions at Railway Bridge. Relative differences of NO3 concentrations were smaller for other reporting locations upstream and downstream of the discharge location. Under Scenario 3 discharge conditions (with KIWS operational), there would be a maximum decrease of approximately 12.7% at Railway Bridge relative to the base case scenario.

Results for TKN show at all reporting locations there would be an increase of between 1% and 2% under Scenario 2 (without KIWS) discharge conditions and a decrease of between 1.5% and 3.5% and Scenario 3 (with KIWS operational) discharge conditions.

With the exception of results predicted for the South Arm reporting location, results for TP show that there was an increase of between 8% and 10% under Scenario 2 (without KIWS) discharge conditions and a decrease of between 6% and 13% under Scenario 3 (with KIWS operational).

Results for PO4 reveal the largest increase relative to the base case (i.e. Scenario 1) would occur under Scenario 2 (without KIWS) discharge conditions with an increase of between 15% and 18% at upstream locations including Second Bend, Hexham, North Arm and Railway Bridge. Similarly, the largest decrease in PO4 concentration (approximately 20%) was predicted to occur under Scenario 3 (with KIWS operational) discharge conditions when compared to existing base case conditions.

Results for marine diatoms show a small increase typically between 1% and 2% for Scenario 2 (without KIWS) at all reporting locations. A decrease of between 1% and 3% was predicted under Scenario 3 (with KIWS) discharge conditions with greater change (relative to the base case) typically occurring at upstream reporting locations.

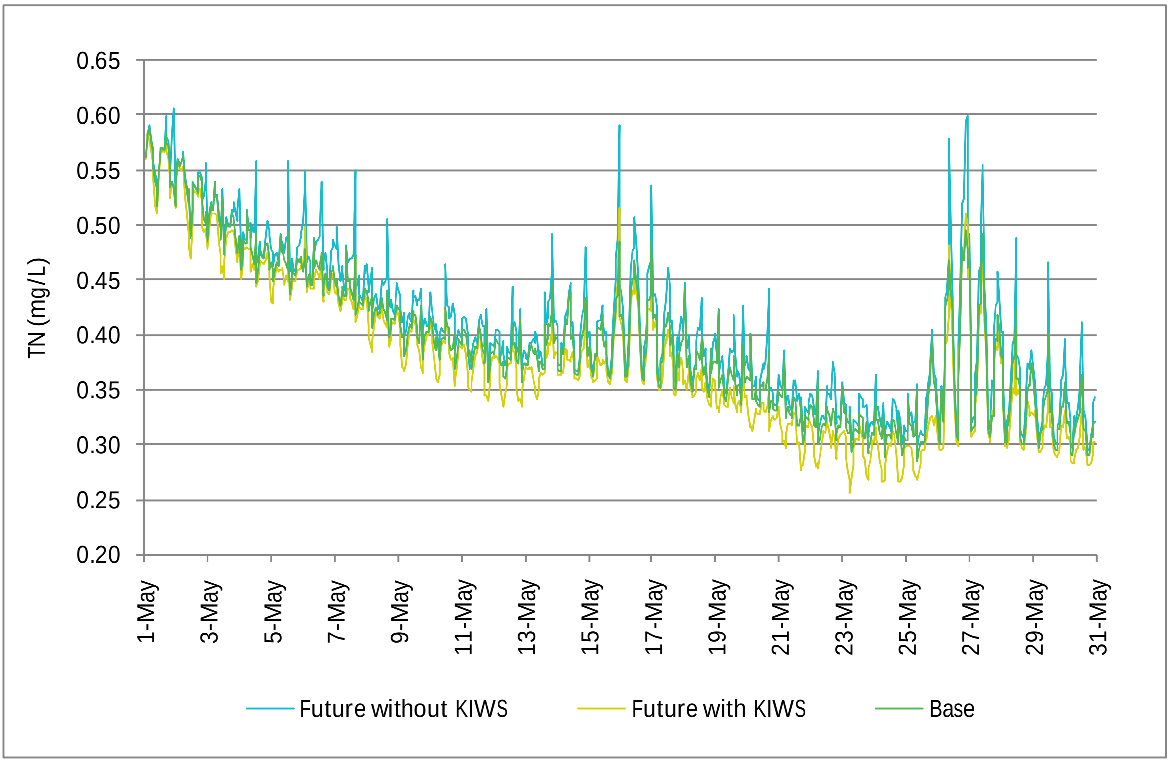

Figure 3-2 TN concentration at Railway Bridge, South Arm (May 2003)

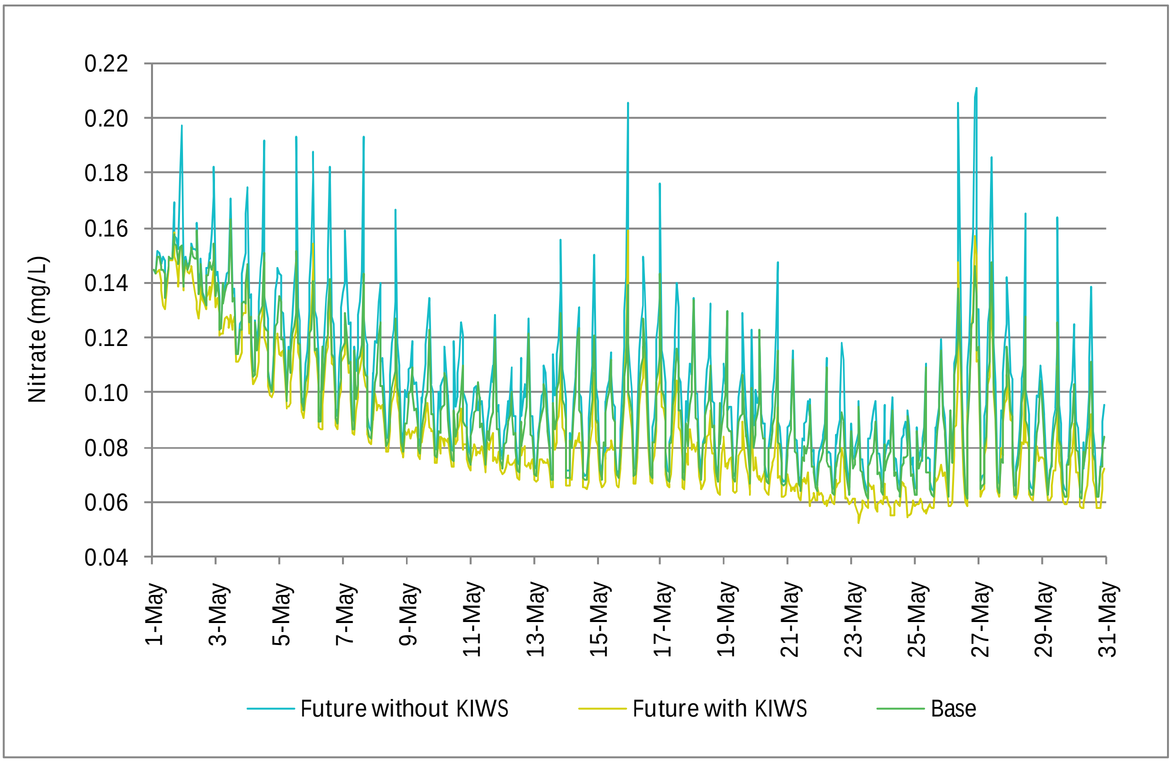

Figure 3-3 NO3 concentration at Railway Bridge, South Arm (May 2003)

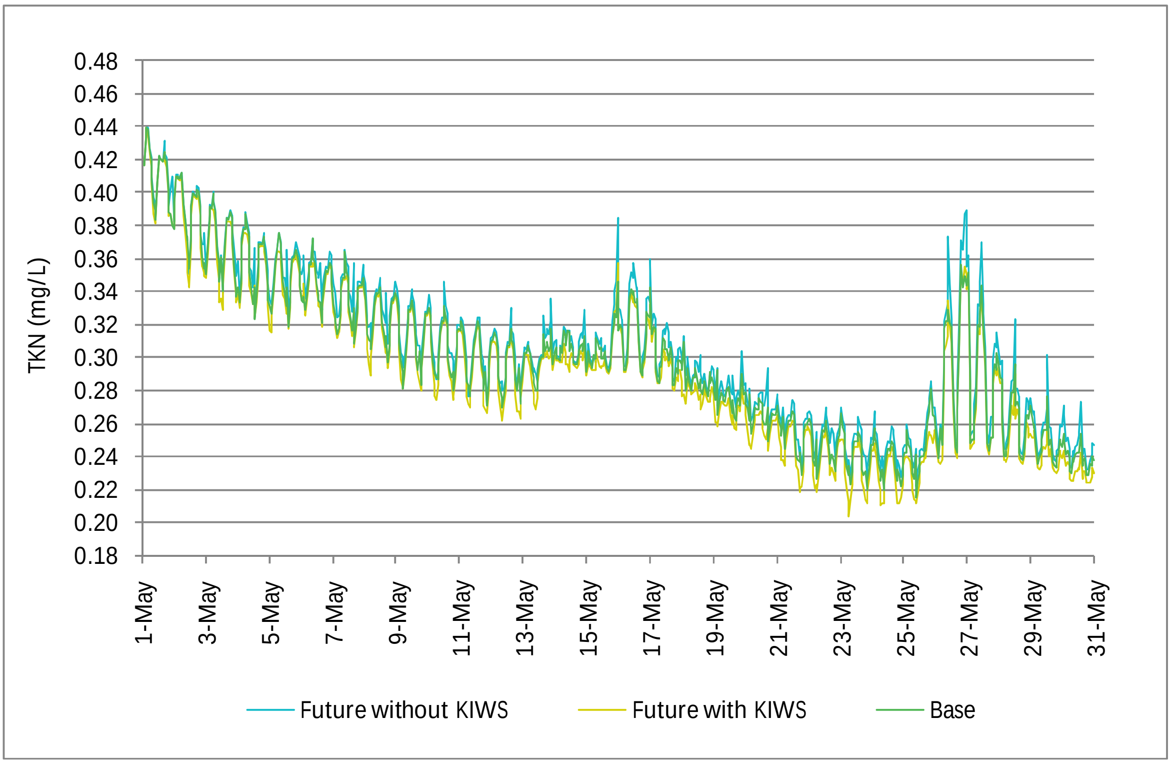

Figure 3-4 TKN concentration at Railway Bridge, South Arm (May 2003)

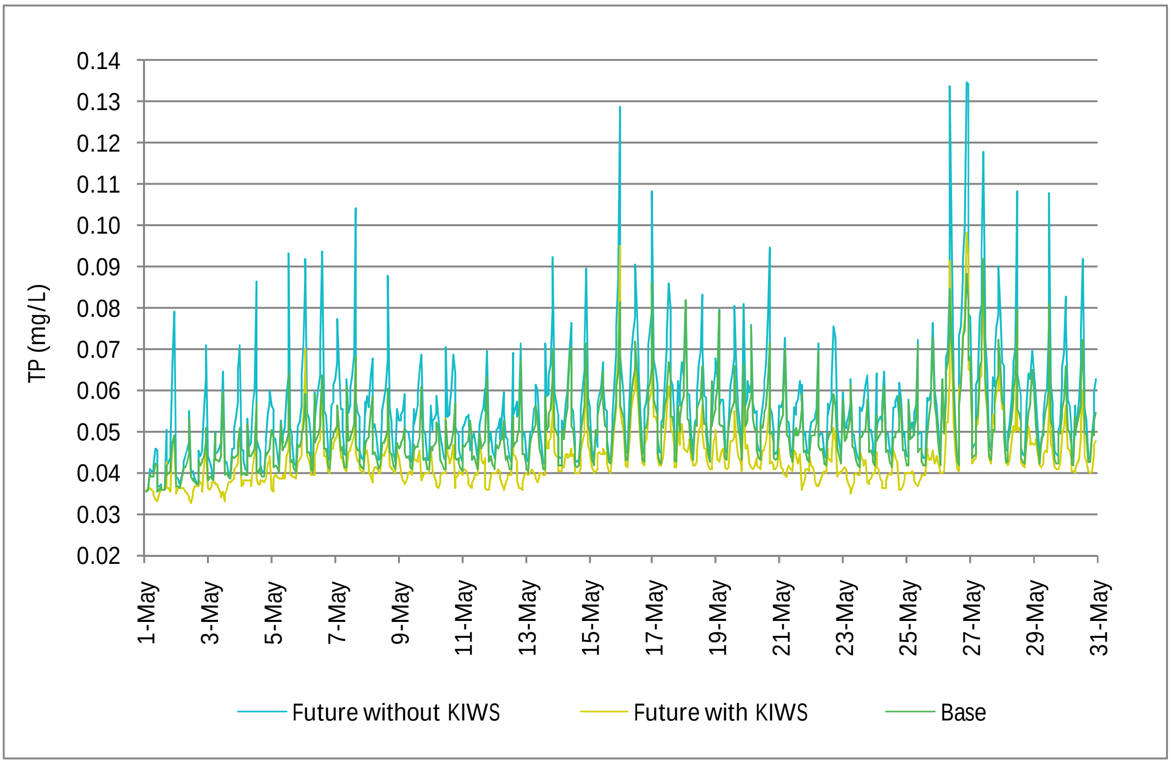

Figure 3-5 TP concentration at Railway Bridge, South Arm (May 2003)

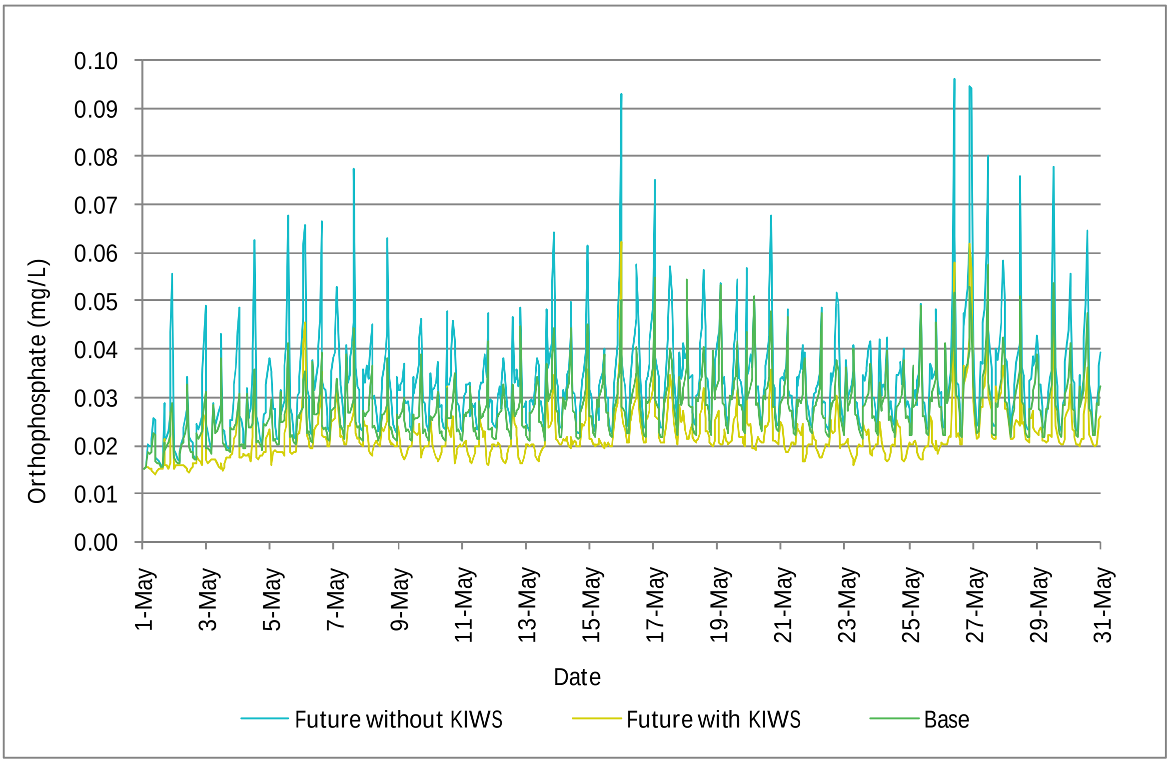

Figure 3-6 PO4 concentration at Railway Bridge, South Arm (May 2003)

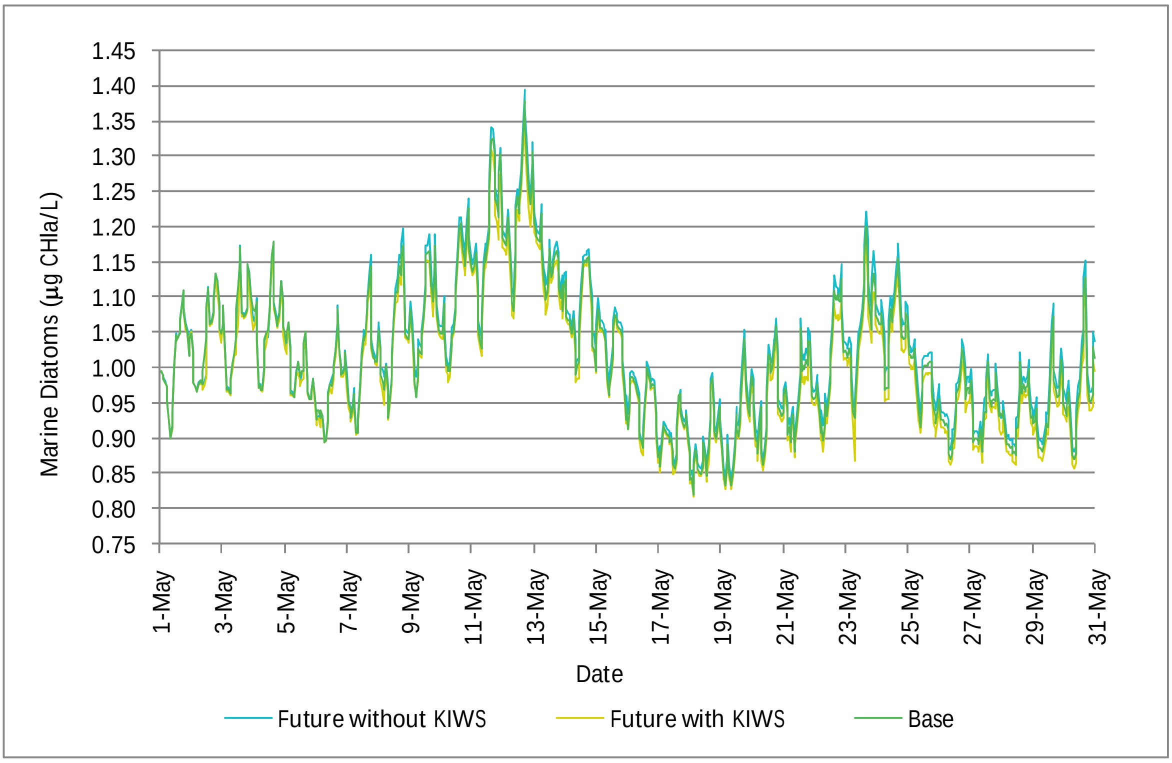

Figure 3-7 Marine diatom concentration at Railway Bridge, South Arm (May 2003)

Table 3-1 Summary of Water Quality Results, May 2003

Location	Parameter	Scenario 1	Scenario 2		Scenario 3	
		Average*	Average*	% Difference	Average*	% Difference
Second Bend	NO3 (mg/L)	0.11	0.11	6.2	0.10	-7.5
	TKN (mg/L)	0.28	0.29	1.9	0.28	-1.5
	TN (mg/L)	0.39	0.40	3.0	0.37	-3.2
	PO4 (mg/L)	0.03	0.03	14.8	0.02	-17.1
	TP (mg/L)	0.05	0.06	8.5	0.05	-9.2
	MDIAT (µg Chla/L)	1.14	1.16	1.8	1.11	-2.4
First Bend	NO3 (mg/L)	0.10	0.11	7.1	0.09	-6.9
	TKN (mg/L)	0.28	0.29	2.1	0.28	-1.5
	TN (mg/L)	0.39	0.40	3.4	0.38	-2.9
	PO4 (mg/L)	0.03	0.03	16.3	0.02	-15.2
	TP (mg/L)	0.05	0.06	9.3	0.05	-8.2
	MDIAT (µg Chla/L)	1.13	1.15	1.8	1.10	-2.3
Hexham	NO3 (mg/L)	0.09	0.10	8.8	0.09	-6.3
	TKN (mg/L)	0.28	0.29	2.5	0.27	-1.7
	TN (mg/L)	0.37	0.39	4.1	0.36	-2.9
	PO4 (mg/L)	0.03	0.03	18.6	0.02	-13.1
	TP (mg/L)	0.05	0.06	10.7	0.05	-7.4
	MDIAT (µg Chla/L)	1.10	1.12	1.9	1.08	-2.0
Railway Bridge	NO3 (mg/L)	0.08	0.09	10.4	0.07	-12.8
	TKN (mg/L)	0.24	0.24	2.8	0.23	-3.4
	TN (mg/L)	0.32	0.33	4.6	0.30	-5.7
	PO4 (mg/L)	0.03	0.03	16.6	0.02	-20.0
	TP (mg/L)	0.05	0.06	11.0	0.04	-13.2
	MDIAT (µg Chla/L)	0.97	0.98	1.6	0.95	-1.6
North Arm	NO3 (mg/L)	0.08	0.09	8.6	0.08	-5.7
	TKN (mg/L)	0.25	0.26	2.4	0.25	-1.9
	TN (mg/L)	0.33	0.35	3.9	0.32	-2.8
	PO4 (mg/L)	0.02	0.03	17.2	0.02	-11.1
	TP (mg/L)	0.05	0.05	9.9	0.04	-6.7
	MDIAT (µg Chla/L)	1.04	1.05	1.8	1.02	-1.8
South Arm	NO3 (mg/L)	0.05	0.06	0.9	0.05	-1.8
	TKN (mg/L)	0.22	0.23	1.0	0.22	-1.7
	TN (mg/L)	0.28	0.28	1.0	0.27	-1.7
	PO4 (mg/L)	0.02	0.02	1.5	0.02	-2.7
	TP (mg/L)	0.04	0.04	1.5	0.04	-2.3
	MDIAT (µg Chla/L)	0.88	0.89	1.2	0.87	-1.2

* average concentration over the last day of the simulation

3.3 Flood Rainfall Event, February 1990

Model scenarios for February 1990 represent a substantially 'wetter' period (compared to the May 2003 rainfall period) with considerable freshwater contribution from river and local catchments. The large rainfall event and associated flood flow conditions that occurred at the start of February correspond to a significant decrease to salinity at Railway Bridge between the 4 February and 15 February as shown in Figure 3-8.

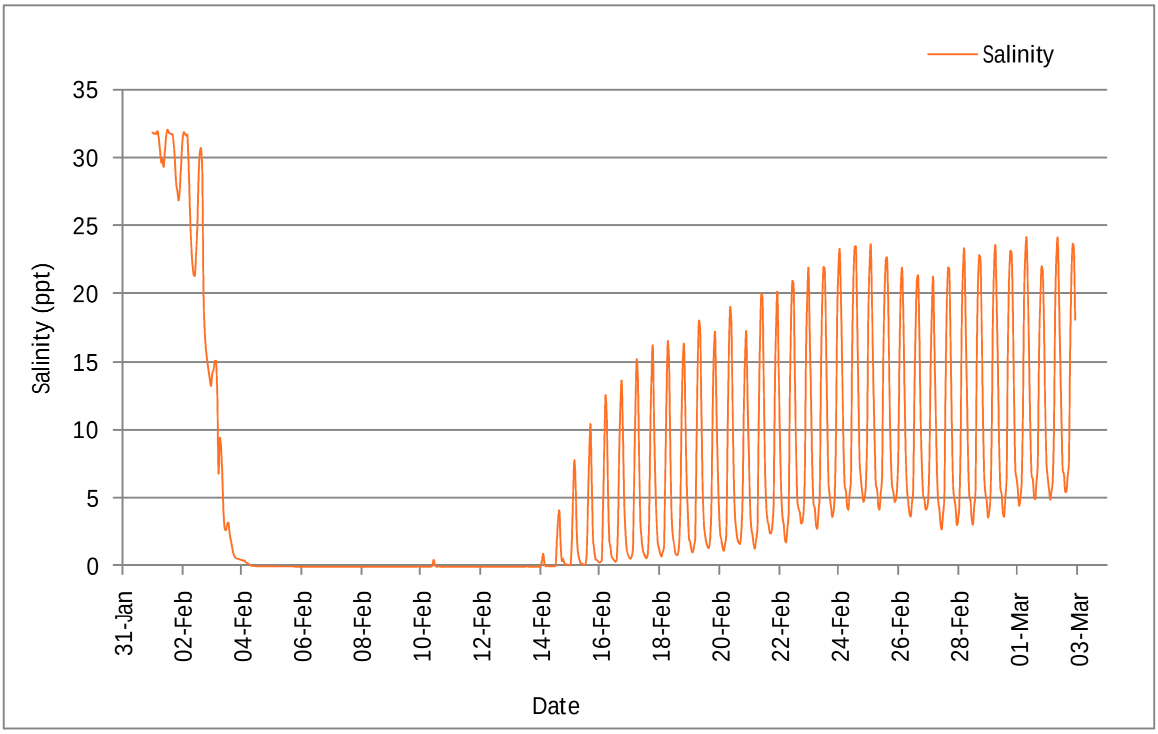

Figure 3-8 Salinity Concentration at Railway Bridge, South Arm (February 1990)

As summarised in Table 2-1, the existing (base case) and future discharge scenarios (without KIWS) and (with KIWS and reject stream operational) under February 1990 wet weather conditions are represented by Scenarios 4, Scenario 5 and Scenario 6 respectively.

Overall, model results for nutrients show a spike in concentration prior to floodwaters entering the South Arm of the Hunter River. Following the initial concentration spike, which is related to nutrient contribution from upstream catchment runoff sources, results show a gradual decrease in nutrient concentration within the main river channel associated with turbulent mixing and dilution caused by increased advection and net downstream transport of freshwater toward the discharge location. Following the high flow event, the influence of downstream tidal conditions were re-established as diurnal variation in water quality associated with tidal mixing processes during flood and ebb tides. Timeseries results for water quality constituents predicted at Railway Bridge are discussed further below.

TP results (refer Figure 3-9) show higher concentrations were predicted under Scenario 5 (without KIWS) discharge conditions, and lower concentrations for Scenario 6 (with KIWS operational) relative to the base case (i.e. Scenario 4). For all model scenarios, TP concentration was predicted to increase on the 3 February as a result of local contributing runoff from sources upstream of the discharge location. A maximum concentration of approximately 0.21 mg/L was predicted under

Scenario 5 (without KIWS) discharge conditions. For the remainder of the modelling period, however, TP concentrations typically varied between 0.05 mg/L and 0.12 mg/L under tidal dominated conditions. TP concentrations under future discharge conditions without the proposed KIWS (i.e. Scenario 5) are consistently higher than concentrations predicted under existing (i.e. Scenario 4) and proposed KIWS (i.e. Scenario 6) discharge conditions. Overall, the concentration of TP with the proposed KIWS was marginally higher than existing base case conditions but considerably less than Scenario 5 (refer to period between 7 February and 14 February), which corresponds to a period where the reject stream was operational and WWTW discharge volumes were greater. However, during the period between 18 February and 4 March, TP concentrations for Scenario 6 (with KIWS operational) show lower concentrations relative to the baseline concentrations (i.e. Scenario 4) as a result of lower discharge volumes from Shortland WWTW and the absence of reject stream inputs (refer Figure 2-3).

Similarly, PO4 concentrations (refer Figure 3-10) show a similar trend to TP predictions outlined above. A common increase was predicted for all three model scenarios on 3 February where PO4 concentration reached a maximum concentration of approximately 0.08 mg/L followed by a gradual decrease over the next 4 days. Concentration spikes in PO4 were predicted under Scenario 5 (without KIWS) discharge conditions, with maximum concentrations of between 0.11 mg/L to 0.13mg/L. Orthophosphate concentration predicted under Scenario 6 (with KIWS operational) reveal similar spikes although concentrations were typically 0.02 mg/L less than those predicted under Scenario 5 discharge conditions.

TN results (refer Figure 3-11) show the variation between modelled scenarios to be relatively minor. A common spike occurring on the 3 February was predicted for all three scenarios with concentrations reaching approximately 1.6 mg/L. For the remainder of the simulation, TN concentrations were considerably less and typically varied between 0.85 mg/L and 1.25 mg/L. The difference in TN concentration between scenarios was less than 0.1 mg/L over the modelling period.

TKN concentrations (refer Figure 3-12) show a similar trend to TN predictions outlined above. A spike in concentration of approximately 1.17 mg/L was predicted on the 3 February with concentration typically between 0.75 mg/L and 0.9 mg/L for the remainder of the modelling period. Overall, minor variation in TKN concentration was predicted between model scenarios. However, future discharge conditions without KIWS (i.e. Scenario 5) were predicted to result in higher concentrations relative to those predicted under existing (i.e. Scenario 4) and future discharge conditions with KIWS operational (i.e. Scenario 6).

NO3 concentrations (refer Figure 3-13) show a maximum peak concentration of approximately 0.42 mg/L predicted for Scenario 5 (without KIWS) between 3 and 4 February. NO3 concentration was predicted to increase gradually until the 8 February when diurnal variations caused by tidal exchange processes are re-established after the initial flood flow event. For the duration of the modelling period, NO3 concentration predicted for Scenario 5 (without KIWS) were typically 0.02 mg/L to 0.06 mg/L higher than the base case (i.e. Scenario 4). During the model period, NO3 concentration predicted for Scenario 6 (with KIWS operational) were less than Scenario 5 discharge conditions even under discharge conditions where the concentrated reject stream was operational (e.g. 7 to 13 February). NO3 concentrations predicted for Scenario 6 during periods when the reject stream was not operational were predicted to be similar an in some cases less than that predicted under existing discharge conditions (i.e. Scenario 4), which is clearly evident in the last 5 day of model results.

The concentration of marine diatoms (refer Figure 3-14) did not vary considerably between scenarios. Sustained and rapid growth of marine diatoms was not predicted for any of the scenarios during the modelled period. Differences predicted between model scenarios are considered negligible and sensitive to upstream flow conditions rather than discharge water quality at Railway Bridge.

The results of water quality modelling results after 31 days of continuous model simulation are summarised in Table 3-2. The average constituent concentration over the last tidal cycle of the modelling period show minor variation between future and the base case scenarios, with no significant increase to nutrient concentrations under Scenario 5 (without KIWS) or Scenario 6 (with KIWS operational) discharge conditions.

TN results show minimal change at reporting locations under base case and future discharge conditions. The only noteworthy change was a 2% decrease at the Railway Bridge for Scenario 6 (with KIWS operational). For all other combinations of reporting location and future discharge scenarios there was less than 1% change relative to the base case (i.e. Scenario 4).

NO3 results for Scenario 6 (with KIWS operational) show a decrease (relative to existing discharge conditions) at South Arm and Railway Bridge of approximately 8% and 1.5% respectively. For all other reporting locations and future model scenarios there was less than 1% change relative to the base case scenario. TKN results also show minimal change between future and existing discharge scenarios.

TP results show minor change at Railway Bridge with a decrease (relative to existing discharge conditions) of approximately 1.4% for Scenario 5 (without KIWS) and approximately 16% for Scenario 6 (with KIWS operational). Other notable changes include a relative decrease of approximately 1.5% within the North Arm under Scenario 6 discharge conditions. For all other combinations of reporting location and future scenario there was less than 1% change relative to the base case scenario.

PO4 results show a minor change to concentration at Railway Bridge with decrease of approximately 2% for Scenario 5 (without KIWS) and a more substantial change of approximately 21% for Scenario 6 (with KIWS operational). For all other combinations of reporting location and future scenario there was less than 1% change relative to the base case scenario.

Results for marine diatom concentration show that for all combination of reporting location and future scenario there was less than 1% change relative to the base case (i.e. Scenario 4).

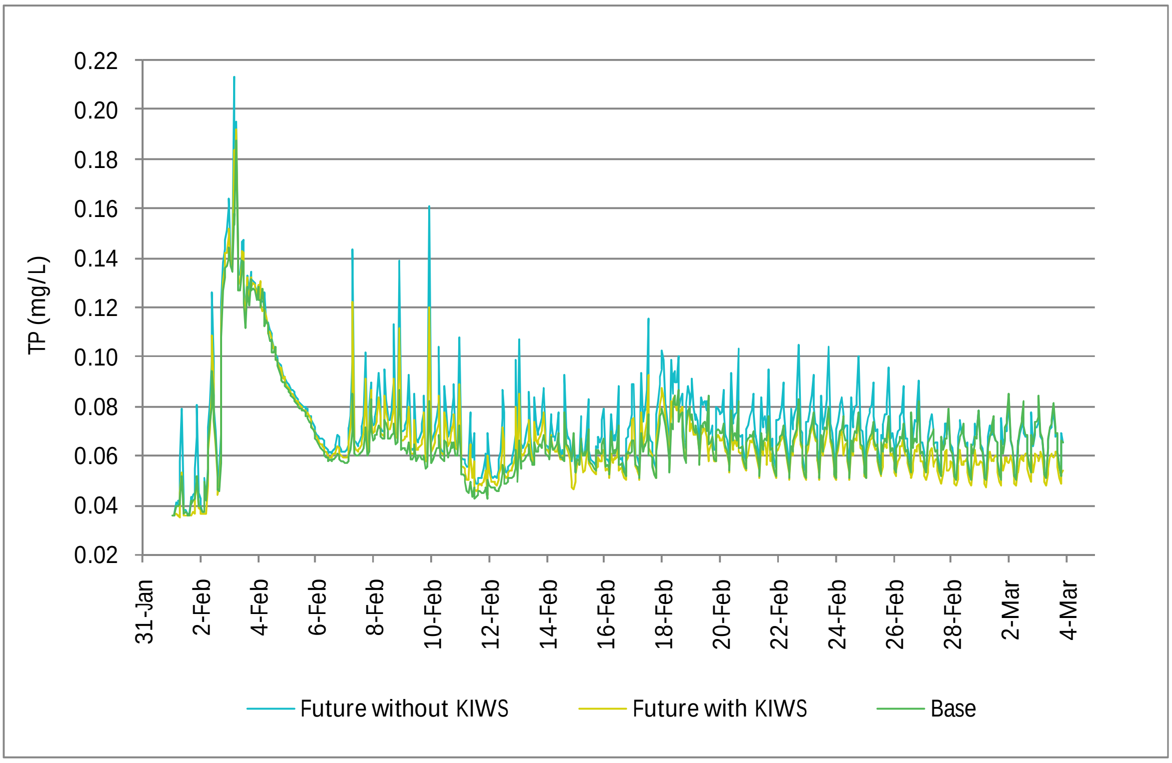

Figure 3-9 TP Concentration at Railway Bridge, South Arm (February 1990)

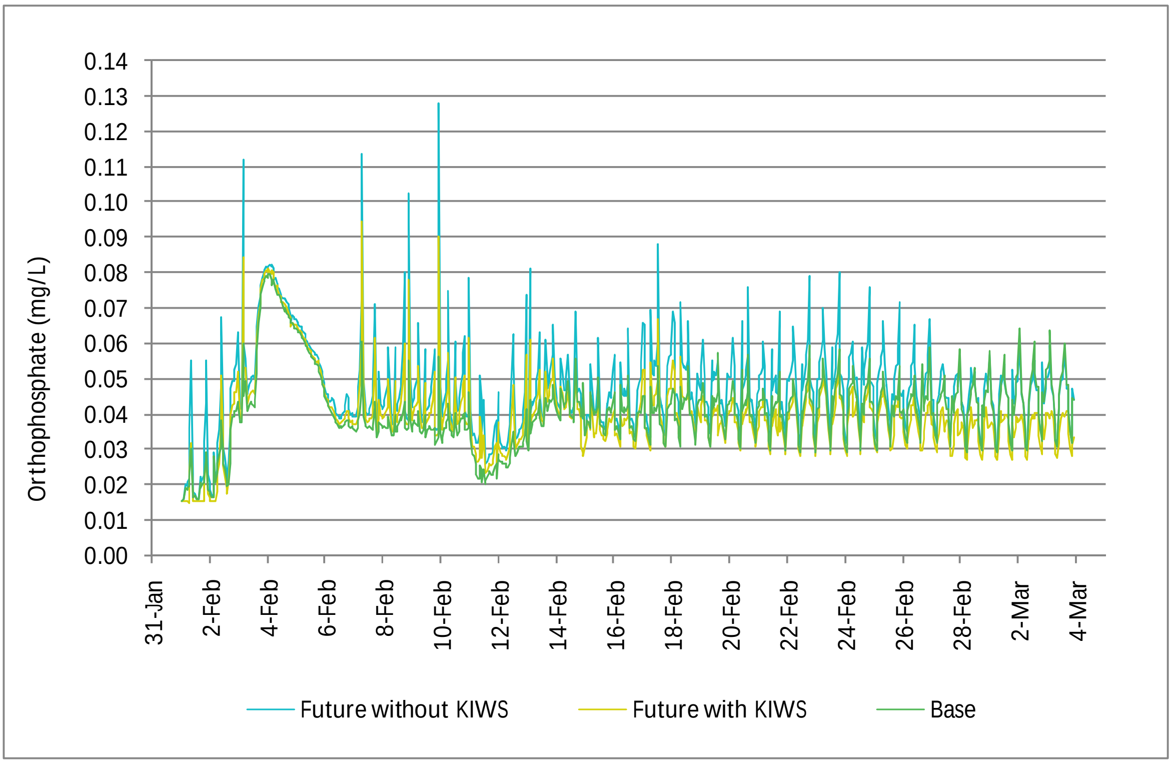

Figure 3-10 PO4 Concentration at Railway Bridge, South Arm (February 1990)

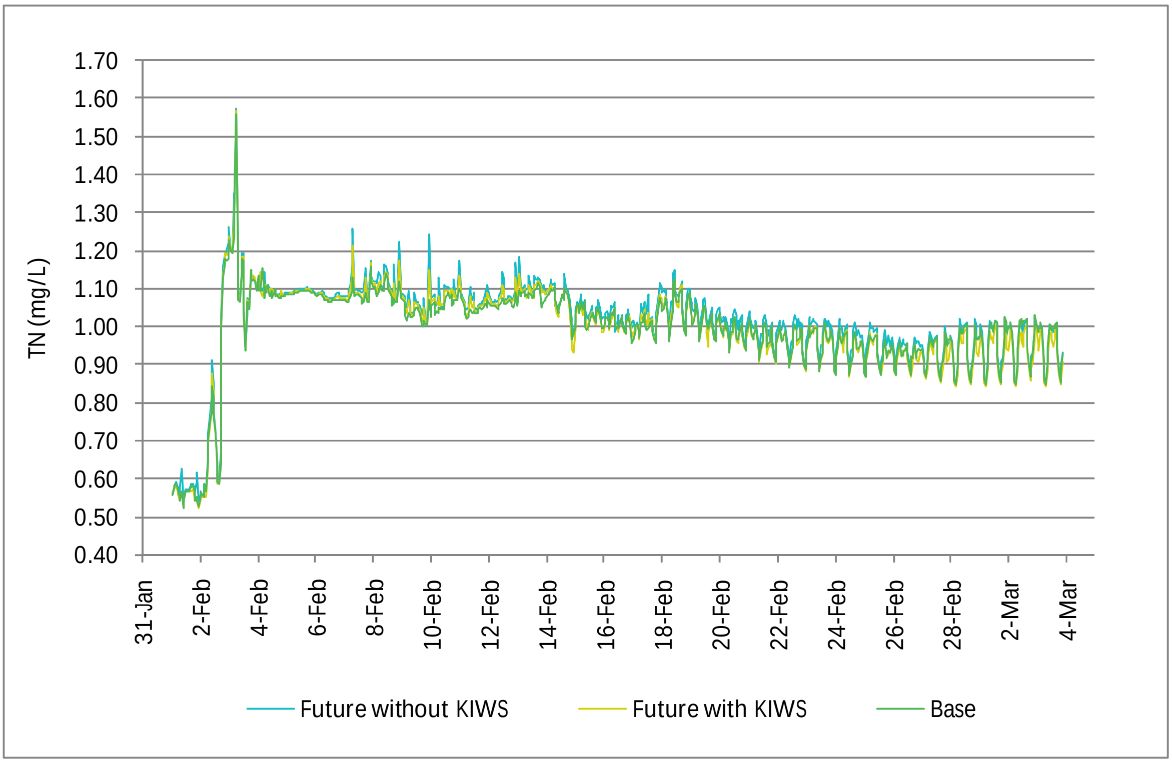

Figure 3-11 TN Concentration at Railway Bridge, South Arm (February 1990)

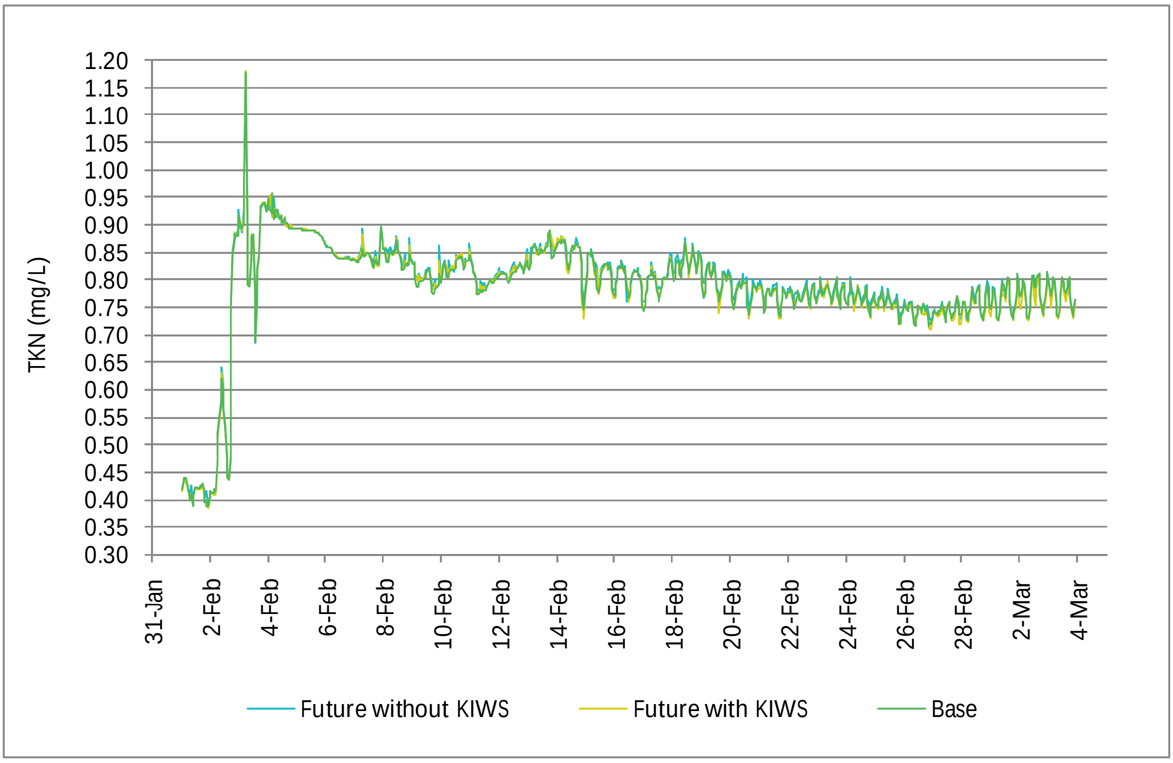

Figure 3-12 TKN Concentration at Railway Bridge, South Arm (February 1990)

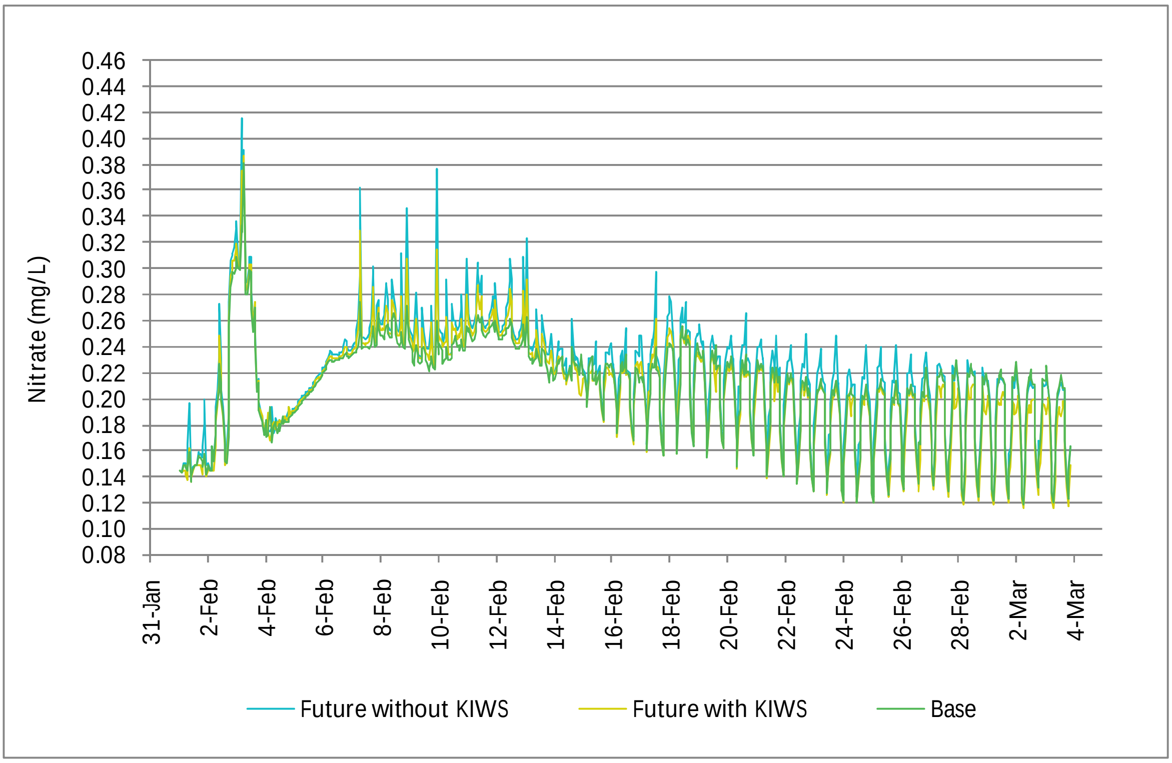

Figure 3-13 NO3 Concentration at Railway Bridge, South Arm (February 1990)

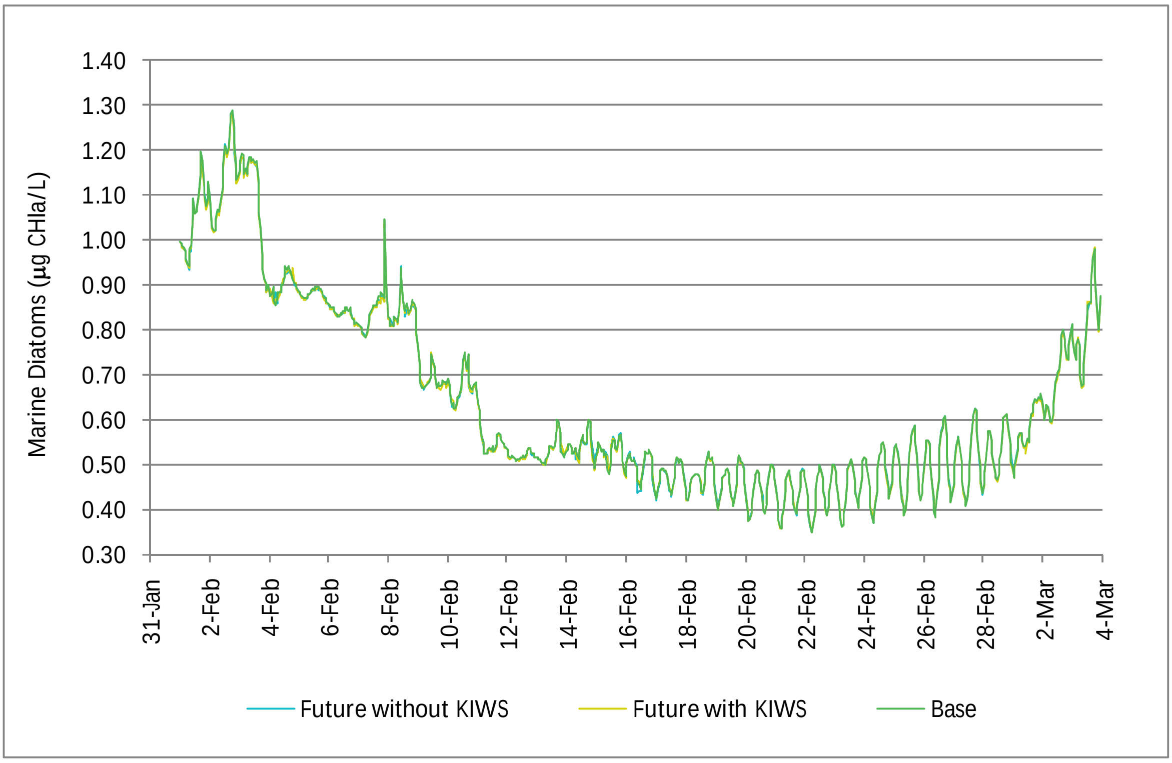

Figure 3-14 Marine diatoms at Railway Bridge, South Arm (February 1990)

Table 3-2 Summary of Water Quality Results, February 1990

Location	Parameter	Scenario 4	Scenario 5		Scenario 6	
		Average*	Average*	% Difference	Average*	% Difference
Second Bend	NO3 (mg/L)	0.26	0.26	0.0	0.26	0.0
	TKN (mg/L)	0.97	0.97	0.0	0.97	0.0
	TN (mg/L)	1.22	1.22	0.0	1.22	0.0
	PO4 (mg/L)	0.05	0.05	0.0	0.05	0.0
	TP (mg/L)	0.07	0.07	0.0	0.07	0.0
	MDIAT (μg Chla/L)	1.91	1.91	0.0	1.92	0.1
First Bend	NO3 (mg/L)	0.26	0.26	0.0	0.26	0.0
	TKN (mg/L)	0.98	0.98	0.0	0.98	0.0
	TN (mg/L)	1.24	1.24	0.0	1.24	0.0
	PO4 (mg/L)	0.05	0.05	0.0	0.05	0.0
	TP (mg/L)	0.07	0.07	0.0	0.07	0.0
	MDIAT (μg Chla/L)	1.70	1.70	0.0	1.70	0.1
Hexham	NO3 (mg/L)	0.26	0.26	0.0	0.26	-0.2
	TKN (mg/L)	0.99	0.99	0.0	0.99	0.0
	TN (mg/L)	1.25	1.25	0.0	1.25	-0.1
	PO4 (mg/L)	0.06	0.06	-0.1	0.06	-0.4
	TP (mg/L)	0.08	0.08	0.0	0.08	-0.3
	MDIAT (μg Chla/L)	1.35	1.35	0.1	1.35	0.1
Railway Bridge	NO3 (mg/L)	0.18	0.18	-0.8	0.17	-8.3
	TKN (mg/L)	0.77	0.77	0.0	0.77	-0.7
	TN (mg/L)	0.96	0.96	-0.2	0.94	-2.2
	PO4 (mg/L)	0.05	0.05	-2.0	0.04	-21.2
	TP (mg/L)	0.07	0.07	-1.4	0.06	-16.0
	MDIAT (μg Chla/L)	0.81	0.81	0.0	0.81	0.2
North Arm	NO3 (mg/L)	0.23	0.23	0.0	0.23	-0.6
	TKN (mg/L)	0.90	0.90	0.0	0.90	-0.1
	TN (mg/L)	1.13	1.13	0.0	1.13	-0.2
	PO4 (mg/L)	0.05	0.05	-0.1	0.05	-1.5
	TP (mg/L)	0.07	0.07	0.0	0.07	-1.2
	MDIAT (μg Chla/L)	1.01	1.01	0.1	1.01	0.0
South Arm	NO3 (mg/L)	0.07	0.07	0.2	0.07	-1.5
	TKN (mg/L)	0.71	0.71	0.0	0.71	-0.2
	TN (mg/L)	0.79	0.79	0.0	0.79	-0.3
	PO4 (mg/L)	0.02	0.02	0.5	0.02	-2.9
	TP (mg/L)	0.04	0.04	0.5	0.04	-1.8
	MDIAT (μg Chla/L)	0.68	0.68	0.0	0.68	-0.2

* average concentration over the last day of the simulation

4 CONCLUSIONS

Based on the results of scenario modelling undertaken to assess water quality conditions for the proposed KIWS, the following key points are noted for coastal rainfall wet weather scenarios:

- The effect of the proposed KIWS (when operational) was a substantial decrease to nutrient concentrations (i.e. N and P) particularly in the vicinity of Railway Bridge. Consequently, under future discharge conditions without KIWS operational, nutrient concentrations were predicted to be considerably higher than the existing scenario;
- Orthophosphate results show the greatest change at Hexham with an increase of approximately 19% when the KIWS was not operational and corresponding decrease of approximately 13% when the KIWS was operational. Closer to the discharge location, near Railway Bridge, orthophosphate concentration within the river was predicted to decrease by approximately 20% when the KIWS was operational; and
- Marine diatoms varied marginally for all model scenarios and reporting locations suggesting minimal impact from the proposed KIWS.

Overall, under coastal rainfall conditions, the affect of the proposed KIWS is clear, that is, nutrient concentrations are predicted to increase (relative to existing baseline concentrations) when the KIWS is not operational and decrease when the KIWS is operational. When the KIWS is operational, nutrient concentration predicted at locations upstream and downstream of the discharge location also decrease relative to baseline (existing) conditions.

Based on results of scenario modelling undertaken to assess high flow conditions during February 1990, the following key points are noted:

- For the majority of constituents modelled, an initial spike and gradual decrease was predicted at Railway Bridge. The increase is considered to be attributed to contribution of nutrients from nearby upstream sources (i.e. localised catchment runoff). The subsequent decrease to nutrient concentration is caused by advection of floodwaters that contribute significantly to mixing within downstream estuarine reaches near the discharge location;
- For the most part, minor changes to nutrient concentration (typically <2% relative to existing conditions) were predicted at the majority of reporting locations for the future model scenarios, however, more substantial change to orthophosphate and Total Phosphorus were predicted at Railway Bridge in the vicinity of the point source discharge;
- Model results for Total Phosphorous, orthophosphate and nitrate show higher concentration near the point source discharge location (i.e. Railway Bridge) when the KIWS was not operational. With the KIWS operational, the concentration of these constituents were somewhat higher than concentrations predicted under existing discharge conditions but in some cases substantially less than discharge conditions where the KIWS was not included;
- Results for marine diatoms show no substantial variation at reporting locations suggesting minimal sensitivity to receiving water quality conditions as a result existing and future discharge scenarios. The concentration and growth of marine diatoms is more likely to be associated with salinity variation caused by high flow conditions rather than changes in the nutrient status of the river.

Overall, under high flow conditions, model results indicate that the comparatively small discharge of high concentration reject water from the KIWS (compared to lower concentration discharges from Shortland WWTW and high volume river flows occurring under extreme wet weather conditions) would result in minor changes to receiving water quality within the Hunter River Estuary. Under such high flow conditions, the contribution of freshwater from upstream rivers is expected to dilute potential water quality impacts near Railway Bridge as a result of Shortland WWTW and KIWS discharges. Receiving water quality under such high flow conditions would therefore be significantly influenced by the contribution of freshwater and nutrients from upstream rivers and local contributing catchment runoff.

5 REFERENCES

BMT WBM (2008) Kooragang Recycled Water Plant Hunter River Water Quality Modelling. Final Draft Report Prepared for Hunter Water Corporation, December 2008.

Sanderson and Redden (2001) Hunter River Estuary Water Quality Data Review and Analysis, Report submitted to Manly Hydraulics Laboratory, December 2001.

BMT WBM Brisbane	**Level 11, 490 Upper Edward Street Brisbane 4000** **PO Box 203 Spring Hill QLD 4004** **Tel +61 7 3831 6744 Fax +61 7 3832 3627** **Email wbm@wbmpl.com.au** **Web www.wbmpl.com.au**
BMT WBM Denver	**14 Inverness Drive East, #B132** **Englewood Denver Colorado 80112 USA** **Tel +1 303 792 9814 Fax +1 303 792 9742** **Email wbmdenver@wbmpl.com.au** **Web www.wbmpl.com.au**
BMT WBM Mackay	**Suite 1, 138 Wood Street Mackay 4740** **PO Box 4447 Mackay QLD 4740** **Tel +61 7 4953 5144 Fax +61 7 4953 5132** **Email wbmmackay@wbmpl.com.au** **Web www.wbmpl.com.au**
BMT WBM Melbourne	**Level 5, 99 King Street Melbourne 3000** **PO Box 604 Collins Street West VIC 8007** **Tel +61 3 8620 6100 Fax +61 3 8620 6105** **Email wbmmelbourne@wbmpl.com.au** **Web www.wbmpl.com.au**
BMT WBM Newcastle	**126 Belford Street Broadmeadow 2292** **PO Box 266 Broadmeadow NSW 2292** **Tel +61 2 4940 8882 Fax +61 2 4940 8887** **Email wbmnewcastle@wbmpl.com.au** **Web www.wbmpl.com.au**
BMT WBM Perth	**1 Brodie Hall Drive Technology Park Bentley 6102** **Tel +61 8 9328 2029 Fax +61 8 9486 7588** **Email wbmperth@wbmpl.com.au** **Web www.wbmpl.com.au**
BMT WBM Sydney	**Level 1, 256-258 Norton Street Leichhardt 2040** **PO Box 194 Leichhardt NSW 2040** **Tel +61 2 9713 4836 Fax +61 2 9713 4890** **Email wbmsydney@wbmpl.com.au** **Web www.wbmpl.com.au**
BMT WBM Vancouver	**1190 Melville Street #700 Vancouver** **British Columbia V6E 3W1 Canada** **Tel +1 604 683 5777 Fax +1 604 608 3232** **Email wbmvancouver@wbmpl.com.au** **Web www.wbmpl.com.au**

Appendix D Terrestrial Flora and Fauna Assessment

Kooragang Industrial Water Scheme

TERRESTRIAL FLORA AND FAUNA ASSESSMENT

- Final
- 30 November 2010

Kooragang Industrial Water Scheme

TERRESTRIAL FLORA AND FAUNA ASSESSMENT

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Sinclair Knight Merz
ABN 37 001 024 095
100 Christie Street
St Leonards NSW 2065 Australia
Postal Address
PO Box 164 St Leonards NSW 2065 Australia
Tel: +61 2 9928 2100
Fax: +61 2 9928 2500
Web: www.skmconsulting.com

Contents

1. Introduction

1.1. Project Description

Hunter Water Corporation (HWC) has undertaken a recycled water strategy study to identify potential water recycling opportunities in the Lower Hunter. The focus of this strategy was to identify potential demands for recycled water that would either substitute current potable water consumption or either directly or indirectly augment potable water supplies. Several large industrial operations in the Kooragang Island and Mayfield Industrial Areas have been identified as potential users of recycled water, to substitute the use of potable water for non-potable applications.

HWC has subsequently commissioned work to develop the Kooragang Industrial Water Scheme (IWS), which would deliver recycled water for industrial use. The infrastructure required to provide this scheme comprises:

1) Upgrade of Shortland Waste Water Treatment Works (WWTW);
2) Construction and operation of a 9 ML/day recycled water plant (RWP) (MF/RO plant) at the Steel River Eco Industrial Estate;
3) Construction and operation of a new rising main between Newcastle 10 Wastewater Pumping Station (WWPS) and the Wallsend Storm Flow WWPS;
4) Distribution of recycled water to customers via a new reticulation system; and
5) Discharge of reject water into the Hunter River from the existing Shortland WWTW outfall located on the South Arm rail bridge during wet weather. During dry weather, it is likely that the reject material will be transferred into the Burwood WWTW catchment and discharged via the deep ocean outfall.

The assessment of impacts on terrestrial flora and fauna on the project involved an investigation of the site planned for the proposed recycled water plant and also along the route proposed for the new rising main. For the purposes of this investigation the 'study area' refers to the land directly subject to these works as well as immediately adjacent areas within proximity to the works, which may be indirectly impacted by construction activities including naturally vegetated areas.

1.2. Objectives

This report documents the results of a flora and fauna assessment conducted by Sinclair Knight Merz to investigate the proposed pipeline routes, potential impacts on biodiversity and their significance associated with the Project. The specific objectives of this report are to:

- Identify species, ecological communities and populations of local, regional, state and national conservation significance, and their habitats, which are known or considered likely to occur within lands affected by the proposal;

- Describe the biological environment of the study area in relation to flora and fauna; and
- Assess the potential impacts of the pipeline route infrastructure on the ecological values of the study area.

1.3. Legislation

The information presented in the report is based on a review of available data and site investigations to assess the potential impacts of the proposal in relation to relevant State and Commonwealth environmental and threatened species legislation. Relevant legislation includes:

- *Environmental Planning and Assessment Act 1979;*
- *Threatened Species Conservation Act 1995* (TSC Act);
- *Environment Protection and Biodiversity Conservation act 1999* (EPBC Act); and
- *The Fisheries Management Act 1994* (FM Act).

2. Preliminary Review

2.1. Existing Environment

The majority of the study area consists of modified and disturbed land which is devoid of remnant vegetation. This includes a cleared industrial and urban landscape, interspersed with maintained grass (parkland) areas and planted trees. Where small isolated fragments of remnant vegetation occur this is typically highly disturbed and dominated by weeds, albeit for natural riparian and estuarine vegetation which occurs along the fringes of the Hunter River, comprising coastal saltmarsh and mangrove vegetation in the area proposed for pipeline infrastructure.

2.2. Biodiversity Databases

A background review of government maintained databases and other sources of data in relation to known records of threatened species in the study area was conducted prior to the field investigation to identify potential target species. The data used in this review included the:

- DECC Atlas of NSW Wildlife;
- Database of the Royal Botanic Gardens PlantNET;
- Records published in scientific journals, reports and general flora and fauna distribution texts;
- Results of local environmental studies, and studies done to support various environmental impact assessments (e.g. SKM and PPK 2000); and
- Other relevant databases including the National Herbarium, Department of Environment and Heritage (nationally threatened species, EPBC Act), and records published by the Hunter Bird Observers Club.

All of the threatened flora and fauna species, endangered populations and ecological communities known to occur within the study locality have been tabulated. This information was used in the preparation of lists of threatened species deemed potential inhabitants of the proposed pipeline routes and the treatment plant (i.e. potential subject species).

2.3. Threatened Flora

A total of 12 threatened flora species have been identified from a 10 kilometre radius of the proposal area (**Table 1**). A review of the habitat requirements of these species in relation to the areas to be impacted by the proposal suggest that at least one of these species, *Zannichellia palustris* may potentially occur in the study area in addition to *Rutidosis heterogama* which is known to occur in disturbed areas and therefore has a low potential of occurring in the study area. The remaining 11 species have either very marginal or have no habitat elements present in the works area and are therefore highly unlikely to occur. No further assessment has been conducted on these species.

- **Table 1: Threatened Flora Species of the Study Locality.**

Threatened Flora	Status			Likely presence in study area
	Cwlth	NSW	RoTAP	
Callistemon linearifolius	-	V	2RCi	Very unlikely
Cryptostylis hunteriana	V	V	3VC-	Very unlikely
Diuris praecox	V	V	2VC-	Very unlikely
Eucalyptus camfieldii	V	V	2VCi	Very unlikely
Eucalyptus parramattensis subsp. *decadens*	V	V	2V	Very unlikely
Grevillea parviflora subsp. *parviflora*	V	V	-	Very unlikely
Melaleuca biconvexa	V	V	-	Very unlikely
Rhizanthella slateri	-	V	3KC-	Very unlikely
Rulingia prostrata	E	E	2ECi	Very unlikely
Rutidosis heterogama	V	V	2VCa	Low potential to occur
Syzygium paniculatum	V	V	3VCi	Very unlikely
Tetratheca juncea	V	V	3VCa	Very unlikely
Zannichellia palustris	-	E	3R+	Potential to occur in wetland areas

2.4. Endangered Ecological Communities

A number of Endangered Ecological Communities (EECs) listed under the TSC Act which occur on coastal floodplains are present in the local area including Coastal Saltmarsh, Freshwater Wetlands, Swamp Oak Floodplain Forest, Swamp Sclerophyll Forest and River-flat Eucalypt Forest. The presence of these within the study area has been investigated as part of this study and is documented in the following chapter.

2.5. Threatened Fauna

A total of 56 threatened fauna species have previously been recorded from the greater Newcastle area (**Table 2-5**). An appraisal of the potential for these species to occur in the proposal area was conducted on the basis of review of the known habitat requirements. This review indicates that at least 9 of these species have marginal habitat elements present within the study area. This is associated with habitat along the fringes of the Hunter River.

- **Table 1-5: Threatened Fauna Species Recorded from the greater Newcastle area**

Species	Status		No. records in region	Likely presence in study area
	TSC Act	*EPBC Act*		
Giant Barred Frog (*Mixophyes iteratus*)	E1	E	2	Very unlikely
Green and Golden Bell Frog (*Litoria aurea*)	E1	E	713	Very unlikely
Black-necked Stork (*Ephippiorhynchus asiaticus*)	E1	E	187	Very unlikely
Painted Snipe (*Rostratula benghalensis australis*)	E1	E	6	Potential habitat along parts of the Hunter River although not impacted by the proposal
Bush Stone-curlew (*Burhinus grallarius*)	E1	V	10	Very unlikely

Species	Status		No. records in region	Likely presence in study area
	TSC Act	*EPBC Act*		
Little Tern (*Sterna albifrons*)	E1	E	299	Potential habitat along parts of the Hunter River although not impacted by the proposal
Swift Parrot (*Lathamus discolour*)	E1	E	23	Very unlikely
Regent Honeyeater (*Xanthomyza phrygia*)	E1	E	10	Very unlikely
Wallum Froglet (*Crinia tinnula*)	V		44	Very unlikely
Magpie Goose (*Anseranas semipalmata*)	V		77	Very unlikely
Blue-billed Duck (*Oxyura australis*)	V		11	Very unlikely
Freckled Duck (*Stictonetta naevosa*)	V		22	Very unlikely
Australasian Bittern (*Botaurus poiciloptilus*)	V		15	Very unlikely
Black Bittern (*Ixobrychus flavicollis*)	V		11	Very unlikely
Osprey (*Pandion haliaetus*)	V		31	Potential habitat along parts of the Hunter River although not impacted by the proposal
Great Knot (*Calidris tenuirostris*)	V		33	Potential habitat along parts of the Hunter River although not impacted by the proposal
Broad-billed Sandpiper (*Limicola falcinellus*)	V		82	Potential habitat along parts of the Hunter River although not impacted by the proposal
Black-tailed Godwit (*Limosa limosa*)	V		286	Potential habitat along parts of the Hunter River although not impacted by the proposal
Terek Sandpiper (*Xenus cinereus*)	V		562	Potential habitat along parts of the Hunter River although not impacted by the proposal
Comb-crested Jacana (*Irediparra gallinacean*)	V		27	Very unlikely
Sooty Oystercatcher (*Haematopus fuliginosus*)	V		16	Very unlikely
Pied Oystercatcher (*Haematopus longirostris*)	V		24	Very unlikely
Greater Sand-plover (*Charadrius leschenaulti*)	V		13	Potential habitat along parts of the Hunter River although not impacted by the proposal
Lesser Sand-plover (*Charadrius mongolus*)	V		354	Potential habitat along parts of the Hunter River although not impacted by the proposal
Wompoo Fruit-Dove (*Ptilinopus magnificus*)	V		7	Very unlikely
Rose-crowned Fruit-Dove (*Ptilinopus regina*)	V		3	Very unlikely
Superb Fruit-Dove (*Ptilinopus superbus*)	V		4	Very unlikely
Gang-gang Cockatoo (*Callocephalon fimbriatum*)	V		11	Very unlikely
Glossy Black-Cockatoo (*Calyptorhynchus lathami*)	V		46	Very unlikely
Turquoise Parrot (*Neophema pulchella*)	V		11	Very unlikely
Barking Owl (*Ninox connivens*)	V		8	Very unlikely
Powerful Owl (*Ninox strenua)*	V		82	Very unlikely
Grass Owl (*Tyto capensis*)	V		4	Very unlikely
Masked Owl (*Tyto novaehollandiae*)	V		51	Very unlikely
Sooty Owl (*Tyto tenebricosa*)	V		10	Very unlikely
Brown Treecreeper (*Climacteris picumnus*)	V		41	Very unlikely
Speckled Warbler (*Pyrrholaemus saggitatus*)	V		20	Very unlikely
Black-chinned Honeyeater (*Melithreptus g.gularis*)	V		33	Very unlikely
Grey-crowned Babbler (*Pomatostomus t. temporalis*)	V		94	Very unlikely
Diamond Firetail (*Stagonopleura guttata*)	V		7	Very unlikely
Spotted-tailed Quoll (*Dasyurus*	V	V	130	Very unlikely

Species	Status		No. records in region	Likely presence in study area
	TSC Act	***EPBC Act***		
maculatus)				
Brush-tailed Phascogale (*Phascogale tapoatafa*)	V		58	Very unlikely
Koala (*Phascolarctos cinereus*)	V		4010	Very unlikely
Eastern Pygmy-possum (*Cercartetus nanus*)	V		1	Very unlikely
Yellow-bellied Glider (*Petaurus australis*)	V		12	Very unlikely
Squirrel Glider (*Petaurus norfolcensis*)	V		179	Very unlikely
Long-nosed Potoroo (*Potorous tridactylus*)	V		2	Very unlikely
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	V	123	Very unlikely
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	V		10	Very unlikely
Eastern Freetail-bat (*Mormopterus norfolkensis*)	V		44	Very unlikely
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V		8	Very unlikely
Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)	V		10	Very unlikely
Little Bentwing-bat (*Miniopterus australis*)	V		782	Very unlikely
Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)	V		107	Very unlikely
Large-footed Myotis (*Myotis adversus*)	V		27	Very unlikely
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	V		55	Very unlikely

3. Site Assessment

An inspection of the proposed pipeline routes and any other associated infrastructure sites was conducted on 10 October 2008 to identify the extent and quality of any native vegetation, fauna habitats and species present. The survey aimed to identify the presence of listed threatened species or their habitat potentially impacted by the proposal in addition to any listed Endangered Ecological Communities as identified in section 2 of the report.

3.1. Survey Method

For the purposes of this assessment, the proposed pipeline routes were separated into discrete areas and the vegetation and fauna habitat values in each area described. This division included the following seven areas:

Major Pipeline Route

Area 1 Steel River Industrial Park

Area 2 Stevenson Park

Area 3 Tourle Street - Hunter River

Area 4 Kooragang Island

Wastewater Diversion

Area 5 Sandgate Road

Area 6 MacClure Reserve and Heaton Park

Area 7 Blue Gum Road

Flora

A flora survey was conducted in each area concentrating on the lands within approximately 30 metres either side of the proposed pipeline. The survey involved identification of the floristics and structure of the vegetation and the type and distribution of any remnant plant communities. Areas of remnant vegetation were assessed to determine the presence and extent of listed Endangered Ecological Communities known from the local area. Field surveys were conducted as traverses along the pipeline route with closer inspections of any areas of ecological significance. The condition of any vegetation within the study area was noted, including the extent of modification and weed invasion.

Fauna

Despite the presence of estuarine and freshwater wetland communities in the wider area, the majority of the proposed pipeline routes will traverse along cleared disturbed lands which are generally devoid of habitat value for threatened fauna species. As such a detailed investigation using the full range of survey techniques was not considered necessary. The field surveys were based on precautionary habitat assessment and the adoption of protective strategies for features deemed likely to be critical habitat for threatened fauna species known from the area. During the survey, all opportunistic sightings of fauna species were recorded. Searches were conducted for threatened flora and fauna species listed under the TSC Act and EPBC Act (refer Section 2), as well as rare or significant plant species (Briggs and Leigh 1996).

3.2. Results

The vegetation communities identified in the general area are typical of those for estuarine areas of coastal floodplains. Remnant vegetation within the proposal area is limited to small areas of disturbed Coastal Saltmarsh and Swamp Sclerophyll Forest. Other vegetation types include weed dominated creeklines and maintained parkland with planted trees. Two different areas have been assessed comprising: the Recycled Water Treatment Plant and pipeline infrastructure between Steel River Industrial Park and Kooragang Island and Pipeline infrastructure between Sandgate Road, Wallsend and Blue Gum Road, Jesmond (**Figure 1**).

LEGEND

- Twin Pipelines
- RO Reject Water
- Recycled Water Pipeline
- Existing Shortland WWTW Discharge Pipeline
- Coastal Saltmarsh (EEC)
- Disturbed Swamp Sclerophyll Forest (EEC) - likely planted
- Golden Wreath Wattle
- Mangroves
- Spotted - Ironbark Gum Forest
- Regenerating Spotted - Ironbark Gum Forest

Figure 1 - Vegetation impacted by KIWS

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DATA SOURCES
Ausimage HWC SKM

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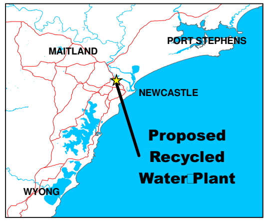

Steel River Industrial Area to Kooragang Island

Area 1: Steel River Industrial Area

The proposed pipeline and IWP starts on the former BHP Billiton site comprising cleared land with a sparse to moderate cover of exotic shrubs and grasses (refer P**late 1**). This area is highly disturbed from past landuse activities and more current disturbances from vehicles and rubbish dumping. Vegetation in this area varies from relatively dense patches of exotic shrubs to a sparse cover of exotic ground covers. Some native species are present in low abundance. Dominant flora species comprise Scarlet Pimpernel (*Anagallis arvensis*), Creeping Monkey flower (*Mimulus repens*), Galena (*Galenia pubescens*), Rhodes Grass (*Chloris gayana*), Hexham Scent (*Melilotus indicus*), Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), Fireweed (*Senecio madagascariensis*) and Golden Wreath Wattle (*Acacia saligna*). Golden Wreath Wattle, indigenous to Western Australia is a weed on the east coast, is particularly abundant in the area.

Several depressions mostly created from vehicle movements are present and contained water during the field inspection (refer **Plate 2**) some of these exhibited high salt concentrations. These areas support a low-moderate abundance of semi-aquatic species including *Bolboschoenus caldwellii* (native) and *Cyperus eragrostis* (exotic) and provide low quality frog habitat suited to only disturbance tolerant species, such as the Spotted Marsh Frog (*Limnodynastes tasmaniensis*) and Striped Marsh Frog (*L.peroni*) both of which were identified in the survey. Habitat within this site is sub-optimal for the endangered Green and Golden Bell Frog (*Litoria aurea*) and the species is not expected. Several common bird species were also recorded consisting of species adapted to modified habitats such as the Magpie (*Gymnorhina tibicen*), Magpie-lark (*Grallina cyanoleuca*), Welcome Swallow (*Hirundo neoxena*) and Golden-headed Cisticola (*Cisticola exilis*). Tracks of foxes (*Vulpes vulpes*) and dogs (*Canis familaris*) were observed in soft mud.

The pipeline continues east through the Steel River Industrial area towards Tourle Street and is restricted to cleared road easements. This area supports no or very limited habitat for threatened flora species and no EECs are present in this area. There will be no direct impacts on high quality fauna habitat given that all infrastructure would be located in cleared lands. There is a requirement to manage indirect impacts as discussed in the recommendations section of this report.


Plate 1. Former BHP Billiton site.


Plate 2. Puddled water on the former BHP Billiton site.

Area 2: Stevenson Park

A small off-take traverses through Stevenson Park to the south of the main proposed pipeline route, before crossing Maitland Road where this section of the proposed pipeline ends. Vegetation in Stevenson Park comprises maintained grass (mown parkland) with planted trees (refer **Plate 3**) which include Broad-leaved Paperbark (*Melaleuca quinquenervia*), Swamp Mahogany (*Eucalyptus robusta*), River Oak (*Casuarina cunninghamiana*), Weeping Willow (*Salix babylonica*) and Brown Plum-pine (*Podocarpus elatus*). The proposed pipeline will avoid the majority of these planted trees however 1-2 Weeping willow trees (an exotic species) will be removed. There is a planted row of vegetation on the south-western side of Maitland Road, where this section of pipeline finishes. Planted trees in this area include Sweet Pittosporum (*Pittosporum undulatum*), Coastal Myall (*Acacia binervia*) and several *Eucalyptus* spp.

Fauna habitat in this area is restricted to mown parkland with no shrub or ground cover. Several common bird species were noted included Magpie, Magpie-Lark and Figbird (*Specotheres viridis*) No hollow-bearing trees are present in this area and there will be no direct impacts on high quality fauna habitat given that all infrastructure would be located in cleared lands. Although this area supports no habitat for threatened flora species and no EECs are present in this area.

Area 3: Tourle Street - Hunter River

From Steel River Industrial Park the proposed pipeline route adjoins Tourle Street before crossing the Hunter River. A recently cleared Telstra cable easement is present within the DELTA EMD plant site and there is an area of regenerating Spotted Gums (*Corymbia maculata*) in this area (refer **Plate 4**). The pipeline proposed to be situated between the DELTA EMD Plant and Tourle Street. This area supports moderately mature Broad-leaved Paperbarks, Swamp Mahogany and Swamp Oaks (*Casuarina glauca*) which appear to be planted, with a dense understorey of *Lantana camara* (refer **Plate 5**). This vegetation has affinities to the EEC Swamp Sclerophyll Forest on Coastal Floodplains.

There was a significant amount of water in the Tourle Street road easement on the day of the field inspection which enters several stormwater drains along the edge of the road. The presence of aquatic flora species including Cumbungii (*Typha orientalis*), *Bolboschoenus caldwellii* and *Isolepis inundata* along the edge of the road suggests this area is regularly inundated. Given the proximity to Tourle Street and density of traffic, the vegetation in this location supports very limited resources and overall low quality habitat for fauna. No fauna was observed during the survey and only disturbance tolerant species would occur which would include a low diversity of common urban dwelling bird, frog and reptile species.

Plate 3. Stevenson Park.

Plate 4. Telstra easement showing regenerating Spotted Gums to the right of picture.

Directional bore drilling will be used for the proposed pipeline across the Hunter River. The northern side of the Hunter River supports Mangrove vegetation and disturbed areas of Coastal Saltmarsh on the landward side (refer **Plate 6**). These areas support a mix of exotic and native species including several characteristic species listed under the Final Determination for the EEC Coastal Saltmarsh. Exotic species include Sharp Rush (*Juncus acutus*) and Pennywort (*Hydrocotyle bonariensis*), and native species include Saltwater Couch (*Sporobolus virginicus*), Sea Rush (*Juncus kraussii*), Common Reed (*Phragmites australis*), Samphire (*Sarcocornia quinqueflora* subsp. *quinqueflora*) and Seablite (*Suaeda australis*).

There are two disturbed EECs present in this area comprising areas of Swamp Sclerophyll Forest along the edge of Tourle Street and Coastal Saltmarsh on the northern side of the Hunter River. The intention is to avoid impacting on the identified areas of saltmarsh and mangrove by utilising cleared and disturbed land.

Tidal areas along the fringes of the Hunter River provide marginal and low-quality habitat for wader birds which may include a number of threatened and migratory species as listed in Table 2. However as the proposal will not directly or indirectly impact on these potential habitat areas no further assessment as to the significance of impacts on threatened wader species is required.

Remaining areas of habitat along the northern side of the Hunter River comprises modified lands dominated by low weeds and is of limited habitat value for fauna. No hollow-bearing trees are present in this area and there will be no direct impacts on high quality fauna habitat, although there will potentially be some impacts to low quality fauna habitats along the edge of Tourle Street and disturbed Saltmarsh area on the northern side of the Hunter River.

Plate 5. Vegetation adjacent to Tourle Street.

Plate 6. Northern side of the Hunter River showing Saltmarsh vegetation to the right and the raised access trail to the left of picture.

Area 4: Kooragang Island Industrial Area

From the directional bore drilling the proposed pipeline crosses Tourle Street and traverses through the existing works compound as part of the Tourle Street bridge upgrade (refer **Plate 5**), and then continues along Cormorant Road within the road easement. In this area the proposed pipeline is restricted to cleared easement areas along Cormorant Road and Heron Road, however there are areas of high quality Mangrove and Saltmarsh vegetation adjacent to the proposed pipeline location.

There will be no direct impacts on high quality habitat for native flora and fauna species given that all infrastructure would be located in cleared easements and other disturbed lands. In some areas high quality Mangrove and Saltmarsh are present particularly adjacent to the existing works compound, therefore there is a requirement to manage potential indirect impacts to these areas as discussed in the recommendations section of this report.

Plate 7. The RTA compound area.

Plate 8. Cleared road easement along Cormorant Road on Kooragang Island.

Sandgate Road to Blue Gum Road

Area 5: Sandgate Road

This proposed pipeline route starts from the Wallsend Storm Flow (SSWAS151) where it is located within an easement on industrial land adjacent to Sandgate Road. A creekline adjacent to the easement supports a diversity of exotic trees, shrubs and groundcovers (refer **Plate 9**). The proposal area is devoid of any significant vegetation (refer **Plate 10**), however the adjacent creekline is dominated by Weeping Willows, Camphor Laurel (*Cinnamonum camphora*), African Olive (*Olea europaea* subsp. *cuspidata*) and a diversity of herbs and grasses including Kikuyu (*Pennisetum clandestinum*), Pennywort, Fennel (*Foeniculum vulgare*) and Cobbler's Peg (*Bidens pilosa*).

From the Sandgate Road the proposed pipeline crosses Sandgate Road and traverses through a park area around residential dwellings on Dennis Place before reaching the walking/bicycle path. The pipeline is located on the southern side of the walking/bicycle path until it reaches the concrete stormwater channel (Dark Creek) which it follows through MacClure Reserve and Heaton Park (Area 6). The vegetation adjacent to the walking/bicycle path comprises maintained grass with spaced planted trees. No tree removal is likely to be required in this area.

There will be no direct impacts on high quality habitat for native flora and fauna species in this area given that all infrastructure would be located in cleared easements and other disturbed lands. The proposed pipeline is located directly adjacent to riparian areas which drain into Hexham Swamp and therefore there is a requirement to manage potential indirect impacts to these areas from sedimentation and nutrient runoff as discussed in the recommendations section of this report.

Plate 9. Creek adjacent to proposed pipeline route off Sandgate Road.

Plate 10. Easement area where pipeline is proposed, showing creek area to right.

Area 6: MacClure Reserve – Heaton Park

The pipeline follows the edge of the concrete stormwater channel through to Blue Gum Road. The proposed pipeline crosses a vegetated drainage line (refer **Plate 11**) which adjoins the concrete stormwater channel, dark Creek a tributary of Ironbark Creek before entering MacClure Reserve. This area supports a mix of native aquatic species and exotic weeds including Cumbungii, Knotweeds (*Persicaria* spp.), Large-leaved Privet (*Ligustrum lucidum*), Camphor Laurel, Green Cestrum (*Cestrum parqui*) and Crofton Weed (*Ageratina adenophora*) (refer **Plate 12**). This area of riparian vegetation is highly disturbed being dominated by exotic species, supporting no significant habitat for native flora and fauna species.

The proposed pipeline continues to follow along the edge of Dark Creek through MacClure Park, across Fraser Street and into Heaton Park. This area is devoid of significant vegetation supporting maintained grass except for several relatively mature Broad-leaved Paperbarks (refer **Plate 13**). Removal of these trees on one side of the concrete stormwater channel will require removal.

There will be no direct impacts on high quality habitat for native flora and fauna species in this area given that all infrastructure would be located in cleared easements and other disturbed lands. The proposed pipeline is located directly adjacent to Dark Creek which drains into Ironbark Creek and Hexham Swamp and therefore there is a requirement to manage potential indirect impacts to these areas from sedimentation and nutrient runoff as discussed in the recommendations section of this report.

Plate 11. Drainage line adjoining concrete stormwater channel (Dark Creek).

Plate 12. Exotic dominated vegetation within the drainage line adjoining Dark Creek.

Area 7: Heaton Park – Blue Gum Road

From Heaton Park the proposed pipeline route crosses Dark Creek before crossing over Blue Gum Road into Newcastle No.10 (SSJES027) where the proposed pipeline terminates. The only vegetation in this area comprises planted Bangalay (*Eucalyptus botryoides*) trees surrounding Newcastle No.10. Several trees may be require removal to accommodate the pipeline infrastructure at Newcastle No.10 (refer **Plate 14**). The understorey comprises maintained Buffalo Grass (*Stenotaphrum secundatum*) and several lawn weed species. No hollow-bearing trees were recorded in this area. There will be no direct impacts on high quality habitat for native flora and fauna species in this area given that all infrastructure would be located in cleared easements and other disturbed lands.


Plate 13. Relatively mature Broad-leaved Ironbarks at Fraser Street.


Plate 14. Planted Bangalay trees surrounding Newcastle No.10

3.2.1. Endangered Ecological Communities

Two EECs were recorded in the study area, these are listed in **Table 3-2**. The extent of these communities is restricted to several small isolated and disturbed areas of vegetation comprising: a thin strip of trees along the western edge of Tourle Street has affinities to Swamp Sclerophyll Forest; and areas of Coastal Saltmarsh on the northern bank of the Hunter River.

- **Table 3-2: Endangered Ecological Communities in the study area**

EEC	Status		Location and Condition
	EPBC Act	TSC Act	
Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions	-	EEC	A thin strip of this EEC is present on the landward side of mangrove vegetation on the northern bank of the Hunter River. This area has a moderate condition supporting a high density of exotic species (Sharp Rush)
Swamp Sclerophyll Forest in the NSW North Coast, Sydney Basin and South East Corner bioregions	-	EEC	A thin strip of this EEC is present on the western side of Tourle Street on the southern side of the Hunter River. This area supports diagnostic canopy species for this EEC, with the trees being possibly planted and the understorey is dominated by thick growth of *Lantana camara*. This area has a low-moderate ecological condition.

3.2.2. Threatened Flora

No threatened flora species were recorded during the field surveys. Based on the modified condition of the habitats within the works area it is considered unlikely that the project would negatively impact on a threatened flora species or potential habitat. While potential habitat exists for the threatened species *Zannichellia palustris* (i.e. estuarine wetland areas) possible indirect impacts on the potential habitat of this species can be adequately managed during construction.

3.2.3. Introduced Flora

Of the 105 flora species recorded along the proposal corridor (**Appendix A**), 72 of these are introduced species. Of these introduced species 6 are declared noxious species in the Newcastle local government area listed under the *Noxious Weeds Act 1993* (NW Act), these are listed in **Table 3-3**.

- **Table 3-3: Noxious weed species present in the study area**

Species	Prevalence on Site	Noxious Class
Bitou Bush *Chrysanthemoides monilifera* subsp. *rotunda*	Present in vacant industrial lands at Steel River Industrial Park (Area 1).	Class 4: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Crofton Weed *Ageratina adenophora*	Present in disturbed riparian areas dominated by exotic vegetation, in (Areas 5 & 6)	
Green Cestrum *Cestrum parquai*	Present in disturbed riparian areas dominated by exotic vegetation, in (Areas 5 & 6)	Class 3: The plant must be fully and continuously suppressed and destroyed
Lantana *Lantana camara*	Main occurrence on the western side of Tourle Street (Area 3)	Class 5: The requirements in the NW Act for a notifiable weed must be complied with
Privet (Broad-leaf) *Ligustrum lucidum*	Present in disturbed riparian areas dominated by exotic vegetation, in (Areas 5 & 6)	Class 4: The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Privet (Narrow-leaf) *Ligustrum sinense*		

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3.2.4. Threatened Fauna

Habitat for fauna within the construction areas consist predominantly of cleared and modified land that includes open areas, vegetated road verges, parkland with planted trees. These habitats are characterised by isolated small patches of disturbed and modified habitat with little value for native fauna and dominated by urban dwelling species. Consequently no threatened fauna or potential habitat was identified.

Green and Golden Bell Frog

Targeted surveys were conducted for the nationally endangered Green and Golden Bell Frog (*Litoria aurea*) which is known from 21 locations on Kooragang Island (Hammer *et al* 2002). However neither the species nor potential habitat for this species was identified from the proposed works areas associated with project, and it is concluded that the proposal will not significantly impact on identified local populations of *L.aurea.*

3.2.5. Migratory Birds

Tidal areas along the fringes of the Hunter River provide marginal and low-quality habitat for wader birds which may include a number of threatened and migratory species as listed below.

- Black-tailed Godwit
- Terek Sandpiper
- Red-necked Stint
- Eastern Curlew
- Curlew Sandpiper
- Common Sandpiper
- Grey-tailed Tattler
- Wandering Tattler
- Ruddy Turnstone
- Ruff
- Pectoral Sandpiper
- Little Curlew

The proposal will not directly or indirectly impact on potential habitat for these species. Potential habitat identified near Tourle Street bridge will be avoided through the use of directional drilling. Indirect impacts are to be managed during construction.

3.3. Summary

Most areas of remnant vegetation have been highly modified and support a high abundance of invasive weed species. The features of conservation value recorded within proximity to the proposed works areas is provided below.

- **Table 2 Summary of ecologically significant features**

Threatened Species/Communities/Habitats	Status	Area						
		1	2	3	4	5	6	7
Swamp Sclerophyll Forest	EEC (EPBC Act; TSC Act)			√				
Coastal Saltmarsh	EEC (TSC Act)			√	√			
Mangroves	Protected (FM Act), Significant fauna habitat			√	√			
Isolated Trees	Local significance		√			√		√

4. Impact Assessment

4.1. General Impacts

The proposed infrastructure for the recycled water project comprises:

- A recycled water treatment plant at the Steel River Industrial Area;
- Pipeline infrastructure between the proposed recycled water plant and Kooragang Island Industrial Area; and
- Pipeline infrastructure between the Wallsend Storm Flow and Newcastle No. 10 substation.

The conservation value of remnant vegetation in the study area was considered in the initial planning phases of the project and the proposed pipeline was located to avoid impacts on native vegetation and fauna habitat. Therefore the majority of the proposed pipeline routes will traverse along residential property boundaries, easements, road verges, maintained parkland and vacant cleared lands such that there minimal clearing would be required.

4.1.1. Industrial Water Treatment Plant

The location of the proposed IWP site comprises a highly disturbed area in the Steel River Industrial area. This area supports a sparse vegetation cover dominated by exotic species. There will no significant impacts to any threatened species, populations or ecological communities from the proposed recycled water treatment plant.

4.1.2. Pipelines

The high conservation value of the Hunter estuary in particular the Kooragang Island wetlands was recognised in the preliminary investigations for this project. As such all proposed pipeline routes have been sited to avoid highly sensitive areas. The proposed pipelines mostly traverse urbanised areas, open parklands, maintained roads and walking tracks, and utility easements.

While minor impacts on vegetation may result from the proposed pipeline infrastructure, direct impacts would be limited to impacts on isolated trees or small stands of planted vegetation within predominantly cleared easements. Areas where there will potentially be impacts to native vegetation comprise:

- Area 3 comprises a narrow linear strip of vegetation along the western edge of Tourle Street. Vegetation comprises several Broad-leaved Paperbark and Swamp Mahogany trees (which appear to be historically planted as roadside vegetation). These species and several of the understorey plants are associated with the listed EEC, ‘Swamp Sclerophyll Forest’. This area is highly disturbed, comprising a thin strip of vegetation with an understorey dominated by dense *Lantana camara*. Impacts on this vegetation will be limited to a traverse of the linear strip via the proposed pipeline comprising a 3-4 m clearance.

- Area 4 on the northern bank of the Hunter River there are areas of Coastal Saltmarsh (EEC) and Mangroves on the edge of the river. These areas of Coastal Saltmarsh are relatively disturbed supporting moderate-high densities of Sharp Rush (*Juncus acutus*) an invasive weed species. However these areas do support several native Saltmarsh species and provide potential habitat for listed migratory bird species. This area has been identified as high conservation value and directional drilling used sensitively to avoid direct impacts. Indirect impacts will be managed during construction.
- Several areas support isolated trees in parks and easements, comprising planted native or exotic species. Isolated trees are present within or directly adjacent to the proposed pipeline are present in Stevenson Park, MacClure Reserve, Heaton Park and surrounding Newcastle No.10 sub-station on Blue Gum Road. These areas do not constitute listed ecological communities and do not provide significant habitat for listed flora or fauna.

4.2. Environmental Planning and Assessment Act, 1979

Section 5A of the *EP&A Act 1979* was amended by the *Threatened Species Conservation Act 1995 (TSC Act)*. Section 5A aims to improve the standard of consideration and protection afforded to threatened species, populations and communities, and their habitats in the planning process. The outcome of any threatened species assessment should be that development is undertaken in a manner that is sensitive to the natural environment and that appropriate measures are undertaken to minimise adverse effects on the environment, threatened species and threatened species habitats.

The *Threatened Species Conservation Amendment Act* 2002 updates the previous eight-part test applied to determine whether an activity is likely to significantly affect threatened species, populations or ecological communities. The result is an amended ‘seven-part’ test, which is presented in **Appendix A**. A list of the threatened ecological communities subject to assessment under the guidelines of the TSC Act (7-part test) includes:

- Swamp Sclerophyll Forest; and
- Coastal Saltmarsh.

There was no threatened flora or fauna species or potential habitat identified immediately in the works area which may be subjected to direct impacts. Indirect impacts on potential habitat have been identified and are to be managed during construction. The assessment for endangered ecological communities has concluded that the proposed development is unlikely to impose a ‘significant impact’ on the identified endangered communities or their habitats as listed under the TSC Act, provided the recommendations of this report are adequately implemented.

This conclusion is based on the premise that the proposed development will not significantly reduce the area of land currently occupied by Endangered Ecological Communities and threatened species in the local area. The high conservation value of remnant vegetation in the area has been recognised and the proposed infrastructure associated with the project has been located where possible to minimise impacts on native vegetation including threatened flora, fauna and ecological communities.

Green and Golden Bell Frog

Targeted surveys were conducted for the nationally endangered Green and Golden Bell Frog (*Litoria aurea*) which is known from 21 locations on Kooragang Island (Hammer *et al* 2002). However neither the species nor potential habitat for this species was identified from the proposed works areas associated with project, and it is concluded that the proposal will not significantly impact on identified local populations of *L.aurea.*

4.2.1. Key Thresholds

Limited impacts on vegetation may result from the clearing activities required for the proposed pipeline infrastructure. From an ecological perspective the project will have very little impact to areas of Swamp Sclerophyll Forest and Coastal Saltmarsh in the study area. Measures to avoid impacts on EECs and potential threatened species habitat imposed by this development include:

- Appropriate placement of pipeline infrastructure based on the identification of EEC areas from field investigations, through locating the proposed pipeline on cleared lands, and along existing easements;
- Avoidance of impacts to the large pond area adjacent to the Hunter River within Steel River Industrial Area.
- Mitigation measures enforced during the construction of the project, particularly where potential impacts on vegetation have been identified adjacent to works areas, to minimise indirect impacts to adjacent wetland, saltmarsh and mangrove areas, such as altered hydrology regimes, sedimentation and nitrification.
- No areas of critical habitat will be impacted.

These measures are combined to ensure that any impacts on EECs and habitat for threatened species would be very minimal and that no areas of high ecological conservation value will be impacted.

4.3. Environment Protection and Biodiversity Conservation Act, 1999

Hunter Water has a statutory responsibility to comply with the requirements and intent of the Commonwealth EPBC Act in relation to the protection and management of threatened species. This assessment deals specifically with the significance of impacts from the Proposal on national listed threatened species in addition to migratory species which are known to use the Hunter River estuary.

Green and Golden Bell Frog

Targeted surveys were conducted for the nationally endangered Green and Golden Bell Frog (*Litoria aurea*) which is known from 21 locations on Kooragang Island (Hammer *et al* 2002). However neither the species nor potential habitat for this species was identified from the proposed works areas associated with project, and it is concluded that the proposal will not significantly impact on identified local populations of *L.aurea.*

Migratory Birds

A number of listed migratory bird species have been recorded from the Hunter River estuary as discussed in chapter 3. The proposal will not directly or indirectly impact on potential habitat for these species. Potential habitat identified near Tourle Street Bridge will be avoided through the use of directional drilling. Indirect impacts are to be managed during construction.

Conclusions of the Assessment

The assessment has been undertaken in accordance with the significant impact criteria for endangered and vulnerable species as outlined in the Significant Impact Guidelines relating to matters of national environmental significance (DEH 2006) to determine whether the proposal would have a significant impact on any of these species, and hence on a matter of national environmental significance. The assessment is provided in **Appendix B**.

The assessment has concluded that the proposed development is unlikely to impose a 'significant impact' on local populations of national threatened species or their habitats as listed under the EPBC Act.

5. Avoidance and Mitigation Recommendations

5.1. Avoidance

Wherever possible design of the proposed IWP and pipelines should consider restricting vegetation clearance through the placement of the pipeline in highly modified and degraded landscapes. Additionally, efforts should be made to conserve and appropriately manage areas of EECs within and adjoining the works areas and/or restore areas of vegetation disturbed from the Proposal, to offset any potential associated impacts.

5.2. Mitigation

Recommended measures for the protection of flora and fauna during construction of the proposed pipeline infrastructure are provided below. This includes measures regarding the protection of natural vegetation and fauna habitat, water quality and drainage, minimising the spread of invasive weed species and protecting local fauna species.

5.2.1. Natural Vegetation

- The majority of the proposal corridor for pipeline infrastructure is limited to modified habitats or maintained grassland, where impacts would be very minimal. Where the pipeline is established in open grass or modified land on the edges of remnant vegetation no heavy machinery should enter these areas;

- Lopping and direct avoidance should always be used to protect tree cover where possible. Where the tree density is sufficiently high to preclude the machinery, consideration should be given to the use of smaller, more manoeuvrable equipment to minimise the width of the disturbance corridor and protect trees and shrubs. Smaller equipment should be available during all stages of the construction and be utilised in all areas where a minimised disturbance width is required to preserve natural habitats;
- Stockpile, storage and depot sites should be situated in cleared/disturbed areas, such as maintained grassland areas and industrial lands.

5.2.2. Water Quality and Hydrology

The preservation of water quality is an important construction issue which needs to be managed effectively. Areas adjacent to saltmarsh, mangrove and wetland habitats in particular need to be protected from sediment laden, high nutrient run-off as well as hydrocarbons and other pollutants associated with construction machinery.

The hydrology regimes within the proposal area and adjacent areas need to be maintained following the construction of the proposed pipeline infrastructure to ensure associated impacts to adjacent sensitive habitats are minimised. The following mitigation measures are required to minimise potential impacts to water quality and hydrology regimes:

- Best-practice sediment and erosion controls would be adopted to prevent impacts to water quality and minimise run-off into adjacent ecologically sensitive areas where present;
- Directional bore drilling across the Hunter River needs to be managed to ensure that hydrology regimes are not impacted. Where possible the existing ground levels should be maintained.
- Appropriate measures to store and manage fuels and oils are to be adopted and spill containment equipment would be carried at all times.

The proposal is not likely to create any significant impacts on water quality or hydrology, provided adequate mitigation measures are implemented.

5.2.3. Introduced Species

The use of the construction machinery and exposure of the ground surface could potentially result in increased spread of weeds, including noxious species. Weed management practices need to be incorporated into the proposed construction activities for the pipeline infrastructure. All weed propagules present within the proposal area need to be removed and disposed of to ensure these are not spread along the proposal corridor or into adjacent habitats. Weed management strategies need to be identified in a Construction Management Plan for the Proposal so they can be effectively implemented.

Introduced fauna is currently prevalent and abundant within the study corridor at present. The construction would not be expected to increase populations or exacerbate the impacts of introduced fauna.

5.2.4. Trenching

Where trenches are used for laying pipelines these should be managed to prevent accidental fauna mortality. Wherever possible, trenches should not be left open overnight. Where trenches are left open overnight, inspections of the trench should be conducted in the morning for captured fauna. All fauna captured should be removed and released in adjacent natural habitats. If possible, trenches should be dug with shallow sloping ends to allow natural fauna escape. Prior to the filling of trenches a final inspection for captured fauna should be conducted.

5.2.5. Induction of construction personnel

Construction personnel should be aware of the importance of protected vegetation in the area, particularly the mangroves and coastal saltmarsh in proximity to the Hunter River. All construction personnel should be inducted to the study corridor and be aware of their environmental responsibilities, including the preservation of vegetation.

6. Conclusions

The information presented in this report has utilised field investigations and a review of available data to assess the potential impacts of the proposed Kooragang Industrial Water Plant in relation to relevant environmental and threatened species legislation.

The assessment has concluded that the proposed IWP is unlikely to impose a ‘significant impact’ on local populations of threatened species, endangered communities or their habitats as listed under the EPBC Act and TSC Act, provided the recommendations of this report are adequately implemented.

This conclusion is based on the fact that the proposed development will not impact ecologically sensitive wetland and estuarine habitats on Kooragang Island. The high conservation value of Kooragang Island wetlands has been recognised and in all cases the proposed pipeline infrastructure associated with the project has been located to avoid impacts on these ecological sensitive habitats.

7. References

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Appendix A Assessment of Significance (EP&A Act 1979)

Swamp Sclerophyll Forest

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Not Applicable

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not Applicable

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

- ***(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or,***
- ***(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,***

The proposal will impact up to 0.2 ha of Swamp Sclerophyll Forest based on the removal of this whole patch of vegetation. It is unlikely the whole patch will be removed and placement of the pipeline will ensure vegetation removal is minimised. This area of Swamp Sclerophyll Forest has possibly been planted and is highly disturbed from weed invasion in the understorey. Current disturbance regimes within Swamp Sclerophyll Forest mainly comprise weed invasion and edge effects. This area supports a moderate-high abundance of *Lantana camara*. Any tree removal within this area will be offset through the restoration of any areas disturbed by the Proposal. This EEC is relatively widespread to the north of the study area on the Tomago Sandbeds and Tilligerry Peninsula.

Considering the small area of this community potentially be removed and the highly modified nature of this area, and the relatively widespread occurrence of this community in the local area to the north of the study area the local occurrence of the community is not at risk of extinction.

(d) in relation to the habitat of a threatened species, population or ecological community:

- ***(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed,***
- ***(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
- ***(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population, or ecological community in the locality,***

The proposal will impact up to 0.2 ha of Swamp Sclerophyll Forest based on the removal of this whole patch of vegetation. It is unlikely the whole patch will be removed and placement of the pipeline will ensure vegetation removal is minimised.

The area of Swamp Sclerophyll Forest in the study area comprises a thin strip isolated from other significant areas of vegetation. Potential impacts from the proposal will be along the edge of the patch and the patch will not be dissected from the Proposal. Therefore vegetation will not be further fragmented or isolated as a result of the proposal.

The proposal may to contribute to further invasion of *Lantana camara*, however mitigation measures will be implemented to ensure weed propagules are not spread and disturbed areas are restored with native plantings following the construction. It is envisaged that the majority of this community retained adjacent to the proposal will retain most of the current disturbance regimes.

This area of Swamp Sclerophyll Forest has possibly been planted and is highly disturbed from weed invasion in the understorey. Current disturbance regimes within Swamp Sclerophyll Forest mainly comprise weed invasion and edge effects. This area supports a moderate-high abundance of *Lantana camara*. This area is unlikely to be of high importance to the long term survival of this community considering the above.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

No critical habitat for these species has been declared by the Scientific Committee.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

No specific recovery plans or threat abatement plans are relevant to this community.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed development has potential to exacerbate the following key threatening processes:

- Clearing of native vegetation.
- Loss of hollow-bearing trees.
- Invasion, establishment and spread of Lantana camara.
- Invasion and establishment of **exotic vines and scramblers.**
- Invasion of native plant communities by **exotic perennial grasses.**
- Removal of dead wood and dead trees.

Coastal Saltmarsh

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Not Applicable

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not Applicable

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(iii) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or,

(iv) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

A very small area of Coastal saltmarsh will be potentially directly impacted from the proposed pipeline infrastructure. This area of Coastal Saltmarsh is disturbed from weed invasion and the construction of a raised trail. The placement of the pipeline will ensure that impacts to this community are minimised with the raised trail being utilised for the majority of the proposal area.

The proposal may contribute to further weed infestations within adjacent areas of Saltmarsh such as Sharp Rush (*Juncus acutus*) which is present in the proposal area. The proposal may alter the current hydrological regime considering that directional bore drilling is being used to cross the

Hunter River. However, impacts to hydrological regime within the remaining areas of saltmarsh will be minimised through the implementation of strict development controls during construction.

To minimise indirect impacts during construction, strict development controls will be implemented including best practice sediment and erosion controls, temporary fencing to protect adjacent vegetation, and all construction materials should be contained within the proposal area.

Considering the small area of this community potentially impacted, large areas of this community in the Hunter River estuary and within Port Stephens to north and lake Macquarie to the south the local occurrence of this community is unlikely to be placed at risk

(d) in relation to the habitat of a threatened species, population or ecological community:

> ***(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed,***
> ***(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and***
> ***(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population, or ecological community in the locality,***

A very small area of Coastal saltmarsh will be potentially directly impacted from the proposed pipeline infrastructure. This area of Coastal Saltmarsh is disturbed from weed invasion and the construction of a raised trail. The placement of the pipeline will ensure that impacts to this community are minimised with the raised trail being utilised for the majority of the proposal area.

The proposal will not fragment any area of saltmarsh into two or more patches. Vegetation will only be potentially impacted on the edge of this area of Coastal Saltmarsh extending west from the existing Tourle Street bridge.

Considering the disturbed nature of this community in the study area and the large area of higher quality coastal saltmarsh nearby on Kooragang Island, this area is unlikely to be important in terms of the long-term survival of the community.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

No critical habitat for these species has been declared by the Scientific Committee.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

No specific recovery plans or threat abatement plans are relevant to this community.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The proposed development has potential to exacerbate the following key threatening processes:

- Clearing of native vegetation.
- Loss of hollow-bearing trees.
- Invasion, establishment and spread of Lantana camara.
- Invasion and establishment of **exotic vines and scramblers.**
- Invasion of native plant communities by **exotic perennial grasses.**
- Removal of dead wood and dead trees.

Appendix B Assessment of Significance on MNES (EPBC Act)

B.1 Green and Golden Bell Frog

1. Lead to a long-term decrease in the size of an important population of a species.

Targeted surveys were conducted for the nationally endangered Green and Golden Bell Frog (*Litoria aurea*) which is known from 21 locations on Kooragang Island (Hammer *et al* 2002). However neither the species nor potential habitat for this species was identified from the proposed works areas associated with project. Such habitats comprise very limited standing water, restricted to a few small brackish soaks on the proposed new plant site.

Pyke and White (1996) examined sites in NSW, where Green and Golden Bell Frogs are known to have been present, and compared the habitat at sites where breeding was identified with that at locations where breeding was not identified. Sites which supported breeding populations were found to contain water bodies which were still, shallow, ephemeral, unpolluted, unshaded, with aquatic plants and free of Mosquitofish and other predatory fish, with terrestrial habitats that consisted of grassy areas and vegetation no higher than woodlands, and a range of diurnal shelter sites. Breeding occurred in a significantly higher proportion of sites with ephemeral (temporary) ponds, rather than sites with fluctuating or permanent ponds, and where predatory fish were absent.

The results of the field survey of the proposed works area concluded that suitable habitat such as that described by Pyke and White (1996) does not occur in the project area.

2. Reduce the area of occupancy of an important population

The results of the field survey of the proposed works area concluded that suitable habitat such as for this species does not occur in the project area.

3. Will the action adversely affect habitat critical to the survival of the species?

There is no critical habitat for this species within the proposed works area.

4. Modify, remove, or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The results of the field survey of the proposed works area concluded that suitable habitat such as for this species does not occur in the project area.

5. Result in invasive species that are harmful to a vulnerable species becoming established in the threatened species habitat.

The results of the field survey of the proposed works area concluded that suitable habitat such as for this species does not occur in the project area.

6. Interferes substantially with the recovery of the species

Not expected, given that the works areas do not contain suitable habitat.

B.2 Migratory species

An action will require approval if the action has, will have, or is likely to have a significant impact on a listed migratory species. Several listed migratory bird species have been recorded from the Hunter River estuary and may utilise tidal flats, salt marsh and mangrove habitat.

▪ Black-tailed Godwit	▪ Grey-tailed Tattler
▪ Terek Sandpiper	▪ Wandering Tattler
▪ Red-necked Stint	▪ Ruddy Turnstone
▪ Eastern Curlew	▪ Ruff
▪ Curlew Sandpiper	▪ Pectoral Sandpiper
▪ Common Sandpiper	▪ Little Curlew

The EPBC Act Policy Statement 1.1 Significant Impact Guidelines (DEH 2006) were reviewed in assessing the significance of impacts from the proposal on migratory species. The guidelines indicate that an action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

1. Substantially modify (including fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species
2. Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for a migratory species; or
3. Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

The proposal will not directly or indirectly impact on potential habitat for these listed migratory species. Potential habitat identified near Tourle Street bridge will be avoided through the use of directional drilling. Indirect impacts are to be managed during construction.

Appendix C Flora Species List

Classification/ Scientific name	Recent Synonyms	Common Name	
Conifers			
PODOCARPACEAE			
Podocarpus elatus		Brown Plum-pine	
Flowering Plants - Dicotyledons			
AIZOACEAE			
Galenia pubescens		Galenia	i
APIACEAE			
Foeniculum vulgare		Fennell	i
Hydrocotyle bonariensis		Pennywort	i
APOCYNACEAE			
Gomphocarpus fruticosus		Narrow-leaved Cotton Bush	i
ASTERACEAE			
Ageratina adenophora	*Eupatorium adenophorum*	Crofton Weed	i
Ambrosia spp.		Ragweed	i
Artemisia verlotiorum		Mugwort	i
Aster subulatus		Wild Aster	i
Bidens pilosa		Cobblers Peg	i
Chrysanthemoides monilifera subsp. *rotundata*		Bitou Bush	i
Cirsium vulgare		Spear Thistle	i
Conyza spp.		Fleabane	i
Cotula coronopifolia		Water Buttons	
Delairea odorata	*Senecio mikanioides*	Cape Ivy	i
Gnaphalium spp.		Cudweed	i
Helianthus annuus		Common Sunflower	i
Hypochoeris radicata		Flatweed	i
Lactuca serriola		Prickly Lettuce	i
Senecio madagascariensis		Fireweed	i
Soliva sessilis		Bindyi	i
Sonchus asper		Toothed Sow-thistle	i
Sonchus oleraceus		Common Sow-thistle	i
Tagetes minuta		Stinking Roger	i
Taraxacum officinale		Dandelion	i
CARYOPHYLLACEAE			
Petrorhagia velutina		Pinks	i
Silene gallica			
Spurgularia marina		Saltspurry	i
CASUARINACEAE			
Casuarina cunninghamiana		River Oak	
Casuarina glauca		Swamp Oak	
Sarcocornia quinqueflora		Samphire	
Suaeda australis		Seablite	
CONVOLVULACEAE			
Dichondra repens		Kidney Weed	
CRASSULACEAE			
Bryophyllum delagoense		Mother-of-millions	i

Classification / Scientific name	Recent Synonyms	Common Name	
Ricinus communis		Castor Oil Plant	i
FABACEAE			
CAESALPINIOIDEAE			
Senna pendula var. *glabrata*	*Cassia coluteoides, Cassia bicapsularis*	Cassia	i
FABOIDEAE			
Melilotus indicus		Hexham Scent	i
Trifolium repens		White Clover	i
Vicia sativa subsp. *sativa*		Common Vetch	i
MIMOSOIDEAE			
Acacia binervia		Coast Myall	
Acacia irrorata subsp. *irrorata*		Rough Green Wattle	
Acacia longifolia		Sydney Golden Wattle	
Acacia saligna		Golden-wreath Wattle	i
FUMARIACEAE			
Fumaria muralis subsp. *muralis*		Wall Fumitory	i
GENTIANACEAE			
Centaurium erythraea		Common Centaury	i
LAURACEAE			
Cinnamomum camphora		Camphor Laurel	i
LYTHRACEAE			
Lythrum hyssopifolia		Hyssop Loosestrife	
MALVACEAE			
Modiola caroliniana		Red-flowered Mallow	i
MYRSINACEAE			
Anagallis arvensis		Pimpernell	i
MYRTACEAE			
Corymbia maculata	*Eucalyptus maculata*	Spotted Gum	
Eucalyptus spp.			
Eucalyptus botryoides		Bangalay	
Eucalyptus robusta		Swamp Mahogany	
Lophostemon confertus	*Tristania conferta*	Brush Box	
Melaleuca armillaris		Coast Paperbark	
Melaleuca quinquenervia		Broad-leaved Paperbark	
Melaleuca styphelioides		Prickly Paperbark	
OLEACEAE			
Ligustrum lucidum		Large-leaf Privet	i
Ligustrum sinense		Small-leaf Privet	i
Olea europaea subsp. *africana*		African Olive	i
PITTOSPORACEAE			
Pittosporum revolutum		Yellow Pittosporum	
PLANTAGINACEAE			
Plantago lanceolata		Plantain	i
Plantago major		Large Plantain	i
POLYGONACEAE			
Acetosa sagittata		Rambling Dock	i
ROSACEAE			
Salix babylonica		Weeping Willow	i
Verbascum virgatum		Twiggy Mullein	i
SOLANACEAE			
VERBENACEAE			
Lantana camara		Lantana	i

Classification / Scientific name	Recent Synonyms	Common Name	
Verbena bonariensis		Purple Top	i
Verbena rigidus		Creeping Verbena	i
Flowering Plants - Monocotyledons			
ARACEAE			
Colocasia esculenta		Taro	i
CYPERACEAE			
Bolboschoenus caldwellii	*Scirpus caldwellii*	Caldwells Club-rush	
Cyperus congestus			i
Cyperus eragrostis		Umbrella Sedge	i
Isolepis cernua	*Scirpus cernuus*	Nodding Club-rush	
Isolepis prolifera	*Scirpus prolifer*	Club-rush	i
JUNCACEAE			
Juncus acutus		Spiny Rush	i
Juncus bufonius		Toad Rush	i
Juncus kraussii subsp. *australiensis*	*Juncus maritimus* var. *australiensis*	Saltmarsh Rush	
POACEAE			
Arundo donax		Giant Reed	i
Avena fatua		Common Oat	i
Axonopus affinis		Carpet Grass	i
Bothriochloa macra		Red-leg Grass	
Briza maxima		Quaking Grass	i
Briza minor		Shivery Grass	i
Briza subaristata			i
Bromus catharticus	*Bromus uniloides*	Prarie Grass	i
Chloris gayana		Rhodes Grass	i
Ehrharta erecta		Panic Veldtgrass	i
Eragrostis curvula		African Lovegrass	i
Ischaemum australe var. australe		Ischaemum	
Lachnagrostis filiformis	*Agrostis avenacea*	Blown Grass	
Lolium spp. (hybrid swarm)		Rye Grass	i
Melinis repens	*Rhynchelytrum repens*	Red Natal Grass	i
Panicum maximum var. *maximum*		Guinea Grass	i
Paspalum dilatatum		Paspalum	i
Paspalum urvillei		Vasey Grass	i
Paspalum vaginatum	*Paspalum distichum*	Salt-water Couch	
Pennisetum clandestinum		Kikuyu	i
Phalaris aquatica		Canary Grass	
Phragmites australis		Common Reed	
Phyllostachys aurea		Fishpole Bamboo	i
Polypogon monspeliensis		Annual Beardgrass	
Sporobolus africanus	*Sporobolus indicus* var. *capensis*	Parramatta Grass	i
Sporobolus virginicus var. *minor*		Saltmarsh Couch	
Stenotaphrum secundatum		Buffalo Grass	i
TYPHACEAE			
Typha orientalis		Broad-leaf Cumbungi	
TOTALS			
Total Flora Species			*105*
Total Number of Families			*29*
Total Monocotyledons			*36*

Classification / Scientific name	Recent Synonyms	Common Name	
Total Dicotyledons			*69*
Total Conifer & Cycad Species			*1*
Total Exotic Species			*72*
ABBREVIATIONS:			
i = introduced (i.e. not indigenous to Australia)			
n = native Australian species not considered to be indigenous to the site			
c = cultivated (i.e. planted on the site)			
t = listed as a threatened species under State and/or Commonwealth legislation			
spp. = several species of the one genus (sometimes occurring as a hybrid swarm)			
sp. = unidentified species[4]			
sp. aff. = unidentified species with characteristics similar to the indicated species or genus[3]			
? = unconfirmed species[4]			
var. = variety			
subsp. = subspecies			
cv. = cultivar (i.e. a anthropogenic form of the species)			
agg. = an aggregate of several yet to be defined species			
NOTES:			
1. Recent 'synonyms' include misapplied names.			
2. A sample flora assemblage obtained from a short term survey, such as the present one, cannot be considered to be comprehensive, but rather indicative of the actual flora assemblage. It can take many years of flora surveys to record all of the plant species occurring within any area, especially species that are only apparent in some seasons.			
3. Not all species can be accurately identified in a 'snapshot' survey due to absence of flowering or fruiting material, etc.			
SCIENTIFIC NAMES & AUTHORITIES:			
Scientific names & families are those used in the *Flora of New South Wales* as maintained by the Royal Botanic Gardens (http://.plantnet.rbgsyd.gov.au).			
Orders and higher taxa are based on Angisperm Phylogeny Group (2003).			
For sake of simplicity, scientific names in this list do not include authorities. These can be found in the *Flora of New South Wales.*			

Appendix D Fauna species recorded in proximity to the works area

FAMILY/Scientific Name	Common Name
MAMMALS	
MURIDAE	
Rattus rattus *	Black Rat
Mus musculus *	House Mouse
LEPORIDAE	
Oryctolagus cuniculus *	Rabbit
REPTILES	
AGAMIDAE	
Physignatuhus lesuerii	Eastern Water Dragon
SCINCIDAE	
Calyptotis ruficauda	Red-tailed Calyptotis
Cryptoblepharus virgatus	Fence Skink
Eulamprus quoyii	Eastern Water Skink
Lampropholis delicata	Delicate Skink
AMPHIBIANS	
MYOBATRACHIDAE	
Crinia signifera	Common Eastern Froglet
Limnodynastes peronii	Striped Marsh Frog
Limnodynastes tasmaniensis	Spotted Grass Frog
BIRDS	
ANATIDAE	
Chenonetta jubata	Australian Wood Duck
ANHINGIDAE	
Anhinga melanogaster	Darter
PODICIOEDIDAE	
PHALACROCORACIDAE	
Phalacrocorax varius	Pied Cormorant
PELECANIDAE	
Pelecanus conspicillatus	Australian Pelican
ARDEIDAE	
Egretta novaehollandiae	White-faced Heron
THRESKIORNITHIDAE	
Threskiornis molucca	Australian White Ibis
FALCONIDAE	
Falco cenchroides	Nankeen Kestrel
CHARADRIIDAE	
Vanellus miles	Masked Lapwing
COLUMBIDAE	
Streptopelia chinensis *	Spotted Turtledove
MELIPHAGIDAE	
Anthochaera carunculata	Red Wattlebird

FAMILY/Scientific Name	Common Name
Manorina melanocephala	Noisy Miner
DICRURIDAE	
Rhipidura leucophrys	Willie Wagtail
Grallina cyanoleuca	Magpie-lark
CAMPEPHAGIDAE	
Coracina novaehollandiae	Black-faced Cuckoo-shrike
ARTAMIDAE	
Cracticus torquatus	Grey Butcherbird
Gymnorhina tibicen	Australian Magpie
Strepera graculina	Pied Currawong
PASSERIDAE	
Passer domesticus *	House Sparrow
HIRUNDINIDAE	
Hirundo neoxena	Welcome Swallow
SYLVIIDAE	
Cisticola exillis	Golden-headed Cisticola
STURNIDAE	
*Sturnus vulgaris**	Common Starling
Acridotheres tristis *	Common Myna

*introduced species

Appendix E Heritage Assessment

Appendix F   Noise Assessment

1. Noise

1.1. Noise

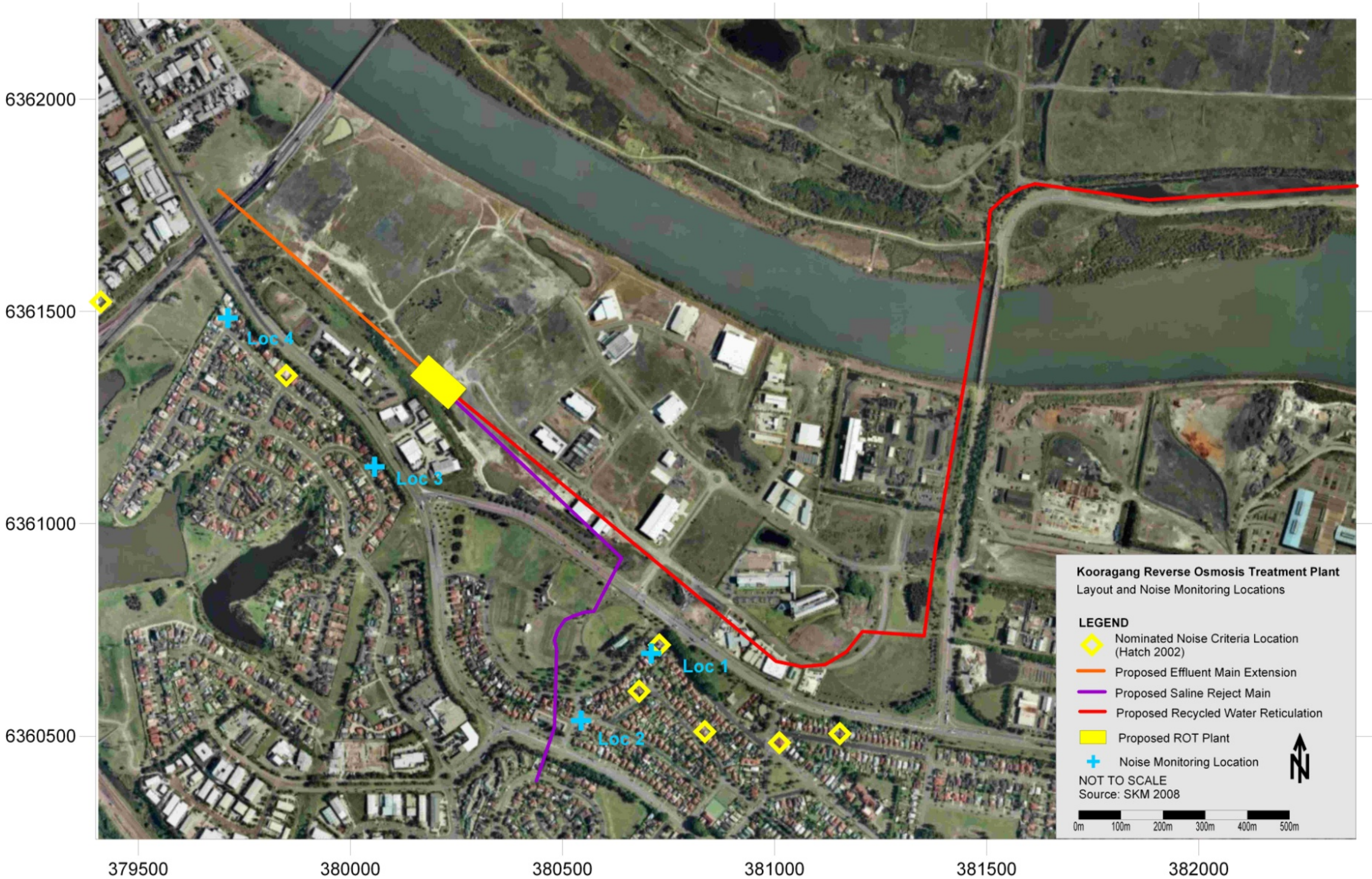
1.1.1. Noise Impact Assessment

Existing Environment

The Kooragang Industrial Water Scheme and the associated development is located within the Steel River Industrial Site on Industrial Drive, in the northern outskirts of the Newcastle Suburb of Mayfield. Surrounding land uses include heavy industry and warehouses in the areas to the south east through to the north west, while residential and recreational areas are located to the south and south west across Industrial Drive. Although the overall project may also require the upgrade of the Shortland Sewage Treatment Plant and associated infrastructure, for the purposes of this assessment, only the Kooragang components of this project will be assessed in this report. The proposed developments under this project are shown on **Figure 1-1**, and have been discussed below:

- Proposed Effluent Main Extension – This pipeline will extend from the existing sewage main pipeline, in the area of the Kooragang Island Coal Loader Rail Line in the north west, along a straight path to the ROT plant. Sensitive receivers in the vicinity of these works are located to the south along Decora Crescent Warabrook. The noise environment in this area is dominated by traffic noise from vehicles moving along Maitland Road, in addition to daytime industrial noise from both Shortland and Warabrook Industrial areas. Engine and track noise from coal trains passing along the railway line to the Kooragang Coal Loading Facility also impact the noise environment, particularly during the night time hours.
- Proposed Reverse Osmosis Treatment Plant (ROT Plant) – As discussed above, this development is proposed for the Steel River industrial site, located along Industrial Drive, Mayfield. Sensitive receivers in the vicinity are generally residential in nature, and predominately located to the south west along Decora and Olearia Crescents, Warabrook and to a lesser extent along Terry Street and Stevenson Avenue Mayfield. The noise environment at both these locations is by traffic noise from Maitland Road and Industrial Drive. In addition residents in Mayfield would be impacted by industrial noise from businesses along Industrial Drive, and daytime impacts from recreational activities in Stevenson Park.
- Proposed Saline Reject Main – Waste saline water produced as a by product of the RO process will be returned to the waste water system via a proposed new pipeline. It is proposed that this pipeline runs south east through the Steel River Industrial site, then turns south, under Industrial Drive and across Stevenson Park. It will then pass along Purdue Avenue, pass under Maitland Road and finally enter the existing wastewater system close to Casuarina Circuit Warabrook. The noise environment along this route is again dominated by traffic noise from

Figure 1-1 Site Layout Plan and Noise Monitoring Locations



both Maitland Road and Industrial Drive, in conjunction with generated by commercial land uses within Warabrook.

- Proposed Recycled Water Reticulation – This proposed pipeline will convey the treated water product to industrial sites on Koorgang Island, and is proposed to run south east, within the Steel River Industrial site until it reaches Tourle Street, it will then run approximately north, under the Hunter River, and then onwards to the eastern areas of Kooragang Island. Noise sensitive receivers are located along Gregson Avenue and Groongal Street Mayfield, however no sensitive receivers have been identified in the vicinity of the pipeline after it has crossed the Hunter River.

Construction traffic site access routes are predominately located along Industrial Drive, Tourle Street and Cormorant Road. These three roads are designated heavy vehicle transport routes, and as such are already heavily influenced by high levels of traffic noise.

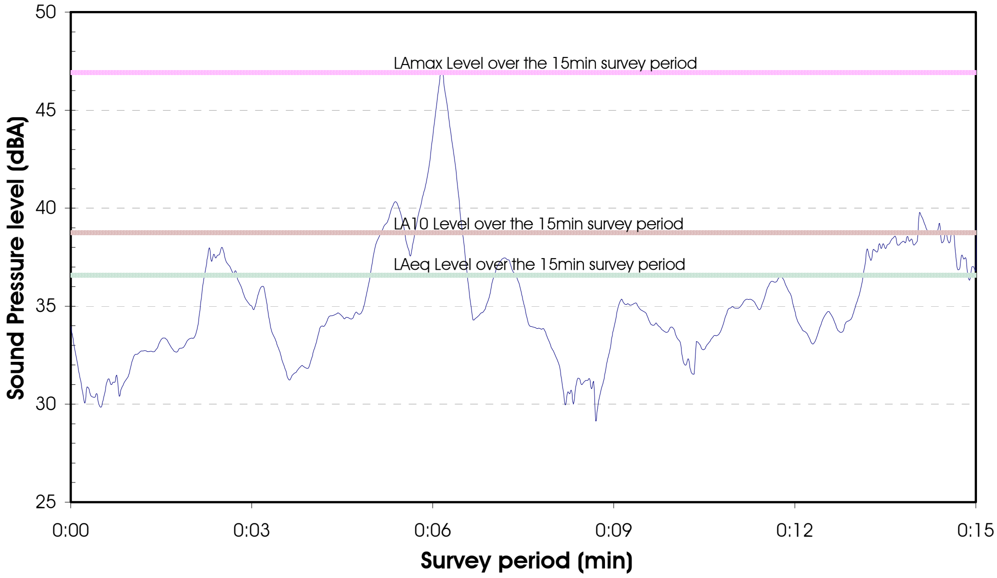
Environmental Noise Descriptors

Environmental noise is described using the following indices:

- L_{A90} - This is the noise level exceeded for 90% of the measurement period. For environmental noise, the interval is usually taken as 15 minutes, thus the L_{A90} represents the level corresponding to the quietest 90 seconds in a 15 minute period;
- RBL – Rating Background Level. This is the lowest 10th percentile, of all of the 15 minute L_{A90} levels within any assessment period (ie day, evening or night-time);
- L_{Aeq} The A-Weighted energy averaged sound pressure level over the measurement period. When assessing environmental noise, the assessment period is taken to be 15 minutes ($L_{Aeq(15 minutes)}$),.

The L_{A10} and L_{Aeq} noise descriptors are shown for a hypothetical 15 minute survey, is presented in **Figure 1-2.** Unlike the L_{A10} index, the L_{Aeq} is more sensitive to infrequent high level events, such as heavy vehicle movements' etc.

▪ **Figure 1-2: L_{Aeq} and L_{A10} Noise Indices**



Noise Monitoring Results

Existing, ambient noise levels were monitored during December 2008. The testing locations have been detailed in **Table 1-1** and were chosen to be representative of all residences where potential noise impacts may be experienced. The results of this background noise testing are included in **Table 1-2**.

▪ **Table 1-1 Sensitive Receiver Locations**

Reference	Address	Distance from Proposed ROT Plant (m)
Location 1	3 Stevenson Avenue, Mayfiield	770m
Location 2	Cnr Purdue and Thornton Avenues, Mayfield	840m
Location 3	18 Olearia Crescent, Warabrook	320m
Location 4	59 Decora Crescent,. Warabrook	585m

Unattended monitoring was carried out at Locations 1 and 4 using ARL noise loggers from the 5 December to 15 December 2008. In addition, attended monitoring was conducted at all locations for a period of 15 minutes during day, evening and night time periods.

▪ **Table 1-2 Background Attended Noise Monitoring Results, 6 – 16 December 2008**

	LA_{eq} - dB(A)	LA_{10} - dB(A)	LA_{90} - dB(A)
Location 1 (Unattended Results)			

	LA_{eq} - dB(A)	LA_{10} - dB(A)	LA_{90} - dB(A)
Day	62	66	54
Evening	59	63	47
Night	60	62	42
Location 2 (Attended Results)			
Day	58	60	48
Evening	53	53	44
Night	46	49	42
Location 3 (Attended Results)			
Day	53	56	46
Evening	51	53	42
Night	48	52	41
Location 4 (Unattended Results)			
Day	56	58	52
Evening	53	56	49
Night	54	55	49

Refer to **Appendix A** for the complete monitoring data

Overall, the results of ambient noise monitoring shows the area surrounding the Kooragang ROT Plant and associated pipe laying works to be a generally noisy environment, with typical night time background (LA_{90}) noise levels of approximately 40 - 45 dB(A). Both day and night time noise levels are impacted by noise from Industrial Drive and Maitland Road, in addition to coal trains approaching the Kooragang Coal Loading Facility. Noise sources such as crickets and frogs were audible during night time hours in the absence of traffic noise sources.

More specifically, the following observations were made about the noise environment at each location:

- Location 1 – 3 Stevenson Avenue, Mayfield. During all monitoring periods, the noise environment at this location was dominated by noise from traffic passing on Industrial Drive. Maximum noise levels generally occurred as a result of local traffic passbys. In the absence of traffic noise sources, noise generated by commercial activities located on Industrial Drive and in Warabrook was audible.
- Location 2 – Corner Purdue and Thornton Avenues, Mayfield. The dominant noise source at this receiver location was traffic passing on Maitland Road in addition to heavy vehicles on Industrial Drive. Local traffic was responsible for maximum noise levels, and local dogs were frequently audible.

- Location 3 – 18 Olearia Crescent, Warabrook. Most noise at this location occurred as a result of traffic on Maitland Road, in addition to occasional coal trains heading towards the Kooragang Coal Loading Facility.
- Location 4 – 59 Decora Crescent, Warabrook. The noise environment at this location was marginally louder than that recorded at Olearia Crescent, however noise sources were generally the same, with noise impacts from Maitland Road and the train line.

Local Meteorology

The region surrounding the proposed ROT plant experiences a warm temperate climate characterised by warm summers, mild winters, and moderate rainfall, throughout the year. Typical morning breezes show a tendency to originate in the north west, whilst south east breezes typically dominate during the afternoon.

The EPA maintains an automatic Meteorological Station at Smith Street in Newcastle West. This location is approximately 7km from the proposed ROT site, and has been judged as providing the most suitable meteorological observations to enable the validation of the unattended noise monitoring data. Data recorded during periods of rainfall and when the wind speed was greater than 5m/s was removed from the analysis according to the procedures outlined in *AS1055.1-1989 – Acoustics -Description and Measurement of Environmental Noise*. These time periods are highlighted on the noise graphs contained in **Appendix A**.

Noise Criterion

Operational Noise Criteria

Steel River Strategic Impact Assessment Study (SIAS)

This document was compiled in 1998 by APT Peddle Thorpe Urban Design Consultants for Newcastle City Council, and outlines design plans, including environmental management issues for industries located on the Steel River site. Section 8.4 of that document outlines noise criteria at sensitive receivers that should apply to noise emissions generated on the property. These have been outlined below in **Table 1-3**.

- **Table 1-3 Steel River Project Noise Limits**

Zone	Day time – dB(A)	Night time dB(A)
2.a) Residential on a main road or near an industrial area	LA_{10} = 48	LA_{10} = 30 LA_1 = 55
2.a) Residential	LA_{10} = 42	LA_{10} = 30 LA_1 = 49

Zone	Day time – dB(A)	Night time dB(A)
4.b) General Industrial	LA_{10} = 65	LA_{10}= 65
5.a) Special Uses (eg Church, School)	LA_{10} = 48	NA
5.b), c) and e) (Railway, road)	LA_{10} = 65	LA_{10} = 65
6.a) Open space and recreation	LA_{10} = 50	LA_{10} =40 LA_1 = 50
3.d) Commercial	LA_{10} = 50	LA_{10} = 40 LA_1 = 50

Hatch Report

In 2002, Hatch Engineering prepared *A Review of Noise Amenity Criteria to Industrial Noise Policy Guidelines for the Steel River Site*. This report was commissioned to overlay the SIAS, and to set project site criteria that complied with the NSW Industrial Noise Policy (NSW INP). The calculated noise criteria contained in this report have been shown below in **Table 1-4**. The locations nominated in this document have been shown on **Figure 1-1**.

- **Table 1-4 Hatch Report Steel River Site Noise Criteria**

Location	LA_{eq} Criteria – dB(A)			Sleep Disturbance Criteria – LA_1 dB(A)
	Day	Evening	Night	
Mayfield West Church - cnr Werribi St and Gregson Avenue, Mayfield	54	44	43	57
Kennards Hire - Ayrshire Crescent Warabroook	64	58	48	58
42 Travers Avenue, Mayfield	55	51	47	57
Cnr Stevenson Ave and Stevenson Park, Mayfield West	52	44	40	50
85 Decora Crescent, Warabrook	51	50	47	58
27 Groongal Street, Mayfield	55	52	48	58
20 Norris Street, Mayfield	48	44	41	52

It should be noted that these noise levels apply to overall noise from the Steel River Site, and not to the proposed HWC ROT Plant alone.

EMA Consulting Engineers

Further to the Connell Hatch report, EMA consulting engineers was commissioned to prepare a noise model for the Steel River site, and determine noise allotments for each site within the Development area that would allow noise emissions from the entire site to comply with with the values in the Hatch report. The allocated noise emissions for the Lots where construction of the

ROT plant is proposed have been detailed below in **Table 1-5** to **Table 1-7**. These are the noise guidelines that will be used for assessing the operational noise emissions from the proposed HWC ROT Plant.

- **Table 1-5 Day Time Noise Allocation for Lots 87 & 88 – dB(A)**

Frequency (Hz)	31.5	63	125	250	500	1k	2k	4k	8k	L / A
LWA	107	105	104	99	95	94	93	88	86	111 / 99.8

- **Table 1-6 Evening Noise Allocation for Lots 87 & 88 – dB(A)**

Frequency (Hz)	31.5	63	125	250	500	1k	2k	4k	8k	L / A
LWA	103	101	100	96	93	92	91	86	84	107 / 97.5

- **Table 1-7 Night Time Noise Allocation for Lots 87 & 88 – dB(A)**

Frequency (Hz)	31.5	63	125	250	500	1k	2k	4k	8k	L / A
LWA	92	90	89	86	81	79	78	75	73	96 / 85.5

Where these noise guidelines are unable to be met after all feasible and reasonable noise mitigated measures have been applied, provision exists for noise impacts to be managed by way of negotiated agreement with the affected community.

NSW Construction Noise Guidelines

Generally the acceptability of construction noise within a community depends on the potential for construction activities to interfere with day-to-day activities, the duration of the event, and the extent of its emergence above the background noise level. The DECC recommends that the free-field LA_{10}(15min) noise levels arising from a construction site (or works) and measured in the general vicinity of any noise sensitive premises should not exceed criteria detailed in the DECC's *Environmental Noise Control Manual (ENCM, 1994), Chapter 171 Construction Site Noise.* These noise criteria are dependent on the existing background noise levels and the expected duration of the works. The noise goals for construction activity are detailed in **Table 1-8**.

- **Table 1-8 DEC Construction Criteria Guidelines**

No.	Duration Of Works	DEC LA_{10} Guidelines
1	Construction period of 4	The LA_{10} level measured over a period of not less than 15 minutes when

	weeks and under	the construction site is in operation must not exceed the background level by more than 20dB(A).
2	Construction period > 4 weeks and not exceeding 26 weeks	The LA_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10dB(A).
3	Construction period > 26 weeks	The EPA does not provide noise control guidelines for construction periods greater than 26 weeks duration. It is generally accepted that provided LA_{10} noise levels from the construction do not exceed a level of 5dB(A) above background, then adverse (intrusive) noise impacts are not likely to be experienced at nearest sensitive receptor locations.

Given these guidelines, and a construction period of greater than 26 weeks the following LA_{10} construction noise goals have been calculated:

- Location 1 (Stevenson Avenue) 59dB(A)
- Location 2 (Purdue Avenue) 53dB(A)
- Location 3 (Olearia Crescent) 51dB(A)
- Location 4 (Decora Crescent) 57dB(A)

Restrictions are also placed on the hours of construction to ensure that the acoustic amenity of the closest residences is protected. Hours of operation for construction works should follow standard construction times listed below wherever possible.

Monday to Friday: 7am to 6pm;

- Saturday: 8am to 1pm; and
- No audible construction work to take place on Sundays or public holidays.

The exception to these hours of operation would be where work involves integration with existing operating wastewater systems; by necessity these activities require work times to coincide with periods of low wastewater flow and will be conducted between the hours of 1am and 6am.

Vibration Guidelines

The effects of vibration can be divided into three main categories:

- Where occupants or users of the building are disturbed or inconvenienced;
- Those in which the building contents may be affected; and
- Circumstances in which the integrity of the building or the structure itself may be prejudiced.

Vibration may be transmitted through the ground or as low frequency pressure waves through the air. There are two types of vibration criteria that are used when assessing impacts. The first is the human comfort criteria, which as the name suggests is designed to minimise impacts that may disrupt day to day activities of humans. The other form of vibration criteria is designed to avoid damage to buildings and structures.

Human Comfort

Vibration from construction activities with regard to human comfort within a building should comply with the *Department of Environment and Conservation (DEC) Assessing Vibration: A Technical Guideline*. It is not always possible to undertake major infrastructure projects in very close proximity to residential dwellings and comply with the more stringent human comfort criterion. However, this should always be used as the objective to aim for, and be the basis of assessment.

When assessing vibration, the NSW Department of Environment and Climate Change (DECC, formerly the DEC) classifies vibration as one of three types:

- Continuous – Where vibration occurs uninterrupted and can include sources such as machinery and constant road traffic;
- Impulsive – Where vibration occurs over a short duration (typically less than 2 seconds) and occurs less than three times during the assessment period, which is not defined. This may include activities such as occasional dropping of heavy equipment or loading / unloading activities; and
- Intermittent – Occurs where continuous vibration activities are regularly interrupted, or where impulsive activities recur. This may include activities such as rock hammering, drilling, pile driving and heavy vehicle or train passbys.

Continuous and Impulsive Vibration Criteria

Human sensitivities to vibration differ depending on the direction of movement. For this reason, the criteria outlined below in **Table 1-9**, provides different acceptable levels for vibration based on the direction of movement.

To assess human comfort vibration the measured levels are subjected to a summation and averaging method. This yields a result referred to as a Root Mean Squared Value (rms). This value is measured in m/s^2, and is derived from the acceleration of the measured surface as a result of the induced vibration.

- **Table 1-9 Preferred and maximum weighted rms values for continuous and impulsive vibration acceleration (m/s^2) 1- 80 Hz**

Location	Assessment Period	Preferred Values		Maximum Values	
		Z axis	X + Y axes	Z axis	X + Y axes
Critical Areas	Day + Night time	0.0050	0.0036	0.010	0.0072
Residences	Day time	0.010	0.0071	0.020	0.014
	Night time	0.007	0.005	0.014	0.010
Schools, Churches, Offices	Day + Night time	0.020	0.014	0.040	0.028
Workshops	Day + Night time	0.04	0.029	0.080	0.058

Source: The guidelines are taken from Table 2.2 of the DECC Guidelines.

Intermittent Criteria

Where vibration is classed as intermittent, the DECC uses a vibration dose value (VDV) to assess levels of vibration (refer **Table 1-10**). VDV is calculated using the acceleration rate of the vibration event and the time over which it occurs. This method is more sensitive to the level of vibration than its duration, and is a measure of the total quantity of vibration perceived. The VDV method is the most suitable for assessing human comfort amenity from intermittent vibration sources.

- **Table 1-10 Acceptable Vibration Dose Values (VDV's) for Intermittent Vibration (m/s$^{1.75}$) 1- 80 Hz**

Location	Day time (7am-10pm)		Night time (10pm-7am)	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Critical Areas (eg Hospitals)	0.10	0.20	0.10	0.20
Residential buildings	0.20	0.40	0.13	0.26
Offices, Schools, Churches, etc	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.6

Criteria for Building Structures

When assessing potential vibration impacts on building structures, the velocity and direction of the movement is measured. The measurement is referred to as the Peak Particle Velocity (PPV), presented in mm/s.

Vibration from construction activities, with regard to building damage, is assessed using the German standard DIN 4150: Part 3 – 1999 *Effects of Vibration on Structures* (DIN Guideline). The DIN Guideline values for PPV measured at the foundation of various structures are summarised in **Table 1-11**.

- **Table 1-11 Guideline Values of Vibration Velocity, for Evaluating the Effects of Short Term Vibration DIN 4150**

Line	Type of Structure	Guideline Values for Velocity, v_i (mm/s)			
		Vibration at the Foundation at a Frequency of			Vibration at Horizontal Plane of Highest Floor at all Frequencies
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz*	
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (eg buildings that are under a preservation order)	3	8 to 10	8 to 10	8
* For frequencies above 100Hz, at least the values specified in this column shall be applied					

Noise Impact Assessment

Operational Noise Assessment

Operational noise from the development may be generated through the followings processes:

- **Table 1-12 Potential Operational Noise Impacts**

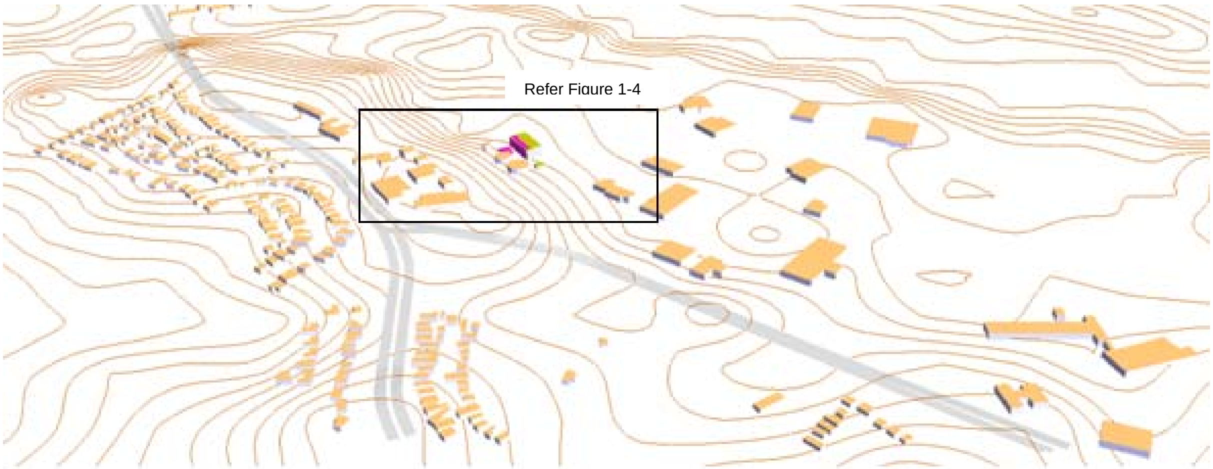
Process	Potential Noise Impacts
Pipeline Noise	Whilst gas pipelines may generate noise impacts at close range, it is generally considered that noise levels generated as a result of liquid travelling through pipelines is negligible. In addition it is also anticipated that all pipes associated with this project will be located approximately 1 – 1.5m below the ground surface level, resulting in considerable attenuation of any pipe generated noise. Consequently the new pipelines are not expected to be audible at any sensitive receiver locations.
ROT Plant Noise	In order to estimate the likely noise levels at sensitive receivers resulting from the operation of the proposed ROT plant, a noise model was developed using SoundPLAN V6.5, a modelling package that is accepted and endorsed by numerous agencies nationally and internationally, including the NSW DECC.

Modelling Methodology

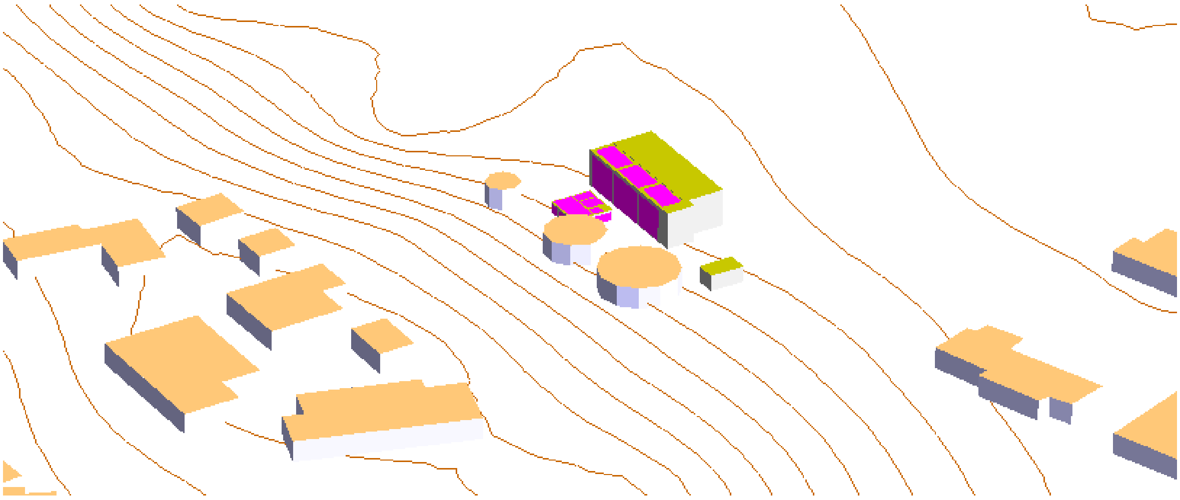
When calculating industrial noise emissions to the broader environment, the CONCAWE prediction algorithm provides the most appropriate form of assessment and was used during modelling. The noise model was constructed using terrain contours and aerial photography to accurately identify the locations of sensitive receivers. The model has been run under assumed 'worst case' meteorological conditions for the transmission of noise. This assumes a wind speed of 3ms^{-1} towards receivers, and a Pasquil Stability class of 'F'.

The proposed layout was obtained from Hunter Water in AutoCAD format, and directly imported into the SoundPlan model. According to information provided to SKM by HWC, the construction of the building is to be of 'Tilt Up' Concrete, with an insulated steel roof. Diagrams showing the area of modelling and the site layout have been included in **Figure 1-3** and **Figure 1-4**.

- **Figure 1-3 SoundPlan Modelled Terrain and Building Locations**



▪ **Figure 1-4 ROT Modelled Site Layout**



The following noise sources were considered inside the building (refer **Table 1-13**), and the reverberant and direct contributions to external noise levels were calculated allowing for facade and roof insulation losses. The resulting noise levels were assigned to each building facade.

▪ **Table 1-13 ROT Plant – Equipment Noise Levels**

Equipment	Estimated Sound Pressure Level (1m) - dB(A)	Equipment	Estimated Sound Pressure Level (1m) - dB(A)
Inlet Feed Pump No. 1	94	Recirculation System	82
Inlet Feed Pump No. 2	94	Service Water Pump 1	85
Inlet Feed Pump No. 3	94	Service Water Pump 2	85
Re-circulation Pump 1	82	Service Water Pump 3	85
Blower No. 1	87	Compressor (Duty)	100
RO Feed Pump No. 1	92	Compressor (Standby)	100
RO Feed Pump No. 2	92	Product Water Pump 1	85
RO Feed Pump No. 3	92	Product Water Pump 2	85
RO Flush Pump No. 1	82	Backwash Pump No. 1	92
Lift Pump No. 1	85	Site Washdown Pump	98

SKM

Model Inputs

In the calculation of facade noise levels and the establishment of the SoundPlan model, the following variables were used:

- **Table 1-14 Model Inputs**

Parameter	Notes
Roof Construction – Insulated Steel Sheet	20dB(A) Attenuation*
Wall Construction – 100mm Tilt Up Concrete	50 dB(A) Attenuation*
Absorption Coefficient - Walls	0.1**
Absorption Coefficient - Roof	0.6**
Absorption Coefficient - Floor	0.02**

* From Acoustics in the Built Environment: Advice for the Design Team. Templeton and Sacre, 2007.

** From Noise and Vibration Control Engineering: Principles and Applications. Ver and Beranek, 2007.

Modelling Results

SIAS Noise Modelling Results

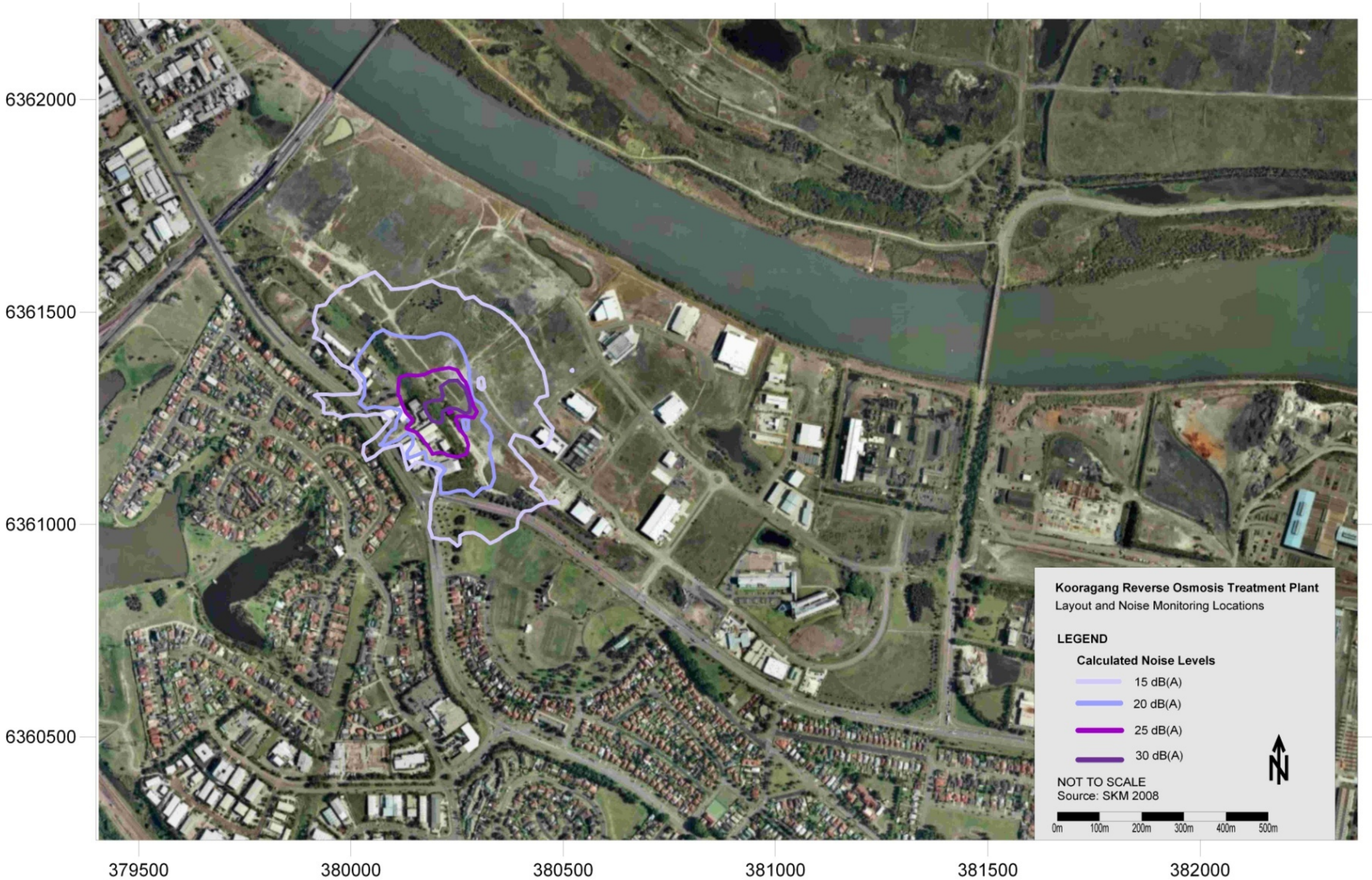
The results of the operational noise modelling have been outlined in **Figure 1-5** and **Table 1-15**.

- **Table 1-15 Point Calculated Noise Results**

Location	Steel River SIAS Noise Criteria – LA_{10}		Calculated Noise Level LA_{eq} (15min)
	Daytime	Night time	
Location 1	48	30	7 dB(A) - 1.8m 10 dB(A) - 2nd Floor
Location 2	48	30	7 dB(A) – 1.8m
Location 3	48	30	8 dB(A) – 1.8m 10 dB(A) – 2nd Floor
Location 4	48	30	10 dB(A) – 1.8m 12 dB(A) – 2nd Floor

As can be seen from the results outlined above, noise levels generated during the operation of the ROT plant have been calculated to remain well within the Steel River LA_{10} noise criteria at all times, and are expected to be inaudible at all sensitive receiver locations.

Figure 1-5 SoundPlan Modelling Results – Operational Noise Contours (1.8m Receiver Hieght)



Assessment of Noise Allocation

The Hatch report outlines noise emission allocations for each lot on the Steel River Site. Under these guidelines, sound power levels have been outlined for each lot; and where these allocated noise levels are met at all sites within Steel River, total noise levels at sensitive receiver locations should also be met.

Calculation of the sound power level of the ROT plant has been carried out in accordance with the ISO8297.1994, *Acoustics – Determination of Sound Power Levels of Multisource Industrial Plants for Evaluation of Sound Pressure Levels in the Environment – Engineering Method*, and with reference to the guidelines contained in the EMA Noise Allocation Entitlements document.

It should be noted that available data for both facade and roof noise attenuation covered the spectral band between 63 Hz and 4kHz, whereas criteria require assessment against the range of 31.5Hz to 8kH. Attenuation levels for these frequencies were estimated using the available data.

As the ROT plant will be operating throughout the 24 hour daily period, noise levels have been assessed against the night time noise criteria, as these contain the strictest limits. The relavent criteria and calculated sound power levels have been given below in **Table 1-16**.

- **Table 1-16 EMA Noise Allocation and Estimated Noise Emissions at Building Facade**

Frequency (Hz)	31.5	63	125	250	500	1k	2k	4k	8k	Lin / Awt
LWA - Criteria	**92**	**90**	**89**	**86**	**81**	**79**	**78**	**75**	**73**	**96.1 / 85.5**
Calculated LWA – RTO Plant	97	84	72	64	57	54	58	53	47	97/65

The results outlined above show that compliance with the total A weighted Lot Noise Allocation is expected to be easily achieved. A minor exceedance of the linear noise allocation is observed, and this is possibly due minor inaccuracies involved in the estimation of attenuation values for building facades and roof materials in 31.5Hz frequency band.

The overall exceedance is considered minor, particularly when considering the ease of compliance in the A weighted noise level.

Sleep Disturbance Assessment

Standard noise emissions from a treatment plant of this type are expected to be relatively constant, and as such are expected to be rarely observed at levels higher than those outlined above. Given this, it should be noted that where activities are foreseen that may generate atypical noise impacts, these are carried out during normal business hours where possible.

Construction Noise Assessment

The following sections will provide as assessment of likely noise levels that may be encountered during the construction of the ROT plant and the associated pipelines. In the preparation of each construction noise assessment, calculations have been based on the equipment noise levels contained in **Table 1-17**. This data has been sourced using internal and government databases, in addition to manufacturer provided noise specifications.

- **Table 1-17 Estimated Equipment Noise Levels**

Equipment	Sound Power Level – dB(A)
Truck - Product 15 t	109
Concrete Pump + Truck - low load on pump	129
Hand Tools Air Wrench	101
Hand Tools Metal Cut off Saw	97
Hand Tools Metal Grinder	107
Hand Tools Ratchet Gun (Air)	101
Hand Tools TIG Welder	98
Generator - Diesel	107
Excavator Cat 245	104
Crane Mobile 100-200kW	105
Air Compressor	100
Piling Rig - Hydraulic Hammer (tubular steel, 4T hammer)	115
Concrete Pump + Truck - low load on pump	129
Rockbreaker Cat - 240E	120
Micro Tunnelling Equipment	107

The noise levels have been used in conjunction with standard noise attenuation methods to calculate likely construction noise levels at the nominated locations. These calculations are based on basic attenuation methods, and do not consider the absorption of noise by local geography or vegetation. Meteorological influences are considered using the CONCAWE algorithm, with a weather category of Class 6. This assumes a clear sky and a light breeze blowing towards the receiver location. In addition, it has been assumed that all equipment described below would be operating at the same time at the nearest point to the receiver. As such these calculations should be seen as possible maximum noise levels, and may not be reached in actuality.

Pipelines – Open Trench Excavation

Open trench excavation is the preferred method of pipe installation for this project, and will be used as a preference to micro tunnelling methods wherever possible. For the purposes of noise assessment, the open trench excavation for the installation of pipes has been divided into two work stages. The first would include the initial excavation, and may require the use of an excavator, product trucks, rockbreaker and generator. Stage two would involve the pipe installation and subsequent back filling; this work is expected to require equipment such as a concrete truck and pump, metal saws, ratchet guns, grinders, TIG welders, excavators and compactors.

Noise criteria for each pipeline construction have been based on the nearest background noise monitoring locations, and these have been set out below in conjunction with an estimated separation distance where compliance with the construction noise criteria would be expected. Therefore where construction works are separated from sensitive receivers by distance less than this estimated compliance separation distance, construction noise levels may potentially exceed the nominated criteria.

- **Table 1-18 Open Trench Excavation – Initial Excavation, Noise Criteria and Separation Distances**

Pipeline Construction	Noise Criteria dB(A)	Nearest Sensitive Receiver (m) / Land Use	Estimated Compliance Separation Distance (m)
Main extension	51	220m Residential	**395m**
Saline Reject	53	20m Residential	**315m**
Product Pipeline	59	20m Industrial / Offices 175m Residential	160m

- **Table 1-19 Open Trench Excavation – Installation and Filling, Noise Criteria and Separation Distances**

Pipeline Construction	Noise Criteria dB(A)	Nearest Sensitive Receiver (m) / Land Use	Estimated Compliance Separation Distance (m)
Main extension	51	220m Residential	**710**
Saline Reject	53	20m Residential	**560**
Product Pipeline	59	20m Industrial / Offices 175m Residential	**280**

In addition, estimated noise levels at nominated distances have been calculated for reference (refer **Table 1-20**.

- **Table 1-20 Open Trench Excavation – Estimated Noise Levels at Nominated Distances**

Distance (m)	Estimated Noise Level Initial Excavation – dB(A)	Estimated Noise Level Installation and Filling – dB(A)
10	70	80
50	71	77
100	68	74
250	58	65
500	49	57
1000	39	48

Examination of the noise level calculations contained in **Table 1-18** and **Table 1-19** show that exceedances of the construction noise guidelines may be experienced at times during pipe laying activities, and the following conclusions may be made:

- Mains Extension Pipeline – The nearest identified sensitive receiver location to these activities was residential and located at a distance of approximately 220m from the proposed work areas. Exceedances of construction noise guidelines have been calculated to potentially occur where excavation works take place within 395m of a residential receiver location, or where installation and filling activities occur within 710m of receiver locations.
- Saline Reject Pipeline – The proposed route for this pipeline passes close to numerous residential properties, along Purdue Avenue and Casurina Circuit with the nearest identified sensitive receiver location to these activities located at a distance of approximately 20m from the proposed work areas. Calculations have shown that exceedances of construction noise guidelines may occur wherever excavation works take place within 315m of a residential receiver location, or where installation and filling activities occur within 560m of receiver locations.
- Product Pipeline – The major component of the proposed route for this pipeline is remote from residential properties, and few noise impacts are expected, however whilst the pipe laying works are located close to the ROT plant, residential receivers have been identified at approximately 175m. It is not expected that initial excavation works will result in noise level exceeding NSW construction noise guidelines, however during installation and filling works, potential exceedances may be experienced where works take place within 280m of sensitive receiver locations.

It should be noted that pipe laying works would continually move along the length of the pipe route, and as such each location would be exposed to construction noise for short time periods. It is expected that this will reduce the overall impact of construction related noise at each receiver location, however where activities take place at separation distances less than the calculated compliance distance, construction activities should be undertaken in consultation with the affected community.

Attended noise monitoring should be carried out at representative residential properties during construction of the Saline Reject Pipeline, and in response to community complaints during other construction stages.

Pipelines - Boring

Boring of pipelines may be required where excavation is not possible, and is expected to be required when encountering obstacles such as Maitland Road and the Hunter River. Where boring is required, potential boring techniques may include Horizontal Directional Drilling (HDD) or micro tunnelling. Where micro tunnelling is required, two work stages would be necessary. The first would involve excavation of a drill pit, an would utilise equipment such as an excavator, compactor and possible hydraulic rock hammer. This stage is followed by the actual tunnelling activities, which would use saw cutters, hand tools, compressors and generators and the drilling rigs themselves. Where HDD boring techniques are used, the drill rig sits on the surface, and as such no excavation is required, however noise impacts from the drill rig would typically be somewhat increased.

For the purposes of the following calculations, no screening by the drill pit has been assumed for Stage 2 of micro tunnelling, and therefore where HDD drilling is proposed, the results contained in **Table 1-22** would be considered valid for this process.

Noise criteria for each proposed boring location have been based on the nearest background noise monitoring locations, and these have been set out below in conjunction with an estimated separation distance where compliance with the construction noise criteria would be expected. Therefore where construction works are separated from sensitive receivers by distance less than this estimated compliance separation distance, construction noise levels may potentially exceed the nominated criteria.

- **Table 1-21 Pipeline Boring – Drill Pit Excavation, Noise Criteria and Separation Distances**

Boring Location	Noise Criteria dB(A)	Nearest Sensitive Receiver (m) / Land Use	Drill Pit Excavation Estimated Compliance Separation Distance (m)
Industrial Drive	53	165m Residential	**315**
Maitland Road	53	10m Residential	**315**
Tourle Street	59	165m Industrial / Offices	160

Boring Location	Noise Criteria dB(A)	Nearest Sensitive Receiver (m) / Land Use	Drill Pit Excavation Estimated Compliance Separation Distance (m)
Bridge		830m Residential	

- **Table 1-22 Pipeline Boring – Micro Tunnelling, Noise Criteria and Separation Distances**

Boring Location	Noise Criteria dB(A)	Nearest Sensitive Receiver (m) / Land Use	Micro Tunnelling Estimated Compliance Separation Distance (m)
Industrial Drive	53	165m Residential	**280**
Maitland road	53	10m Residential	**280**
Tourle Street Bridge	59	165m Industrial / Offices 830m Residential	140

In addition, estimated noise levels at nominated distances have been calculated for reference.

- **Table 1-23 Pipeline Boring – Estimated Noise Levels at Nominated Distances**

Distance (m)	Estimated Noise Level Drill Pit Excavation	Estimated Noise Level Micro Tunnelling
10	70	68
50	71	66
100	68	63
250	58	54
500	49	46
1000	39	37

Examination of the noise level calculations contained in **Table 1-21** and **Table 1-22** show that exceedances of the construction noise guidelines may be experienced during pipe laying works at both Industrial Drive and Maitland Road. Residential properties in both these areas are located within the calculated compliance separation distance, and construction activities will generally need to be undertaken in consultation with local residents as works progress.

Attended noise monitoring should be carried out at representative residential properties during boring activities, and in response to community complaints during other construction stages.

ROT Plant

For the purposes of this noise assessment, construction of the ROT plant will be divided into two main work stages. The first will involve the laying of the concrete slab and general site preparation. This will require equipment such as hydraulic hammer piling rig, excavators, concrete trucks and pumps, delivery trucks and hand tools. The second stage will involve the installation of the building structures and internal pipes and equipment. It is expected that these works will require a large crane, delivery trucks, assorted hand tools and an excavator.

Estimated noise levels during each stage of the construction process have been calculated and included in **Table 1-24**.

- **Table 1-24 ROT Plant Construction – Estimated Noise Levels at Sensitive Receivers**

Location	Construction Noise Criteria – LA_{10} dB(A)	Estimated Noise Level Site Preparation – LA_{10} dB(A)	Estimated Noise Level Construction – LA_{10} dB(A)
Location 1	59	51	36
Location 2	53	50	35
Location 3	51	**62**	47
Location 4	57	55	40

With the exception of properties on Oleria Crescent during initial site preparation works, the calculated construction noise levels contained in **Table 1-24** show that construction of the ROT plant will not result in noise impacts at nearby receiver locations. It should be noted however that these calculations do not take into account losses due to local geography, and significant screening of construction noise would be expected to be obtained by the ridge between the construction site and Warabrook residential properties. As a consequence of this expected noise reduction, exceedances of construction noise guidelines are considered unlikely, and it is considered that monitoring should only be necessary where complaints are received.

Traffic Noise Assessment

Construction traffic site access routes are predominately located along Industrial Drive, Tourle Street and Cormorant Road. These three roads are designated heavy vehicle transport routes, and as such are already heavily influenced by high levels of traffic noise. The expected increase in heavy vehicle traffic generated by construction of this development is considered negligible.

However it is recommended that most deliveries of construction materials occur during normal business hours where possible. Additionally where trucks are required to wait for site access, they should be parked away from residential properties.

Vibration Assessment

Construction Vibration Assessment

The prediction of vibration impacts from construction activities is not straight forward as the type and size of equipment, the proximity to a sensitive receiver and the local geology all play a significant role the in the actual vibration levels experienced at a residence. Estimates of vibration levels may be made, however these are based on typical conditions and equipment types. The primary method of ensuring no adverse vibration impacts are encountered is by setting vibration limits and carrying out monitoring during construction at potentially affected receiver locations.

An indication of generally accepted minimum buffer distances is presented in **Table 1-25**. This table identifies distances where the more stringent human comfort criteria are likely to be met. These levels are for reference only and are not to be applied as project specific limits.

- **Table 1-25 Recommended Buffer Distances for Human Comfort Impacts from Ground Vibration**

Equipment Type	Buffer Distances from Sensitive Receiver
Hydraulic rock breaker	15 m
Vibratory Roller	25 m
Truck movements	10 m

It should be noted that this discussion is based on ground borne vibration. Vibration may also be air borne and transmitted in the form of low frequency sound waves. This type of vibration may travel much further distances from the construction area than ground borne vibration, and its magnitude is difficult to predict.

A qualitative assessment of potential vibration impacts during each construction stage have been outline below in

Table 1-26:

■ Table 1-26 Potential Construction Vibration Impacts

Construction Stage	Potential Vibration Impacts
Effluent Main Extension	Given the proposed construction program for the open trench excavation required for the installation of the effluent main extension, and considering the distances to nearest receivers, no off site vibration impacts to either human comfort or building integrity are anticipated. However, where vibration inducing construction activities, such as hammering or dynamic compaction, take place within 10m of onsite buildings or structures, vibration levels may approach building damage limits, and consideration should be given to the monitoring of vibration levels by a qualified contractor.
Saline Reject Main	The proposed route for the saline reject main pipeline passes within 10m of numerous residential properties. Several activities involved with open trench excavation have the potential to result in result in vibration impacts at nearby receivers. These primarily include rock breaking, and compacting activities. As pipe laying works are carried out in close vicinity to residential receivers, vibration levels may impact human comfort levels where vibratory roller and rock breaking works are carried out within 25m of a building. Vibration monitoring should be carried out at these locations at the commencement of work and where vibration impacts are considered possible. Where construction works are undertaken at distances of more than 10m from residential receivers, any risk of building structural damage is considered low, however where rockbreaking or compacting works are undertaken within 10m, building inspections or vibration monitoring should be considered.
Product Water Reticulation	The majority of the proposed route for the product water pipelines is more than 400m from any building structures. However within the Steel River site, some industrial buildings are located approximately 20 - 40m from the proposed pipeline route. Given the nature of these industries, and the short term nature of pipe installation works, particularly vibration inducing activities, vibration impacts on human comfort levels are considered unlikely, however should works be undertaken within 10m of building structures, building inspections or vibration monitoring should be considered.
ROT Plant	Given the proposed construction program for the RO plant, and considering the distances to nearest receivers, no off site vibration impacts to either human comfort or building integrity are anticipated.

Operational Vibration Assessment

ROT Plant

Given the distances to nearby structures and the equipment proposed for use during the operation of the ROT plant, no operational vibration impacts to either human comfort or building integrity are anticipated.

Noise Mitigation Strategies

The construction noise levels are target levels that are to be achieved where possible. It is recognised that during various stages of the construction activities these levels may be exceeded. Exceedances of the construction noise levels will be mitigated where possible, through management of the proposed construction works. The construction contractor will prepare a Noise Management Plan (NMP) as part of the CEMP which will detail how work is to be carried out to minimise the impact of noise from construction operations on adjacent properties. Mitigation measures could include operational controls such as:

- Where both reasonable and feasible, the substitution by an alternative process,
- Where both reasonable and feasible, restricting times when noisy work is carried out, and
- Notifying the nearest noise receptors of the works plan and expected levels of noise well in advance of the works occurring.

The NMP should cover all significant noise generating activities and include specific measures for control of the overall work site. Mitigation measures are listed below and should be considered during the planning phase, construction phase and hours of work. The recommendations for measures to reduce noise impacts at nearby sensitive receivers are:

- Maximising the offset distance between noisy plant items and Sensitive Receivers;
- Construction timetabling to minimise noise impacts - this may include time and duration restrictions and respite periods, or the scheduling of particularly noisy activities outside school examination periods or normal classroom hours;
- Avoiding using noisy plant simultaneously and/or close together;
- Orienting equipment away from Sensitive Receivers;
- Carrying out loading and unloading away from Sensitive Receivers;
- Use of dampened tips on rock breakers if required;
- Selection of plant and equipment based on noise emission levels;
- Use of alternative construction methods; and

- Where OH&S issues can be safely managed, the use of alternatives to reversing alarms such as spotters, closed circuit television monitors and 'smart' reversing alarms.

Where it has been identified as necessary, noise monitoring should be undertaken in response to community complaints to ensure noise mitigation measures are effectively implemented.

Vibration Mitigation Strategies

Where construction activities, including hammering or dynamic compaction, may cause damage through vibration to nearby public utilities, structures, buildings and their contents a Building Condition Inspection of these items may be undertaken by the construction contractor.

Vibration monitoring should be considered where work that involves a vibratory or impact source is used within 25m of a building. Vibration monitoring would also take place where a member of the community reports adverse effects or where the contractor expects that the vibration criteria are likely to be exceeded at a vibration sensitive receiver.

The construction contractor will prepare a Vibration Management Plan as part of the CEMP to show how work will be carried out to minimise the impacts from construction operations on adjacent properties. This could include operational controls such as:

- substitution by an alternative process
- restricting times when work is carried out
- consultations with affected residents

The Vibration Management Plan will detail how construction vibration will be managed for various plant items working adjacent to buildings. Records will be kept as evidence of compliance with these construction vibration and air blast restrictions.

Noise and Vibration Summary

Operational impacts from the proposed Kooragang ROT Plant are considered unlikely. Compliance of A weighted noise levels with the Lot noise allowances contained in the Hatch Report was shown, although a minor exceedance of linear noise levels was calculated.

Noise impacts at receiver locations were calculated to be inaudible during operation of the proposed ROT Plant.

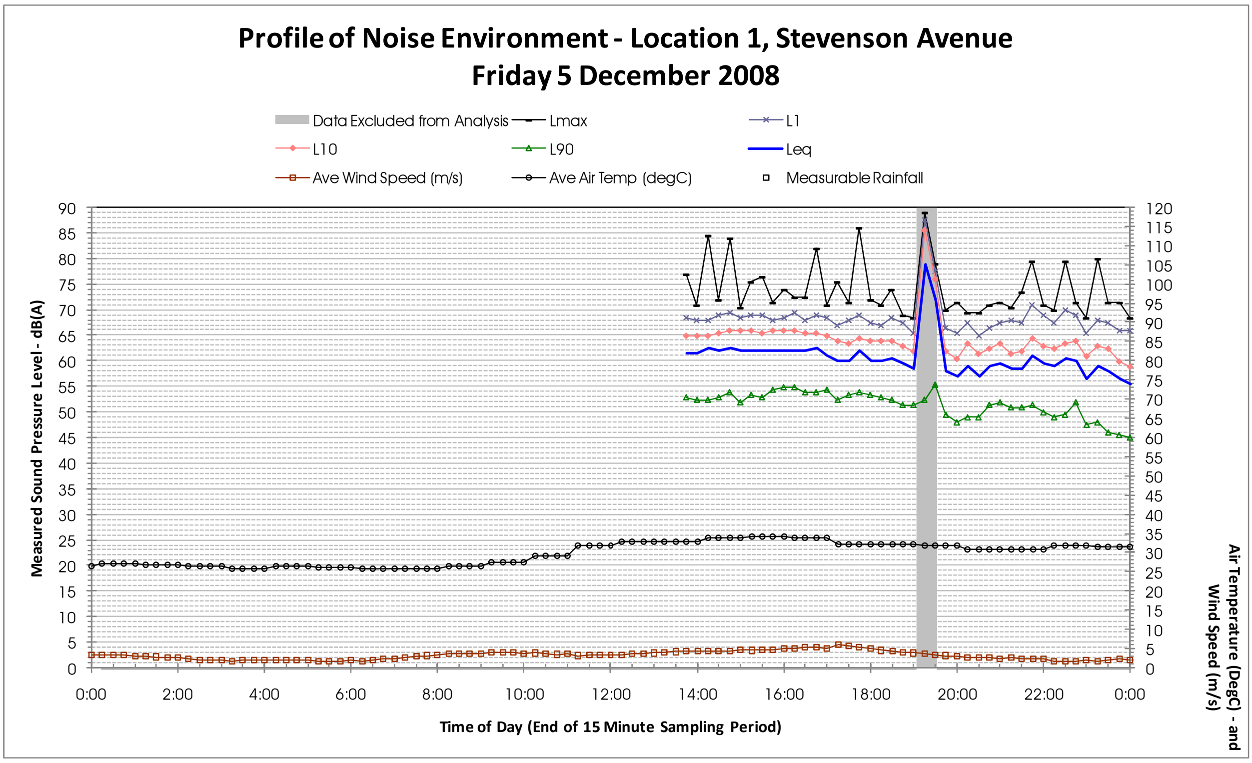
Construction of the ROT plant is not expected to result in noise impacts at receiver locations, however noise levels during pipe laying works and micro tunnelling activities may result in short term impacts at numerous residential properties.

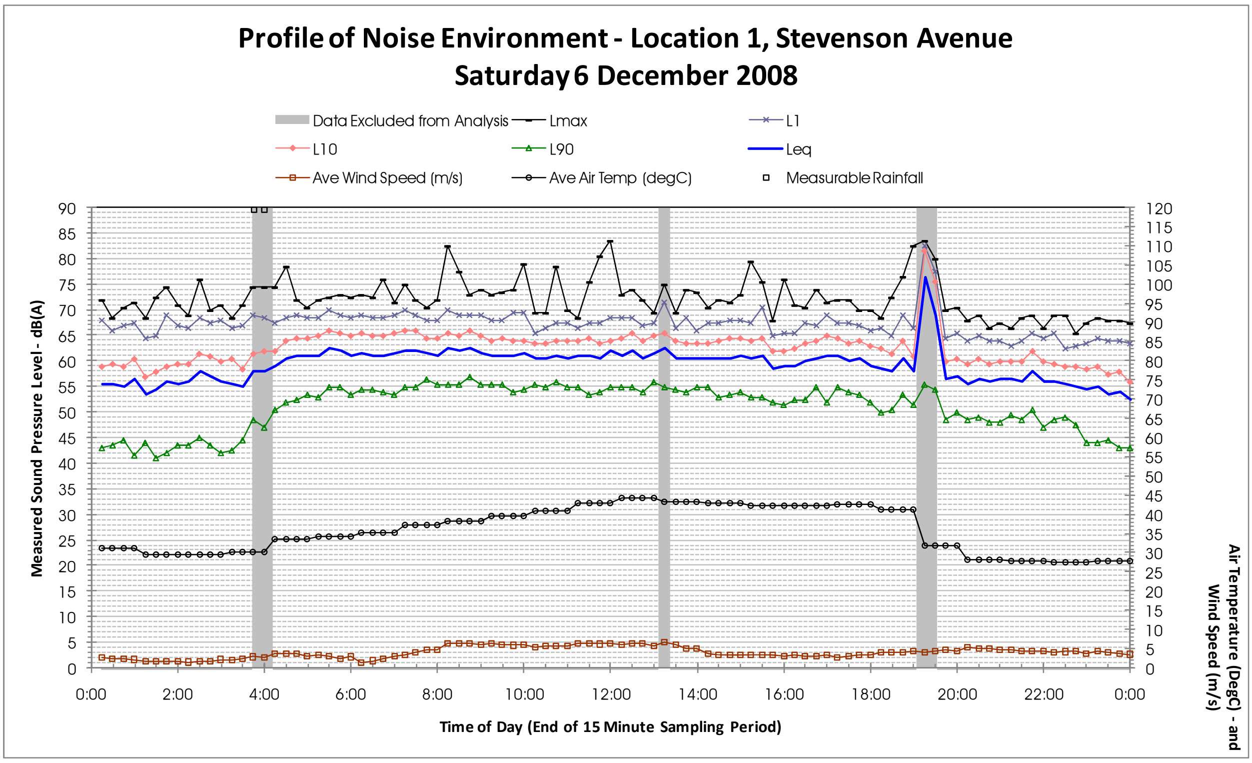
Where pipe laying works are carried out adjacent to residential properties, particularly during the installation of the Saline Reject Main, vibration monitoring or building inspections may be considered necessary.

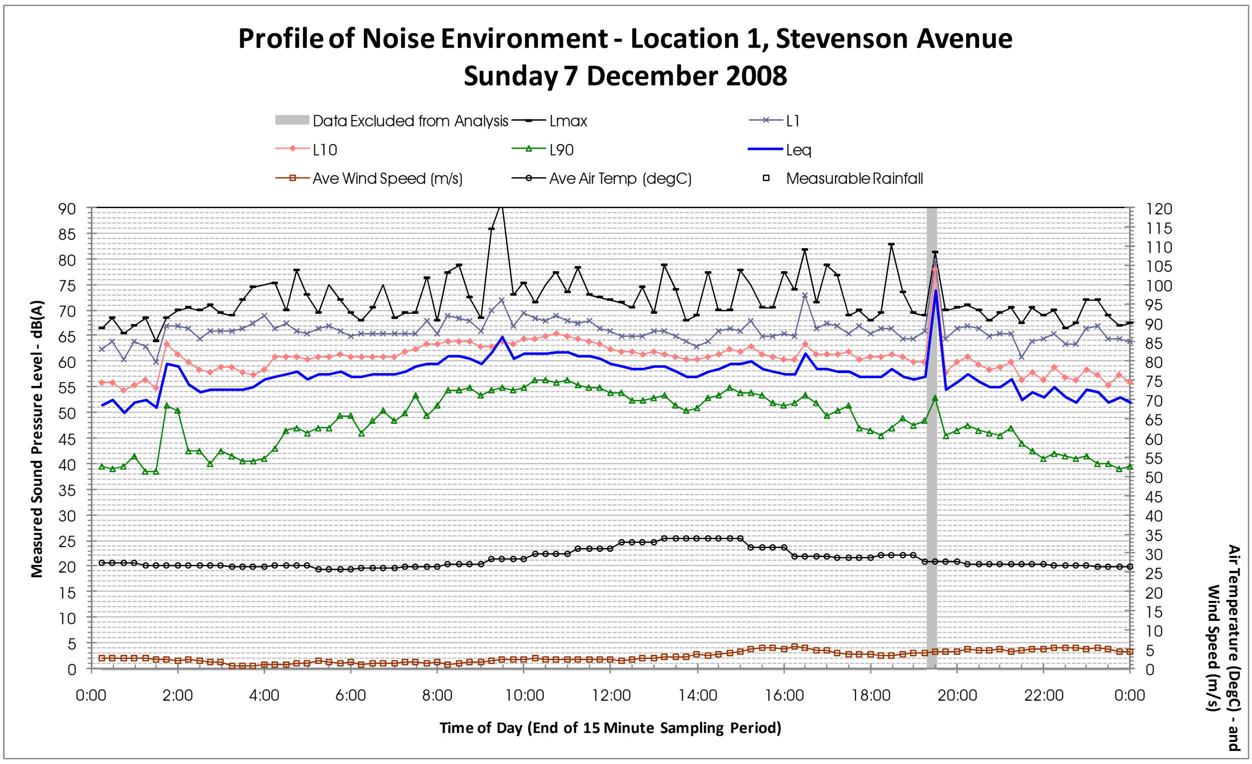
The preparation of a Noise Management Plan (NMP) for incorporation into the Construction Environmental Management Plan (CEMP) has been recommended.

Appendix A

Noise Monitoring Data



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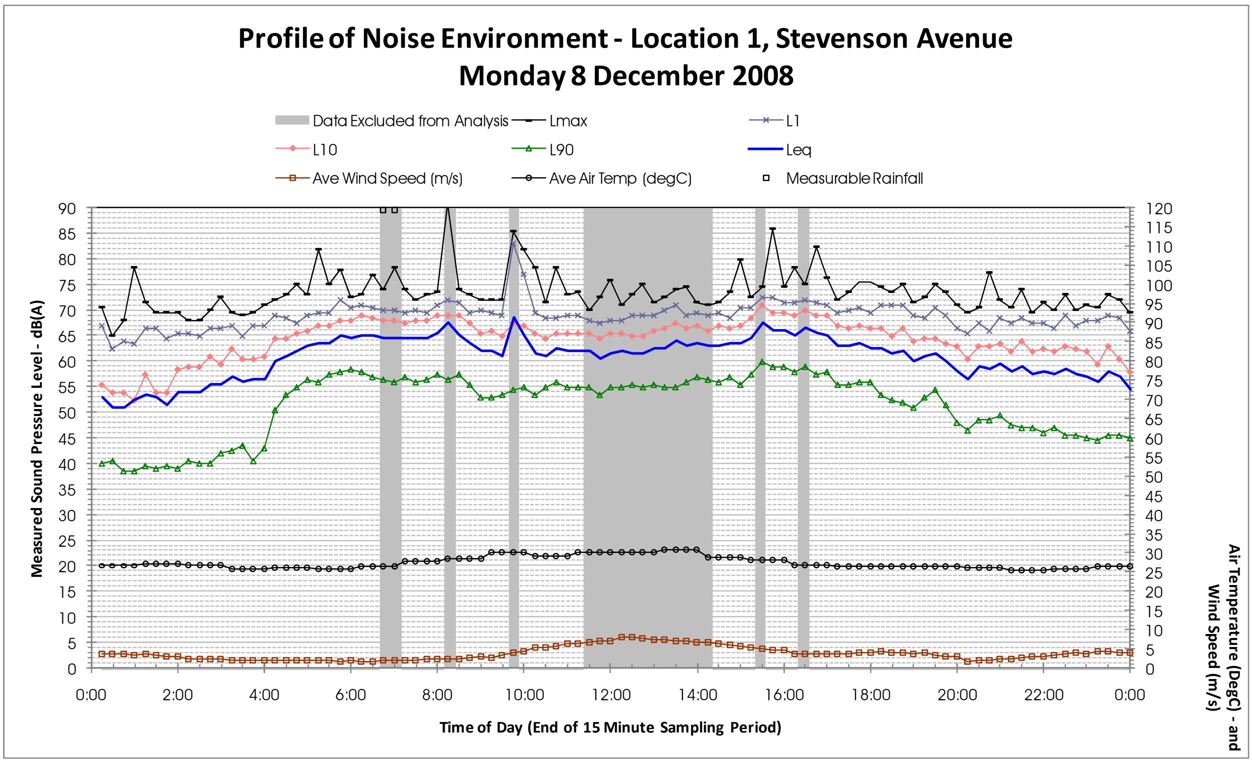
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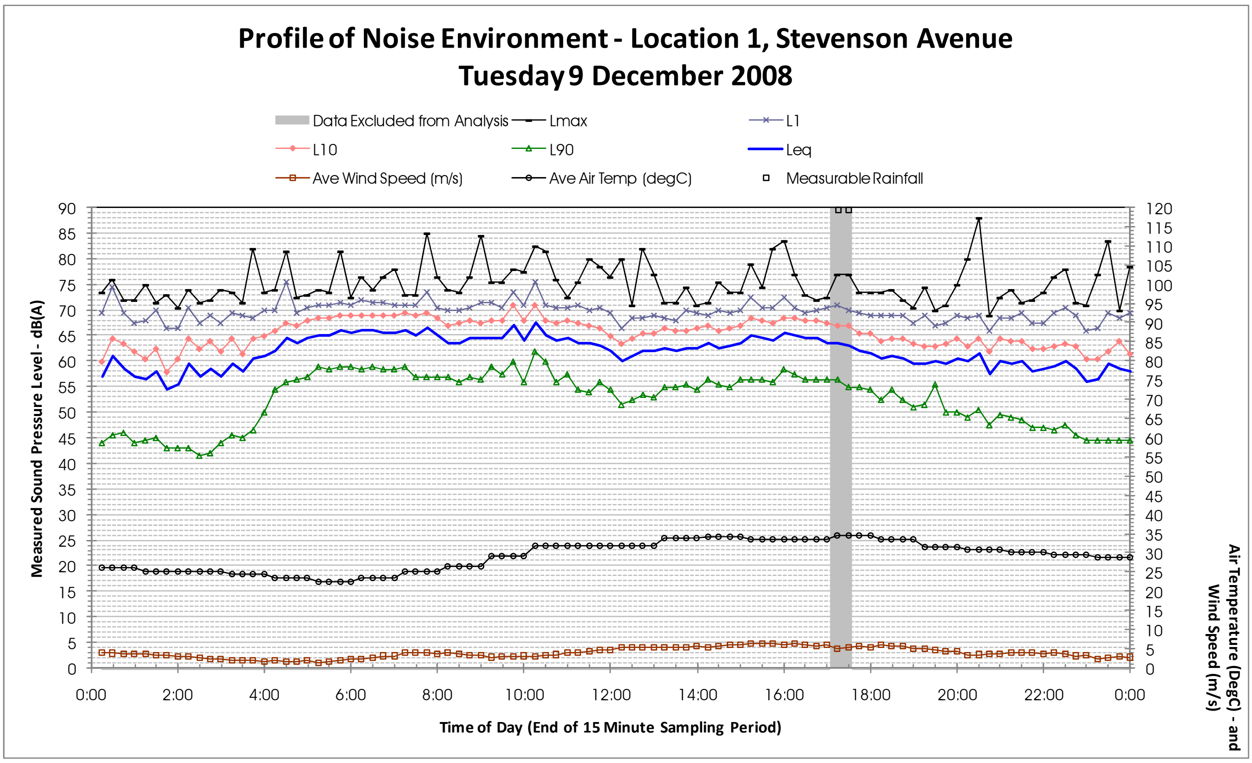

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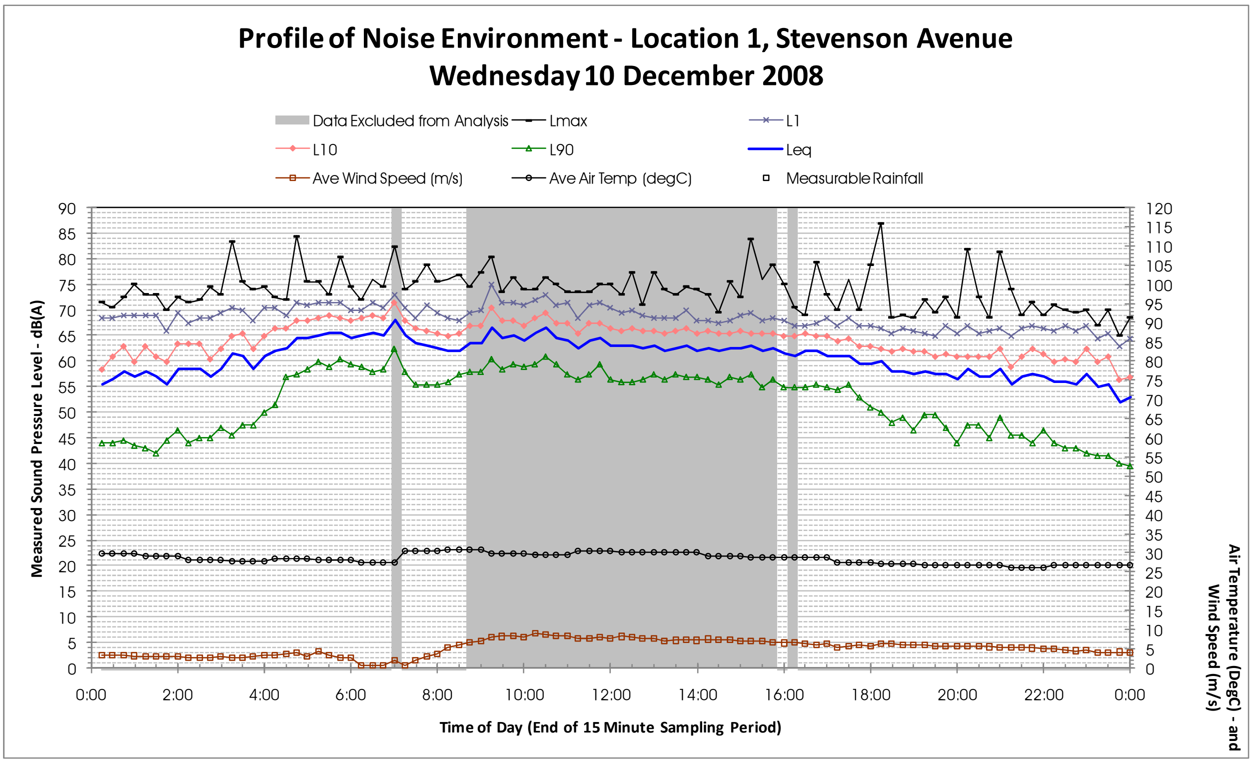

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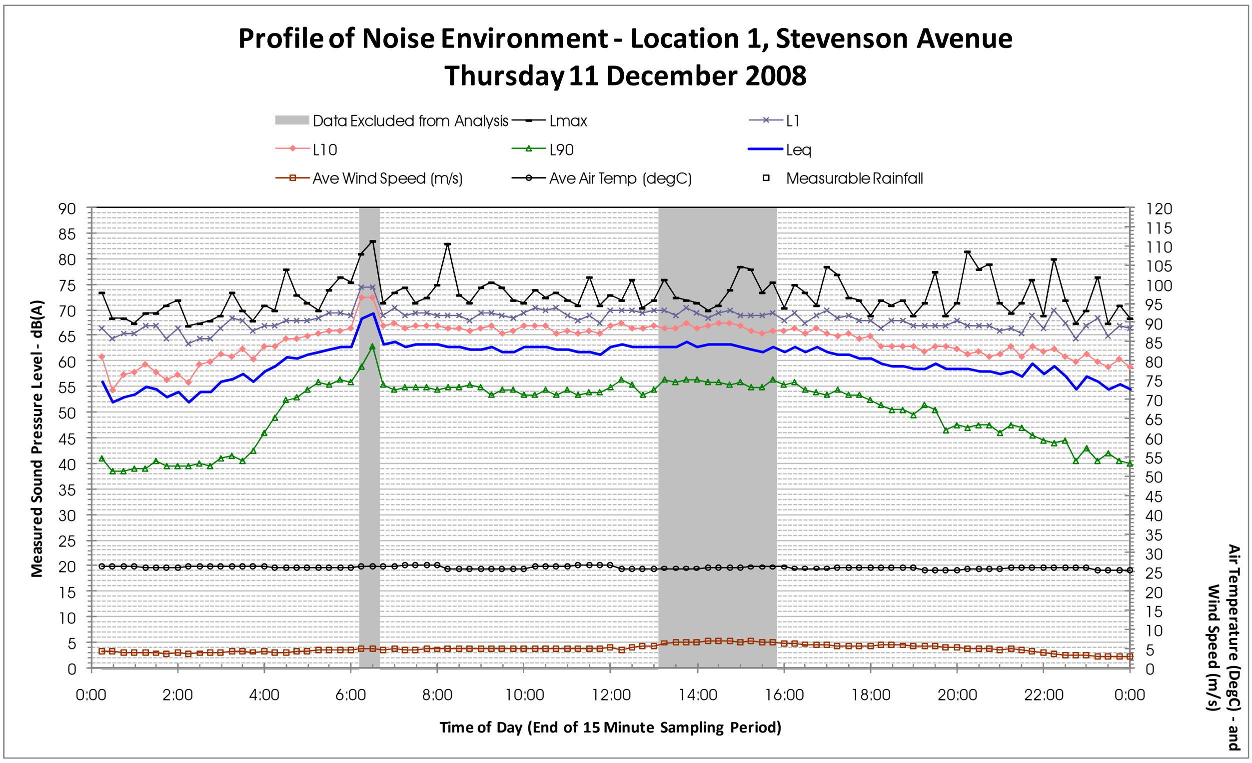

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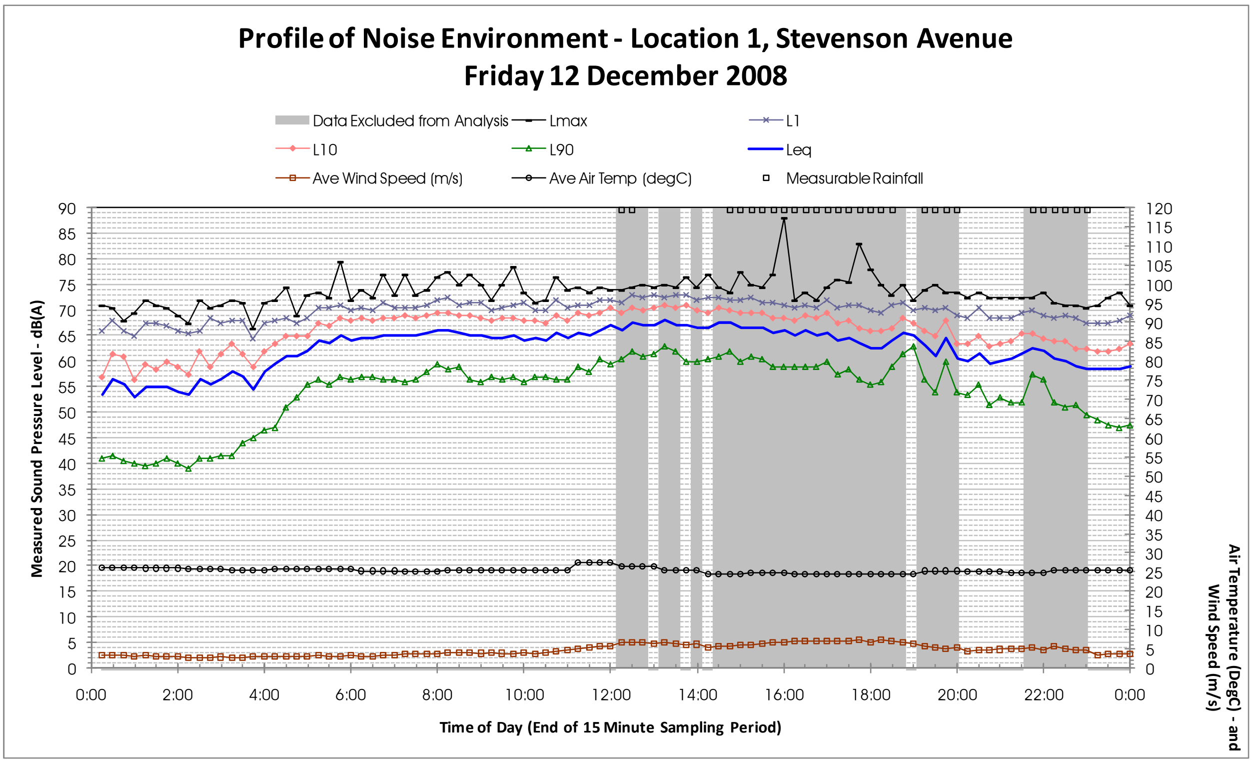

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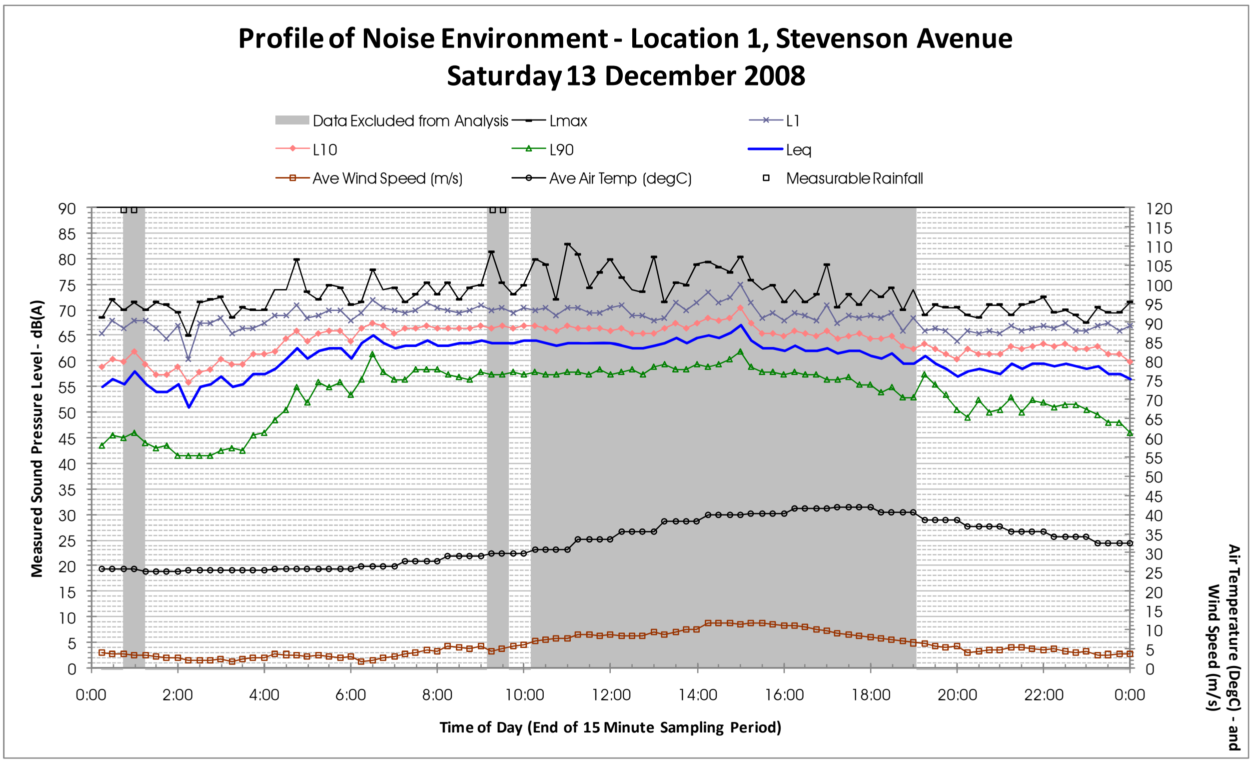
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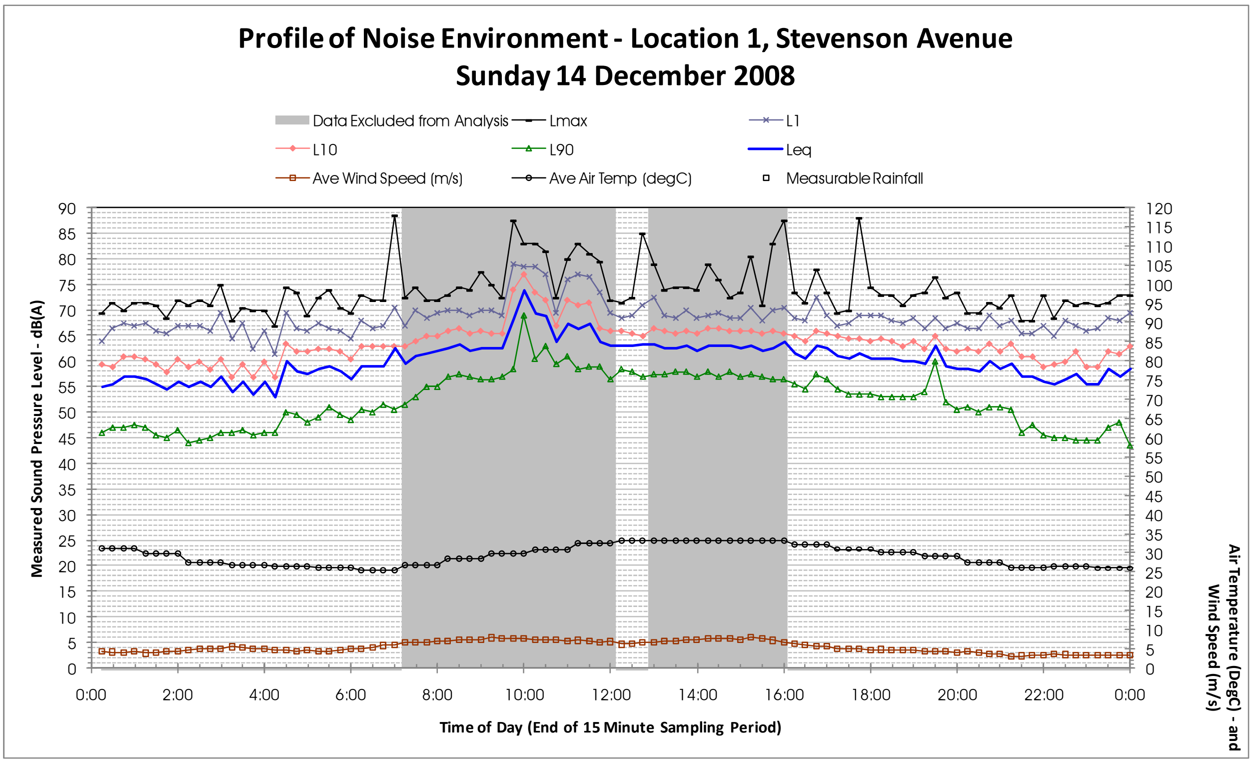
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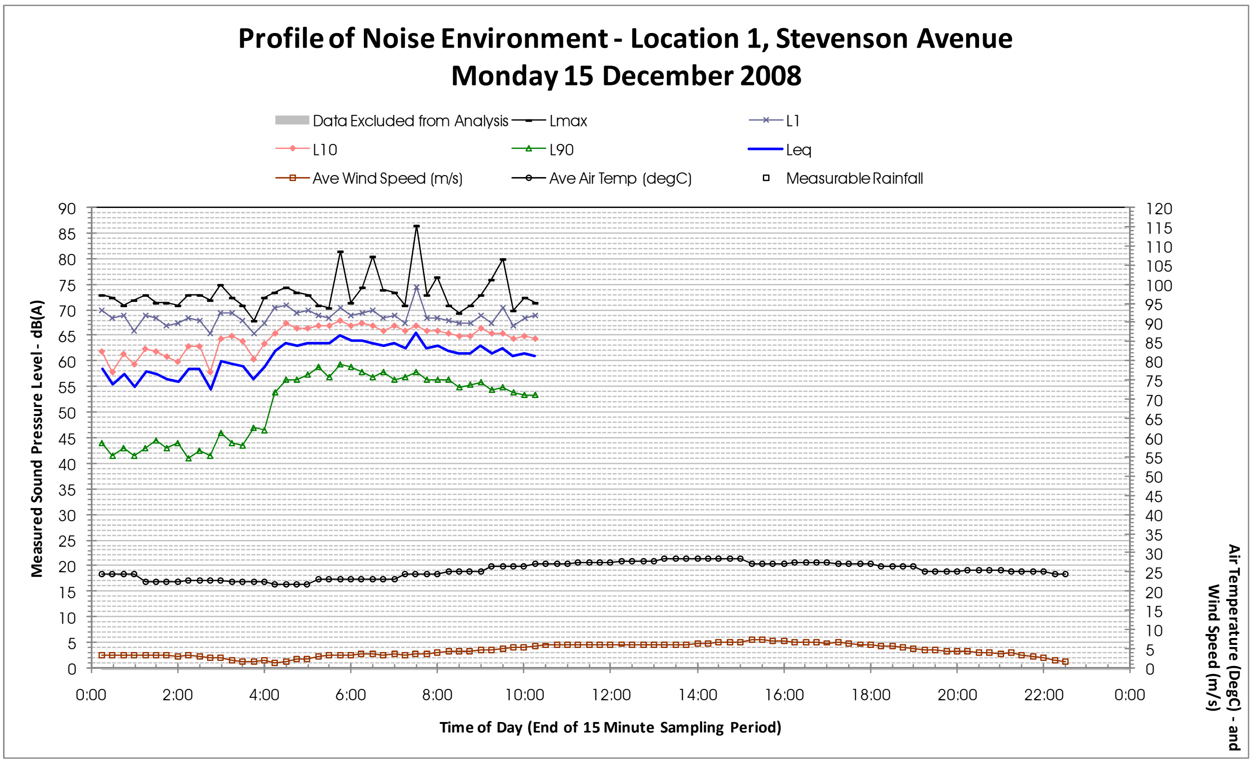
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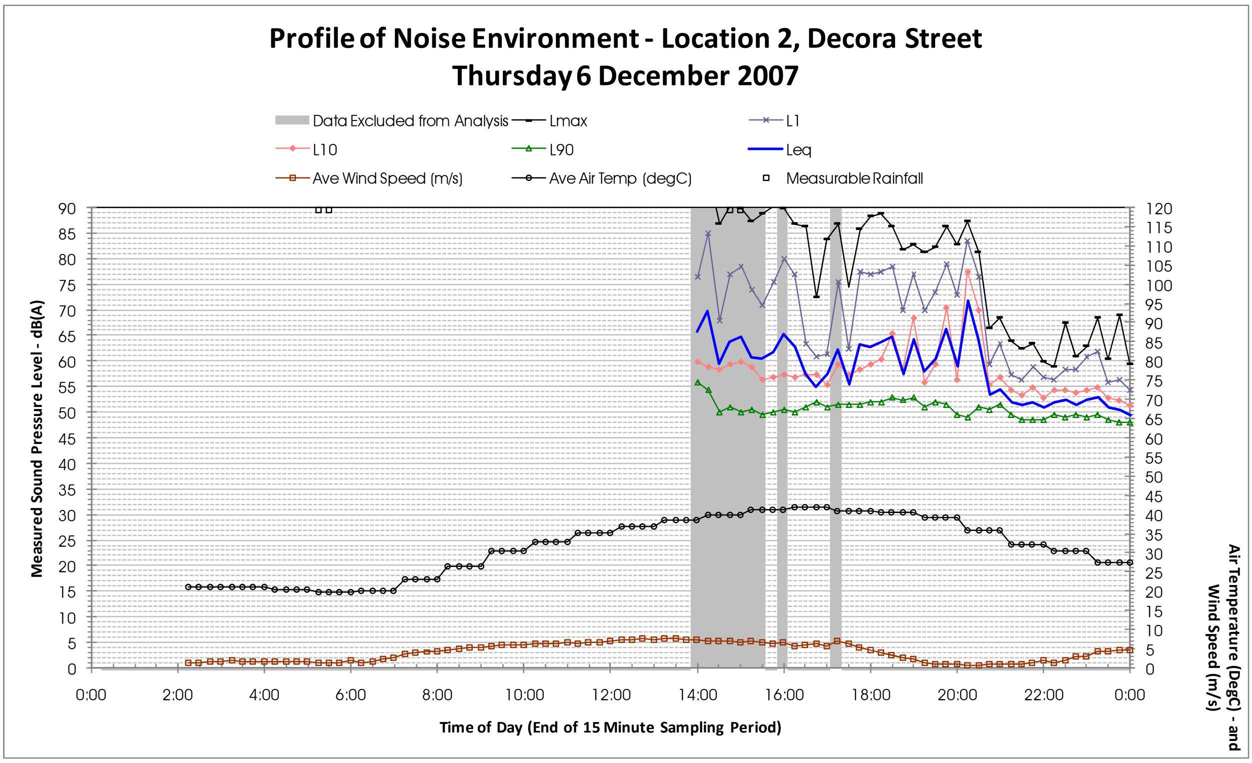
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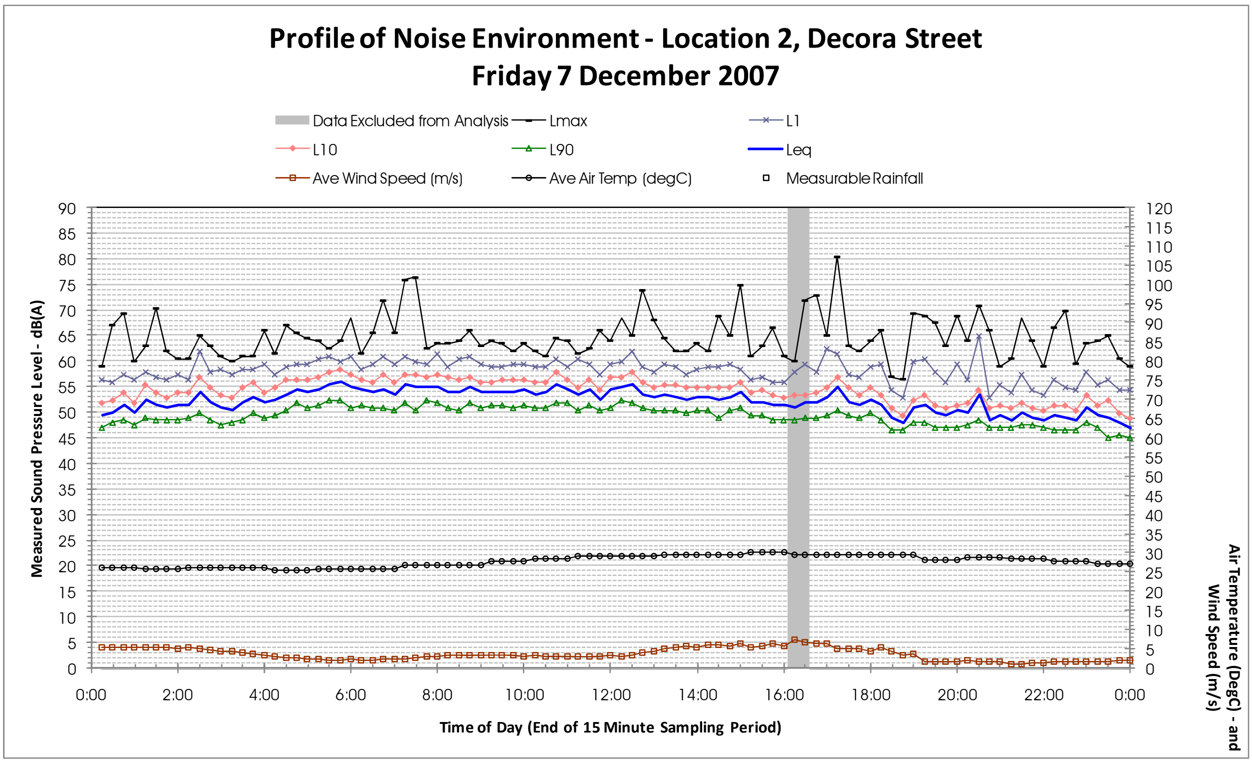

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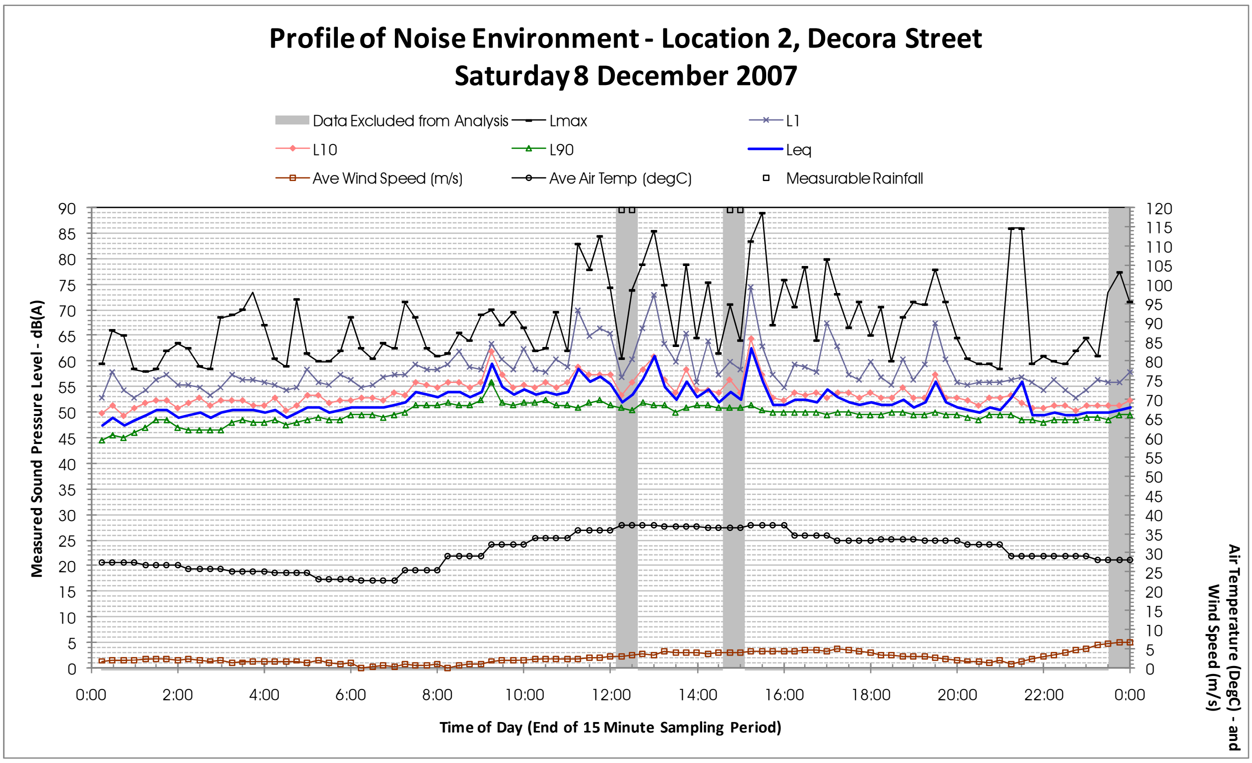

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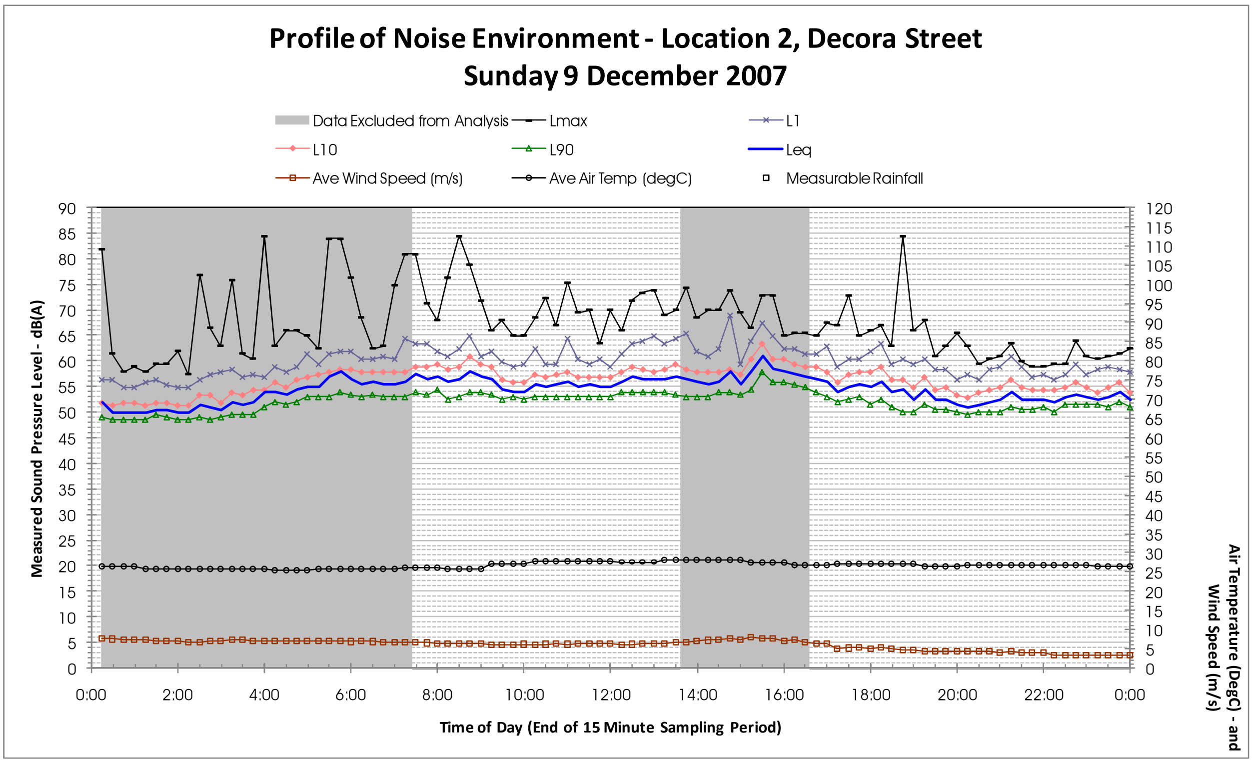

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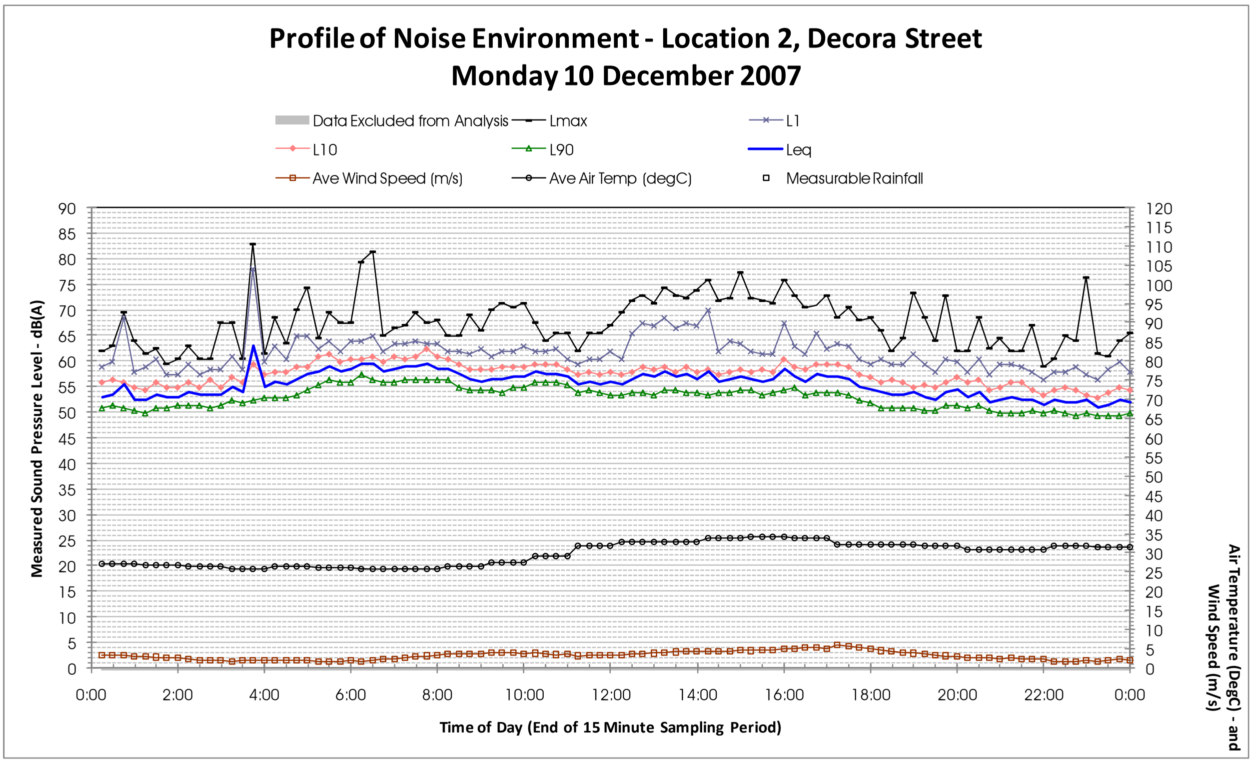

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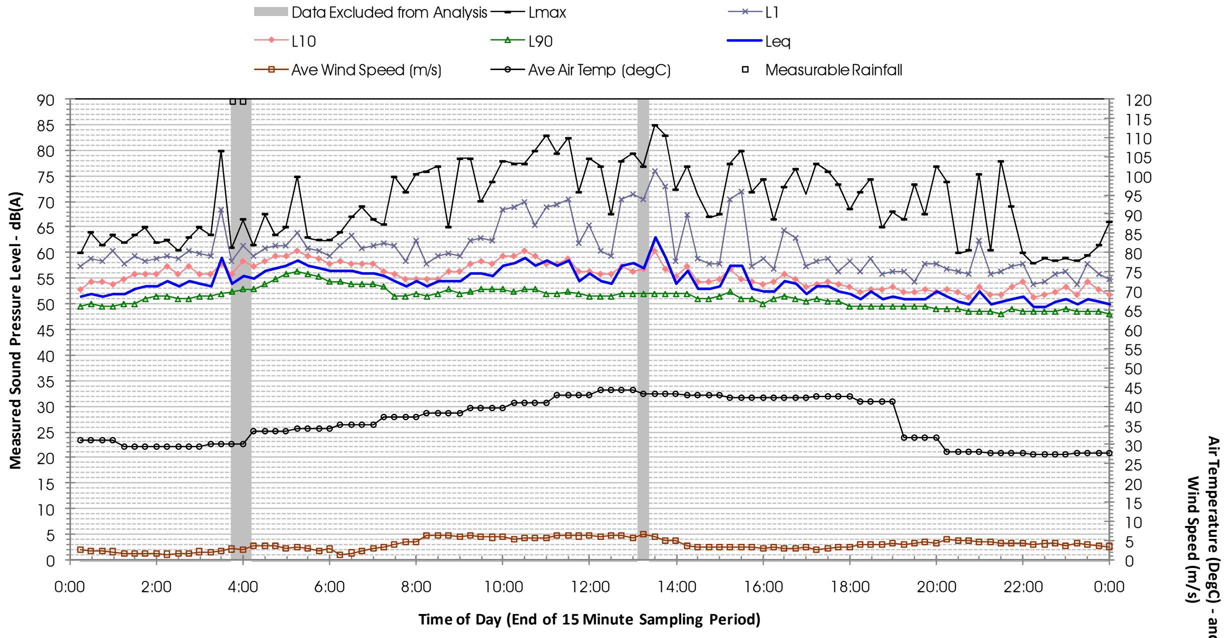

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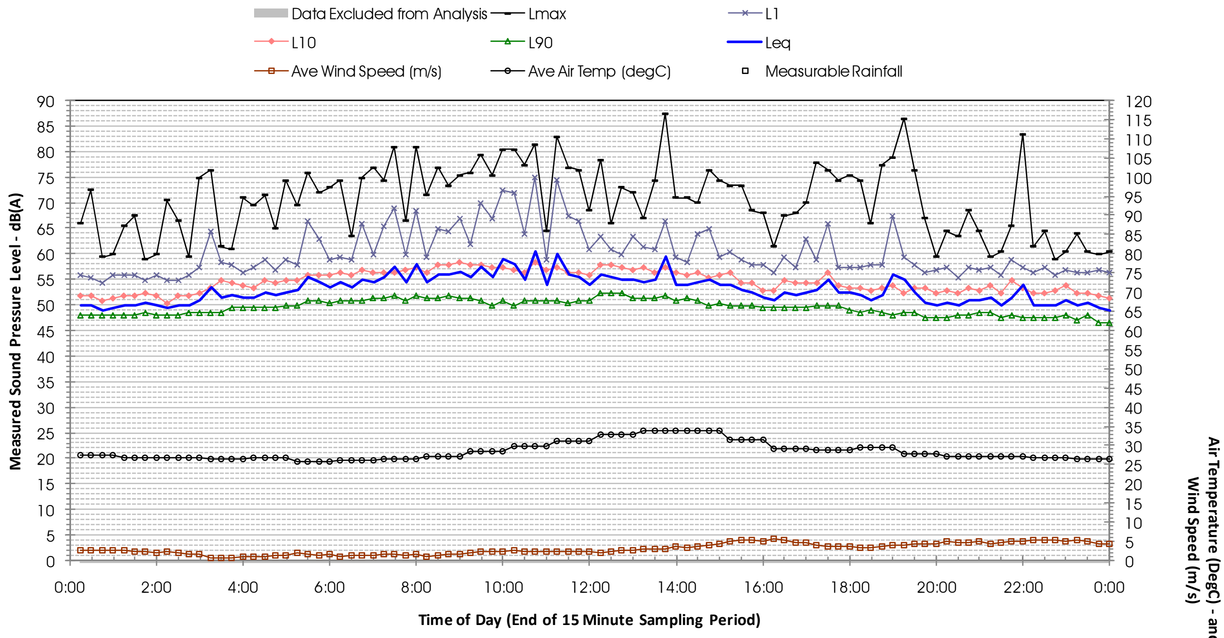

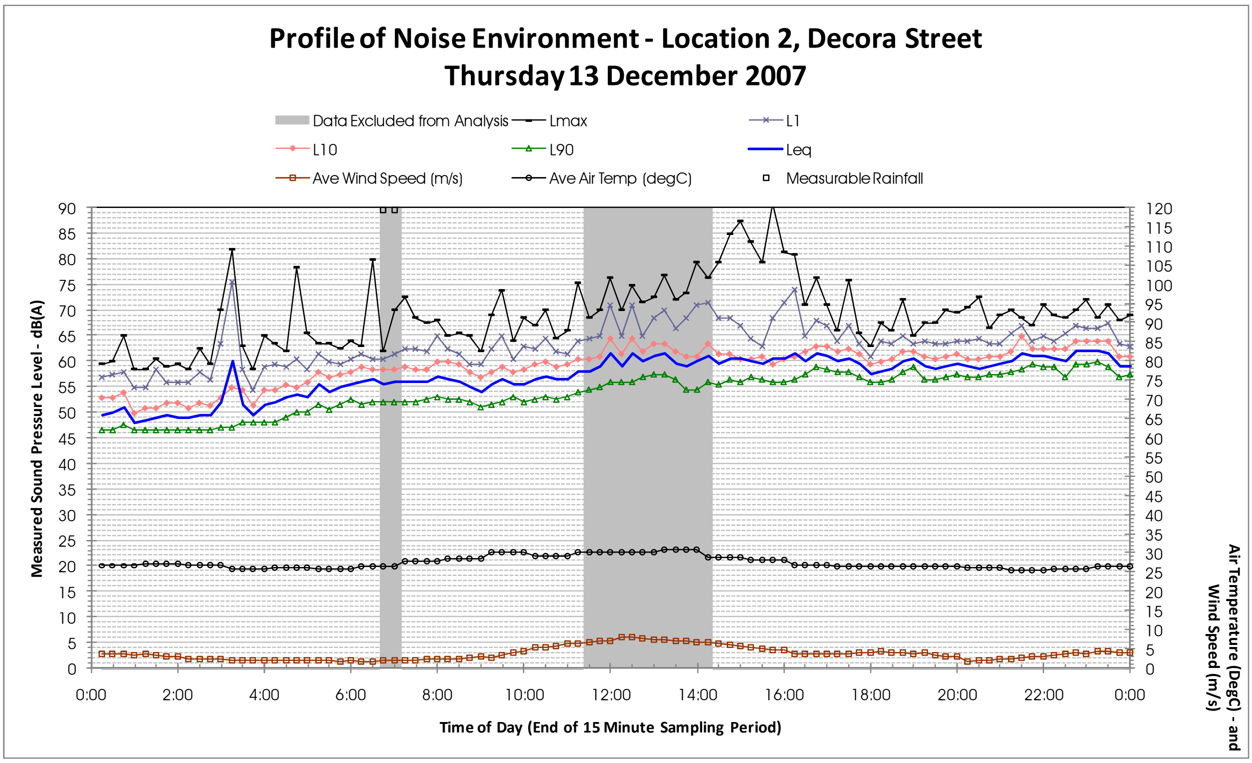

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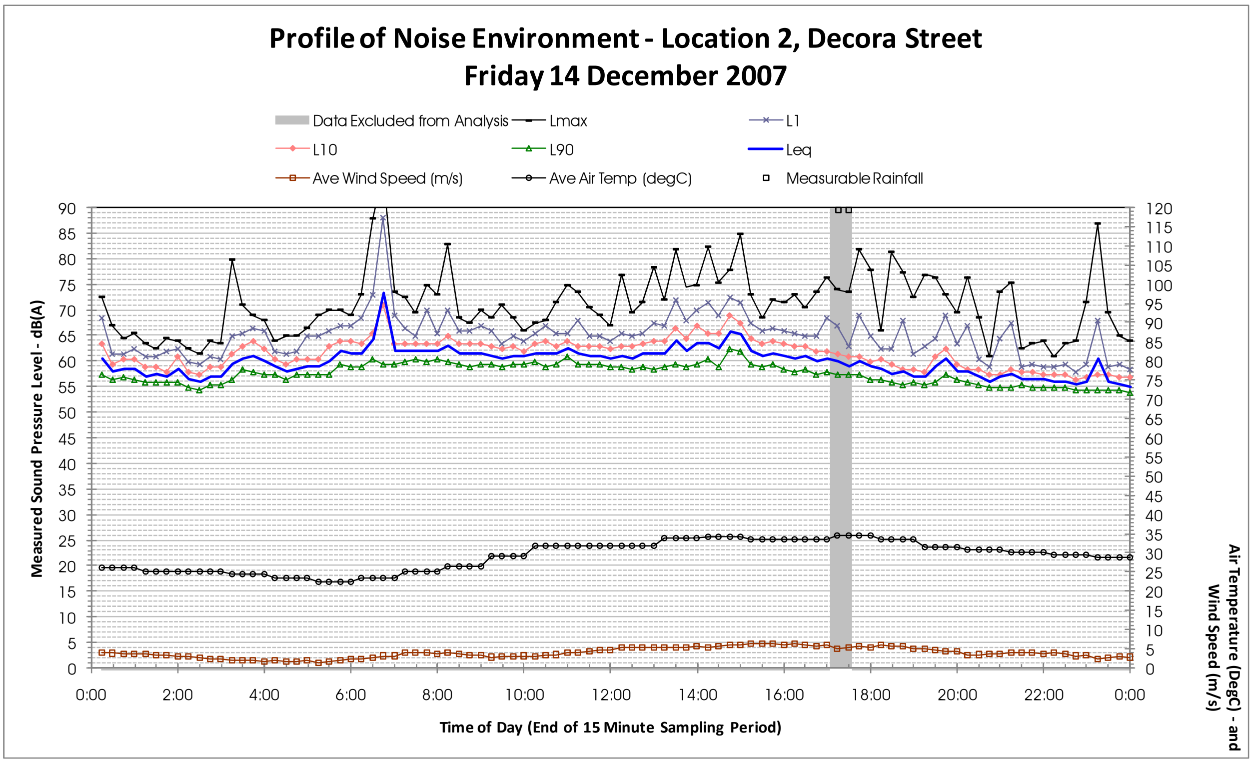

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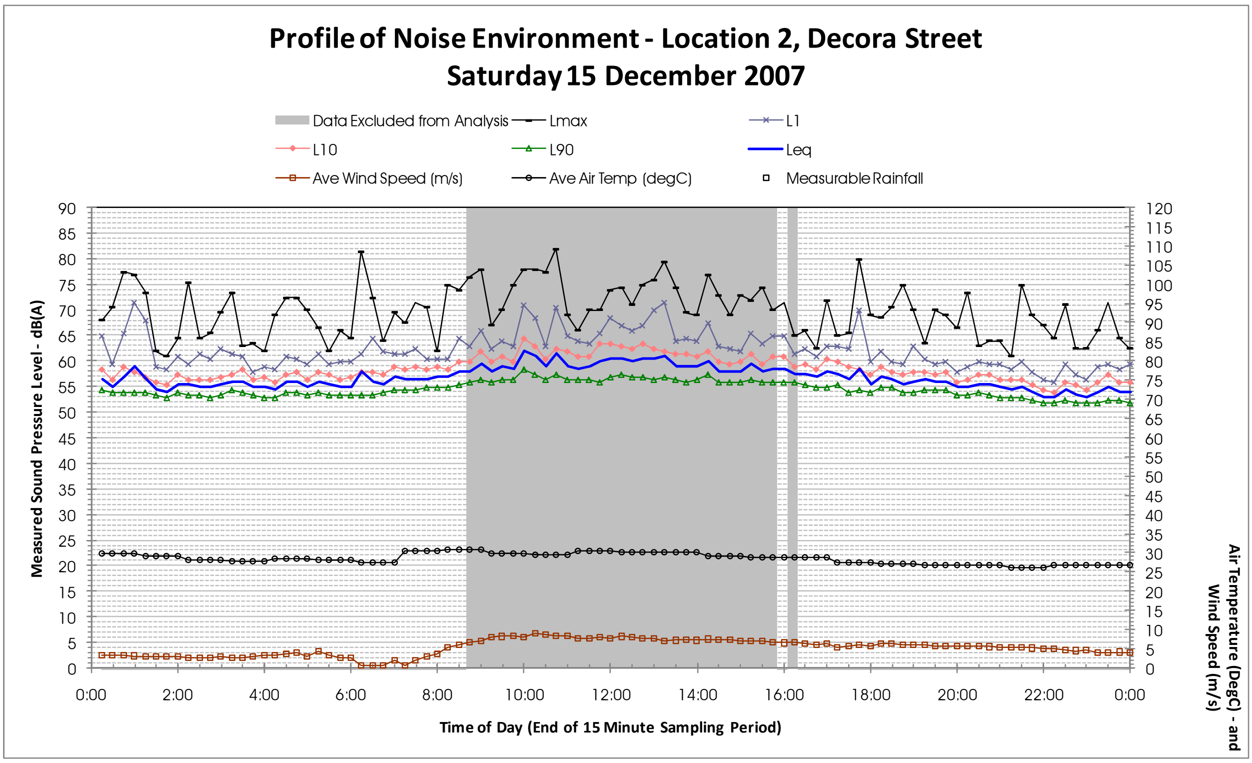
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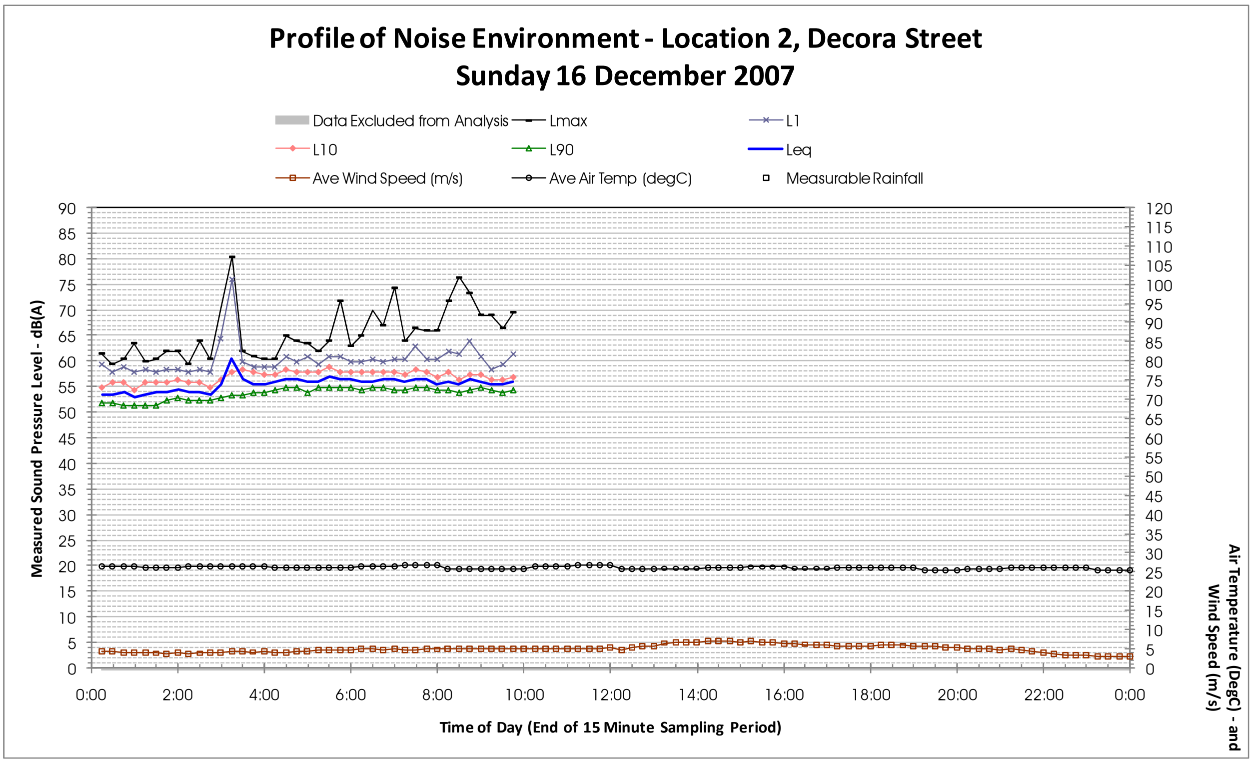
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Measured Sound Pressure Level - dB(A)
Air Temperature (DegC) - and Wind Speed (m/s)
Time of Day (End of 15 Minute Sampling Period)

Appendix G Greenhouse Gas Assessment

SINCLAIR KNIGHT MERZ

Hunter Water Corporation Kooragang Industrial Water Scheme

GREENHOUSE GAS AND ENERGY ASSESSMENT

- Final
- 26 February 2009

Hunter Water Corporation Kooragang Industrial Water Scheme

GREENHOUSE GAS AND ENERGY ASSESSMENT

- Final
- 26 February 2009

Sinclair Knight Merz
ABN 37 001 024 095
710 Hunter Street
Newcastle West NSW 2302 Australia
Postal Address
PO Box 2147 Dangar NSW 2309 Australia
Tel: +61 2 4979 2600
Fax: +61 2 4979 2666
Web: www.skmconsulting.com

Contents

1. Introduction

1.1. Project Background

Hunter Water Corporation (HWC) operates the Shortland Wastewater Treatment Works (WWTW) located outside Shortland in NSW. The Shortland Wastewater Treatment Works (WWTW) services the Sandgate, Shortland, Birmingham Gardens and Maryland communities. The WWTW also receives sewage diverted from decommissioned WWTWs at Stockton and Minmi, the University of Newcastle, and Saint Joseph's Nursing Home (Sandgate), as well as collecting industrial wastewater from Kooragang Island, the Steel River site and Steggles Potatoes (high strength waste). The WWTW currently treats six megalitres (ML) per day, and has a nominal capacity of 40,000 equivalent population (EP).

HWC identified potential demands for recycled water that would either replace or augment potable water supplies through the preparation of a Recycled Water Strategy. Several large industrial operations in the Kooragang Island and Mayfield industrial areas were identified as potential users of recycled water from the Shortland WWTW. Subsequently, HWC developed the Kooragang Industrial Water Scheme (KIWS) concept, which involves upgrading the Shortland WWTW, construction of a rising main, and construction of a membrane filtration/reverse osmosis (MF/RO) plant and reticulation system to distribute treated effluent to industrial users on Kooragang Island.

This document reports on the greenhouse gas (GHG) and energy assessment of the MF/RO plant associated with the Proposal.

1.2. Study Objectives

The objectives of this report were to determine the GHG emissions likely to result from the operation of the MF/RO plant. GHG emissions associated with operation of the Proposal were calculated in accordance with the Department of Climate Change (DCC) National Greenhouse Accounts (NGA) Factors (2008) (DCC, 2008a) and Technical Guidelines (DCC, 2008b). Potential energy/emissions savings associated with the Proposal were also identified.

2. Proposed Development

2.1. Site Location

The proposed MF/RO plant would be located at the Steel River Industrial site near Mayfield, NSW, which is bordered by the Pacific Highway/Industrial Drive, Tourle Street, the South Arm of the Hunter River, and the Kooragang Goods Rail Line. The proposed plant and associated infrastructure are located within the Newcastle Local Government Area. Land uses surrounding the site include residential, industrial and open space. The closest residences to the plant are located 240 m to the south. The location of the proposed works is shown in **Figure 1-1.**

2.2. Scheme Overview

The proposed KIWS involves the construction and operation of a MF/RO plant and associated infrastructure that would deliver up to 9 ML per day of treated water to customers. The locations of the proposed pipelines and plant are shown in **Figure 1-1**. A 700 m extension to the existing Shortland WWTW effluent main would be constructed between the MF/RO plant and the Kooragang Island Coal Loader Railway to transport treated water to customers. A separate pipeline would be constructed to return the reject saline water to the Shortland WWTW; this pipeline would be approximately 1 km in length, and would run through the Steel River site, under Industrial Drive, across Stevenson Park, passing under Maitland Road, and entering the existing wastewater system near Casuarina Circuit in Warabrook as shown in **Figure 1-1**.

During dry weather, treated effluent from the Shortland WWTW and Burwood WWTW would be diverted to the MF/RO plant for further treatment and delivery to customers. During wet weather, effluent from Burwood WWTW would not be required due to the additional stormflow from the Shortland WWTW. Up to 12.6 ML of treated wastewater from Shortland WWTW would be fed through the MF/RO plant per day to generate up to 9 ML/day of high quality industrial water and approximately 3.6 ML per day of reject water (consisting of backwash from the MF and concentrate from the RO). The reject water would be transferred to either the Burwood Beach WWTW for discharge through the deep ocean outfall during dry weather or the existing Shortland WWTW outfall located on the South Arm rail bridge for discharge into the Hunter River during wet weather.

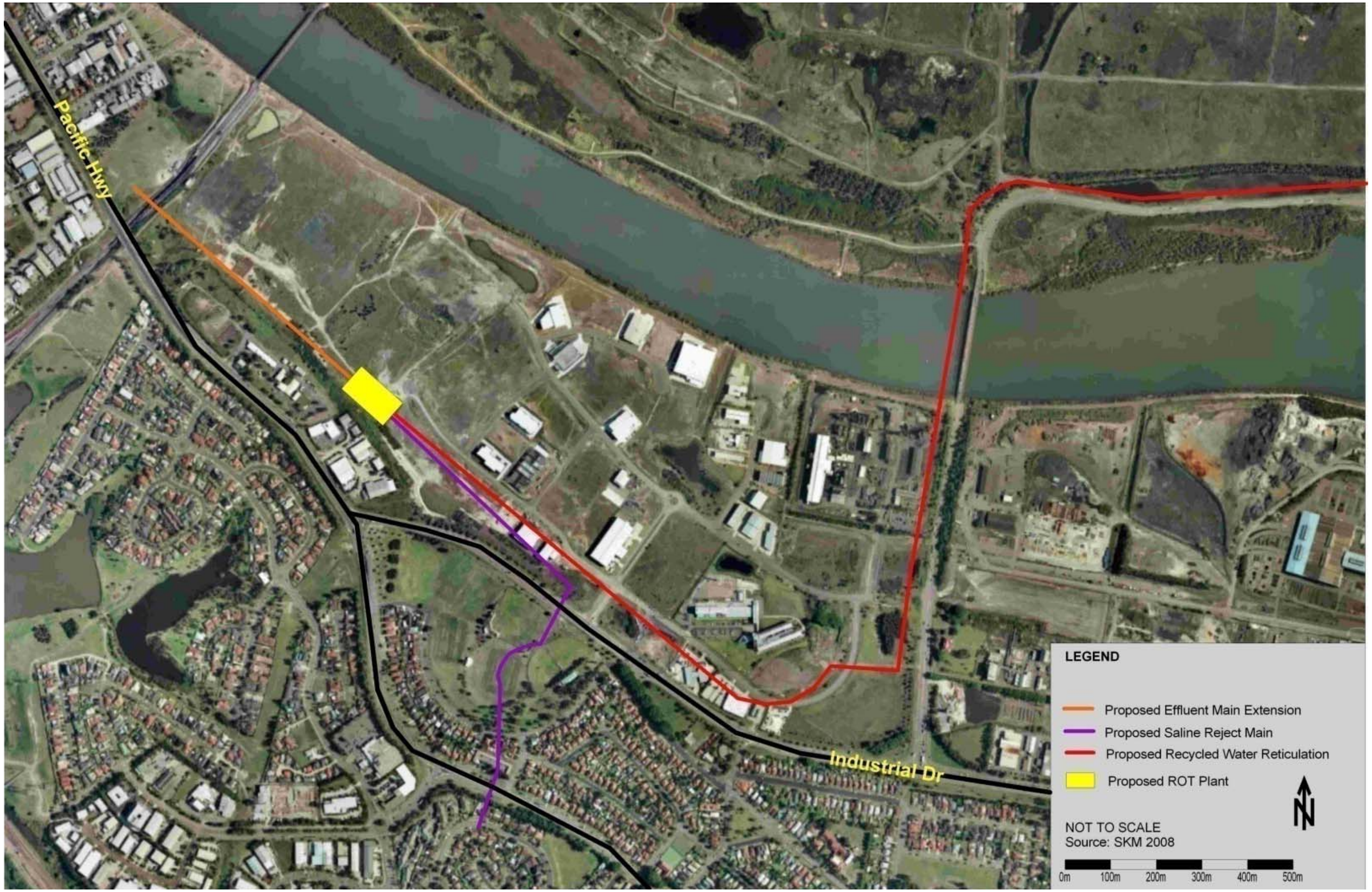
Some of the customers require desalinated water, which would be achieved through the proposed RO plant. As the reverse osmosis treatment process requires feed water that has very low levels of suspended solids, the RO feed water would need to be fed through MF.

Chlorinated effluent from the Shortland WWTW would be diverted from the discharge pipeline to the MF plant. Flows would be screened through a fine sieve (minimum of 1 mm) to protect the membranes. The MF process would filter colloidal material from the effluent. The filtered water would be pumped to a storage reservoir that would feed the RO membranes. This filtered water storage may also provide storage to supply customers with Class A quality water (water that has not undergone microfiltration; suitable for industrial uses such as washdown water).

The filtered water would be dechlorinated prior to treatment through the fouling-resistant RO membranes, which would desalinate (i.e. remove the salt from) the water. Some low level chlorination (i.e. the use of ammonia and hypochlorite) may be required to manage biological fouling in the reverse osmosis process. Antiscalant would also be used to control crystallisation on the RO membranes. The RO process would consist of a two-stage process targeted at providing approximately 75 % efficiency (i.e. ratio of desalinated water to feed water). RO pumps would be used to transfer the desalinated recycled water to the next process unit.

The water would be stabilised through a degassing tower after desalination, resulting in a water pH within the target range of 6.5 to 8.5. Industrial water would be stored in a reservoir and pumped to each customer on demand.

Details regarding the MF and RO processes are provided in the following sections.



- **Figure 1-1: KIWS Recycling Scheme**

2.2.1. Membrane Filtration

Membranes are thin films or barriers that are used to filter solids from fluids. The types of membranes proposed for this project would typically include the micro-filtration or ultra-filtration range of membranes, which are characterised by pore sizes in the range of 0.2 or 0.01 microns, and can effectively remove small solid material.

Membrane filtration is capable of consistently delivering filtered water with turbidity less than 0.1 NTU and a Silt Density Index (SDI) of less than 3 without chemical coagulation of the raw water. MF does not affect the colour or the level of dissolved contaminants in water, but can effectively remove bacterial and particulate matter to provide feed water suitable for RO plant.

Solids that accumulate at the membrane surface require periodic removal to maintain flow through the membranes, which is achieved by dislodging the material into the water surrounding the membrane through a process called backwashing. The reject stream, or backwash, is characterised by high concentrations of solids, and would be returned to the Shortland WWTW for reprocessing. MF plants have typical recovery rates of 95 % (i.e. only 5 % of the influent water forms part of the waste stream).

2.2.2. Reverse Osmosis

RO is a process that uses membranes with extremely small pore sizes (down to 0.001 µm) that can prevent the flow of molecules larger than a water molecule. RO is generally the favoured approach for the removal of dissolved ions, particularly highly soluble salts. High pressure conditions force water molecules through the membrane while leaving the contaminants behind. The resulting brackish reject concentrate requires disposal, and contains high concentrations of dissolved contaminants such as salts and organics.

Generation of the high pressure conditions requires a large amount of power. The costs and efficiency of the RO process are highly dependent on the feed water. Efficiencies can be increased where the feed water has undergone a chemical or physical pre-treatment process. Based on experience at other plants, the recovery efficiency (ratio of product water to feed water) of the KIWS would be in the order of 75 %. The relatively low salinity of the treated effluent from the Shortland WWTW may increase the potential recoveries from the RO process.

The RO process removes carbonates from the water. This affects the stability of the water by changing the carbonate/carbon dioxide balance. The RO plant requires feed water to be dechlorinated prior to processing as the presence of chlorine in the destabilised water could lead to the corrosion of structures in the distribution system. Additionally, the RO process affects the pH of the water. The pH would be corrected through degassing the purified water through a degassing tower, which releases excess dissolved carbon dioxide.

3. Climate Change and Greenhouse Gases

Greenhouse gases (GHGs) are gases found in the atmosphere that absorb outgoing heat that is reflected from the sun. The absorption of the heat energy warms the air, enabling life to survive, and is known as the Greenhouse Effect. The primary greenhouse gas is carbon dioxide (CO_2).

Human activities, such as the combustion of carbon-based fuels, increase the amount of GHGs in the atmosphere. This leads to greater absorption of heat and increases in atmospheric temperature, known as the Enhanced Greenhouse Effect. The atmospheric concentration of CO_2 has risen from 280 parts per million (ppm) to 370 ppm since 1860. At the same time, the average global temperature has increased by nearly 1°C. Projections show that if this trend continues, global temperatures could rise between one and four degrees by the end of the 21st century, with annual average temperatures in Australia projected to increase by 0.4 - 2.0°C by 2030 and by 1 - 6°C by 2070 compared to 1990 levels (WBCSD, 2004).

Although Australia contributes just one percent of the global GHG emissions, our per capita emissions are amongst the highest in the world (AGO, 1998). Overall, the total net greenhouse gas emissions in Australia increased 2.2% between 1990 and 2005. Most of the increases resulted from energy generation and industrial processes.

Different GHGs have different heat absorbing capacities, or global warming potentials. In order to achieve a basic unit of measurement, each GHG is compared to the absorptive capacity of CO_2, and measurements and estimates of GHG levels are reported in terms of CO_2 equivalent emissions (CO_2-e). The primary GHG that would be generated by the proposal is CO_2, which is generated by coal-fired electricity production.

3.1. National Response to Climate Change

The Department of Climate Change (DCC) was established on 3 December 2007 as part of the Prime Minister and Cabinet Portfolio. It followed the establishment of the Australian Greenhouse Office (AGO) in 1998, part of the Department of the Environment, Water, Heritage and the Arts, which was the world's first government agency dedicated to reducing emissions of greenhouse gases.

The National Greenhouse Strategy (AGO, 1998) was developed to provide the strategic framework for an effective greenhouse response and for meeting current and future international commitments. The Strategy was endorsed by the Commonwealth and all State and Territory governments in 1998. The three goals of the National Greenhouse Strategy are to:

1) Limit net GHG emissions, particularly to meet our international commitments;
2) Foster knowledge and understanding of greenhouse issues; and
3) Lay the foundations for adaptation to climate change.

The DCC delivers the majority of programs under the Australian Government's $1.8 billion climate change strategy. This strategy is centred on five key areas including emissions management, international engagement, strategic policy support, impacts and adaptation, and science and measurement. Major initiatives include:

- Boosting renewable energy actions and pursuing greater energy efficiency;
- Investing significant resources into greenhouse research and monitoring Australia's progress towards its Kyoto target through the National Greenhouse Gas Inventory;
- Studying the landscape of Australia through the National Carbon Accounting System;
- Encouraging the development and commercialisation of low emissions technologies;
- Encouraging industry, business and the community to use less greenhouse intensive transport; and
- Fostering sustainable land management practices.

3.2. National Greenhouse Gas Inventory

Australia's *National Greenhouse Gas Inventory 2006* (DCC, 2008c) has the dual purpose of providing estimates of Australia's net greenhouse gas emissions and of tracking Australia's progress towards its internationally-agreed target of limiting emissions to 108% of 1990 levels over the period 2008–2012. Australia has updated and published annual national greenhouse gas inventories for each year from 1990 to 2006 inclusive. The inventories are prepared according to international guidelines established by the IPCC and Kyoto accounting provisions.

In 2006, Australia's net greenhouse gas emissions using the Kyoto accounting provisions were 576.0 Mt of CO_2-e. The energy sector was the largest source of greenhouse gas emissions, accounting for 69.6% (400.9 Mt CO_2-e) of emissions in 2006, followed by agriculture (15.6%) and land use, land use change and forestry sectors (6.9%). The industrial processes (4.9%) and the waste sectors contributed (2.9%) (refer to **Table 3-1**).

Table 3-1: Australian Net Greenhouse Gas Emissions by Sector, 2006

Sector and Subsector	Emissions (Mt)				
	CO_2	CH_4	N_2O	HCFCs/ PFCs SF_6	CO_2-e
All energy (combustion + fugitive)	367.8	30.4	2.7	NA	400.9
Stationary energy	285.3	1.1	1.0	NA	287.4
Transport	76.8	0.6	1.7	NA	79.1
Fugitive emissions from fuel	5.8	28.7	0.02	NA	34.5
Industrial processes	22.6	0.1	0.02	5.8	28.4
Agriculture	NA	69.8	20.3	NA	90.1
Land use, land use change and forestry	37.4	2.1	0.6	NA	40.0
Waste	0.03	16.0	0.6	NA	16.6
Total Net Emissions	427.8	118.3	24.2	NA	576.0

Notes:
NA = not applicable
Source: National Greenhouse Gas Inventory 2006 (DCC, 2008c:4)

3.3. Greenhouse Gas Reporting

The *National Greenhouse and Energy Reporting Act 2007* (the Act) was passed on 29 September 2007, establishing a mandatory reporting system for corporate GHG emissions and energy production and consumption in Australia. The first reporting period under the Act commenced on 1 July 2008. Information obtained from the reporting process is intended to be used for the development of the Carbon Pollution Reduction Scheme (refer to **Section 3.4**).

The National Greenhouse and Energy Reporting (NGER) Guidelines were developed to help corporations understand their obligations under the Act. The Reporting Guidelines are applicable across industry sectors and cover important concepts under the Act and the *National Greenhouse and Energy Reporting Regulations 2008* (the Regulation), including determining the need to report, how to register, reporting obligations, and record keeping requirements. The Reporting Guidelines were designed for use with the NGER Technical Guidelines.

The NGER Technical Guidelines (DCC, 2008b) were developed to assist stakeholders understand and apply the NGER (Measurement) Determination 2008, which outlines calculation methods and criteria for greenhouse gas emissions, energy production and consumption. The methods are based on those used for the National Greenhouse Accounts. The range of emission sources covered in the Technical Guidelines and Determination include:

- The combustion of fuels for energy;
- Fugitive emissions from the extraction of coal;
- Oil and gas;
- Industrial processes (such as producing cement and steel); and
- Waste management.

3.4. Carbon Pollution Reduction Scheme

The Australian Government is implementing a comprehensive strategy for tackling climate change in Australia. The strategy is built on three pillars: reducing Australia's carbon pollution; adapting to unavoidable climate change; and helping to shape a global solution.

The *White Paper – Carbon Pollution Reduction Scheme* was released on 15 December 2008. The Paper set out the Government's policy in relation to two major elements of its mitigation strategy - a medium-term target range for national emissions, and the final design of the Carbon Pollution Reduction Scheme. The White Paper follows from the Green Paper, released in July 2008, that canvassed options on the design of the scheme...

Commencement of the Carbon Pollution Reduction Scheme is targeted for 1 July 2010. The Scheme will be Australia's primary policy tool to drive reductions in emissions of greenhouse gases. The economic cost of GHG emissions is not currently reflected in the costs of business or the price of goods and services as firms currently face no cost from increasing emissions. The Carbon Pollution Reduction Scheme is designed to redress this market failure through a cap-and-trade system to reduce carbon pollution.

The Scheme will cover the major GHG emitters - approximately 1,000 entities that together account for around 75 per cent of Australia's emissions from the stationary energy, transport, fugitive, industrial processes, waste and forestry sectors. The Scheme will cover all six greenhouse gases covered under the Kyoto Protocol [CO_2, methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs)].

4. Greenhouse Gas Emissions Estimates

Prediction of the greenhouse gas emissions likely to be generated by operation of the proposed MF/RO plant was undertaken using the methodologies outlined in the *National Greenhouse Accounts (NGA) Factors* (DCC, 2008a). The workbook aims to provide a consistent set of emission factors, adopting the emissions categories of the international reporting framework of the World Resources Institute and World Business Council for Sustainable Development (WBCSD, 2004).

The NGA Factors provide three types of assessment categories:

- **Scope 1 -** covers direct emissions from sources within the boundary of an organisation such as fuel combustion and manufacturing processes.
- **Scope 2 -** covers indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation.
- **Scope 3 -** includes all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned or controlled by the organisation; that is, emissions from offsite waste disposal, emissions associated with the production of fuels, and emissions from the generation of purchased electricity.

Scope 1 and 2 emissions categories are carefully defined to ensure that two or more organisations do not report the same emissions in the same scope.

Due to the information available for the proposed KIWS, this assessment was constrained to emissions resulting from the operation of the MF/RO only. This limited the assessment to the generation of GHG emissions from the use of electricity; transport and construction emissions were not included. Both Scope 2 and Scope 3 emissions were considered.

4.1. Electricity Consumption

HWC calculated the specific power consumption for the KWIS process to be 1.14 kWh/kL of product water pumped into the distribution system; applying a 30 % contingency resulted in a power consumption of 1.48 kWh/kL. This estimate was based on the production of 9 ML per day of treated water from the reverse osmosis plant with pre-treatment with micro/ultra filtration and de-gassing, and only included power used by the MF/RO plant and the distribution of treated water to customers. As such, transport of the effluent to the KIWS and of the backwash/brine reject from the plant was not included, nor was the embodied energy of chemicals used in the process.

The power consumption values were used to determine the GHG emissions on a daily and yearly basis using the emission factors for purchased electricity for NSW from the NGA Factors published in November 2008 (DCC, 2008a). As shown in **Table 4-1**, the MF/RO plant is expected to generate approximately 4000 tCO_2-e per year, or over 5000 tCO_2-e when allowing for a 30 % contingency (**Table 4-2)**.

- **Table 4-1: Greenhouse Gas Emissions from Electricity Consumption**

Emissions Type	Emission Factor (kg CO_2-e/kWh)	GHG Emissions (t CO_2-e)	
		Per day	Per year
Scope 2	0.89	9.1	3333
Scope 3	0.17	1.7	636.6
Full Fuel Cycle (Total)	1.06	10.9	3969.6

- **Table 4-2: Greenhouse Gas Emissions from Electricity Consumption – 30 % Contingency**

Emissions Type	Emission Factor (kg CO_2-e/kWh)	GHG Emissions (t CO_2-e)	
		Per day	Per year
Scope 2	0.89	11.9	4327.0
Scope 3	0.17	2.3	826.5
Full Fuel Cycle (Total)	1.06	14.1	5153.5

4.2. Comparison of Emissions

Desalination is an energy intensive process, and can use more than twice the energy required to pump and distribute water from rivers or reservoirs [1]. Desalination of treated effluent, however, is much less energy-intensive than desalination of saltwater (1.48 kWh/kL compared to more than 4 kWh/kL[2]).

A total of 73,543 tCO_2-e were emitted by HWC's operations in 2007/08 (HWC, 2008a). Energy consumption associated with the Proposal would increase HWC's GHG emissions by 3969.6 tCO_2- e per year as a base case, or 5153.5 tCO_2-e per year with a 30% contingency. For the

[1] http://www.coastal.ca.gov/desalrpt/dchap1.html; accessed 24/2/09

[2] Sydney Desalination Project EA, 2006; http://majorprojects.planning.nsw.gov.au/index.pl?action=view_job&job_id=485; accessed 24/2/09

30 % contingency scenario, the additional emissions constitute a 7 % increase over existing GHG emissions.

A total of 160.0 $MtCO_2$-e of GHG were emitted NSW in 2006 (DCC, 2008c). The GHG emissions calculated above represent approximately 0.003 % of the total NSW emissions.

As some industrial processes require high quality, low salinity water for operational processes, some form of water purification is necessary. RO plants have a number of environmental advantages over alternative processes such as distillation. These include lower energy requirements, higher recovery rates, and smaller surface area plants for the same amount of water production[3]. Based on existing technologies, the MF/RO plant was considered by HWC to be the most cost effective and energy efficient desalination technology for this application.

[3] http://www.coastal.ca.gov/desalrpt/dchap1.html

5. Hunter Water Corporation Policies and Procedures

5.1. Reporting, Reviewing and Continuous Improvement Approach

HWC would measure electricity consumption from the KIWS in order to calculate and report greenhouse gas emissions over the lifespan of the project. Emissions would be reported in HWC's Annual and Environmental Performance Indicators Reports, and used in state and national greenhouse inventories as required by the National Greenhouse and Energy Reporting (NGER) System.

A 'continuous improvement approach' would be adopted by HWC; advances in technology and potential operational improvements of plant performance would be assessed on an annual basis, with feasible actions implemented and reported in the Annual Report. The types of improvements that can be assessed annually include:

- Appropriate maintenance of equipment to maintain or improve greenhouse efficiency;
- The use of up to date technology (with a focus on greenhouse efficiency) when sourcing components for maintenance and overhaul activities;
- Minimisation of vehicle use; and
- Minimisation of distillate fuel use.

5.2. Policies and Greenhouse Gas Emission Reduction Activities

5.2.1. Energy and Emissions

HWC is a medium-level consumer of electricity. Energy consumption is a major source of GHGs for HWC, with the majority (approximately 80 %) of the GHG emissions from HWC's operations due to electricity use. HWC's primary uses of electricity are water transport (42 %), wastewater treatment (41 %) and wastewater transport (12 %) (HWC, 2008a).

As stated above, a total of 73,543 tCO_2-e were emitted by HWC's operations in 2007/08. Energy consumption associated with the Proposal would conservatively increase HWC's by 7 % over existing GHG emissions.

While desalination is an energy-intensive process, use of recycled water saves significant amounts of potable water for other users. Australia has experienced significant periods of drought, and such periods are expected to increase in the coming years due to climate change. As such, saving potable water supplies will become increasingly important. HWC is working with its service providers to prepare Energy Saving Action Plans to ensure that their energy requirements are met in an efficient and cost-effective way.

5.2.2. Water Conservation

HWC led the water industry in Australia through its water conservation strategies, including user pays pricing, which led to a sustained reduction of around 30 % in residential per capita demand (HWC, 2008b). Further actions to conserve water included leakage reduction and water recycling initiatives. HWC developed a comprehensive Integrated Water Resource Plan (IWRP) in consultation with the community in 2002. The Integrated Water Resource Plan is a blueprint for managing both water demand and supply to achieve an optimal mix of the available demand and supply options, and was developed to meet the current circumstances that are driving water use and water supply in the lower Hunter. The $H_2$50 Plan was developed as a major revision of the Plan.

HWC is committed to encouraging water recycling where environmentally, socially and economically beneficial. HWC has a long history of developing recycled water schemes, such as the provision of recycled water to the Eraring Power Station. In 2006, HWC commissioned preparation of a Recycled Water Strategy to identify and evaluate recycled water opportunities in the lower Hunter. The Strategy identified the Kooragang Recycled Water Scheme and dual reticulation for greenfield developments as the highest priority recycled water opportunities. HWC has committed to supply the Thornton North, Cooranbong North and Gilleston Heights development areas with recycled water for non-potable uses such as garden watering, toilet flushing and laundry.

Since 2001-02, more than 4,000 ML of recycled water from HWC has been beneficially reused in the lower Hunter. Around half of this water served as a replacement for potable water (HWC, 2008b).

6. Possible Management Options

6.1. Overview

The carbon footprint of a desalination plant depends on the amount of electricity used by the plant and the sources used to generate that electricity. Potential energy/emissions savings associated with the Proposal were identified and summarised below.

6.2. Energy Management Options

6.2.1. Use of Renewable Energy

The Proposal involves use of electricity from the grid. The main source of electricity in NSW is the combustion of black coal, which has a high GHG intensity.

Australia has a national accreditation program for electricity produced by renewable sources (known as Greenpower). Renewable energy sources generate no GHG emissions. Most electricity retailers offer a variety of Greenpower options that allow customers to select the percentage of renewable energy purchased, ranging from 10 – 100 % of electricity use. Once a customer signs a Greenpower supply contract, the electricity retailer is committed to purchasing an equivalent amount of power from renewable sources such as wind, solar, biogas, and some hydropower. The supply of renewable energy attracts a premium cost over and above that charged for conventional electricity.

Purchasing 100% renewable energy to power the KIWS would remove all GHG emissions associated with electricity use for the Proposal.

6.2.2. Energy Efficient Design and Operations

Energy recovery systems could be installed that could, for example, use the waste stream water to power pistons that pump feed water into the RO membranes. Such systems include energy recovery turbines (e.g. Pelton wheels), pressure and work exchangers, or hydraulic turbo booster systems. These systems can maximise energy efficiencies, and have been successfully implemented at other plants in the world.

6.2.3. Green Building Design

Buildings could be designed so as to use minimal energy, such as through efficient lighting, air conditioning and air ventilation. Equipment could also be selected based on minimal energy use (while maintaining appropriate operational standards).

6.2.4. On-site Power Generation

While the size of the site is too small to generate sufficient electricity to power the MF/RO processes, electricity to power lights and other building power requirements could be generated from rooftop photovoltaic cells.

6.2.5. GHG Offsets

One way of reducing the GHG emissions from a project is to offset the emissions; that is, to invest in a project or activity that reduces or sequesters carbon from the atmosphere, thereby compensating for the emissions created by the project. Carbon offset projects include native tree planting or forestry sequestration, renewable energy technology investment, and greenhouse abatement certificates. While prevention and minimisation of emissions are generally accepted to be best practice, carbon offsets play an important role in mitigating residual emissions.

6.3. Identifying a Preferred Energy Management System

Determining how to manage the greenhouse gas emissions from the Project will require assessment of the cost and feasibility of the identified options for HWC. Hunter Water has committed to purchasing renewable energy or carbon offsets for the operation of KIWS.

7. Conclusion

HWC proposes to construct and operate a MF/RO plant at the Steel River site in Newcastle to supply high quality desalinated water to industrial customers on Kooragang Island and in Mayfield. Allowing for a 30 % contingency in expected electricity use, operation of the proposed plant would increase HWC's existing GHG emissions by 7 % (i.e. an additional 5153.5 tCO_2-e per year). These emissions would be offset either through the purchase of renewable energy or carbon offsets. Determination of appropriate energy management systems should include an assessment of cost and feasibility of the various emission reduction options.

The MF/RO process is considered to be the most energy efficient and environmentally sustainable option for generating high quality water for the identified customers. Additionally, the proposal would save up to 9 ML of potable water per day for other users.

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