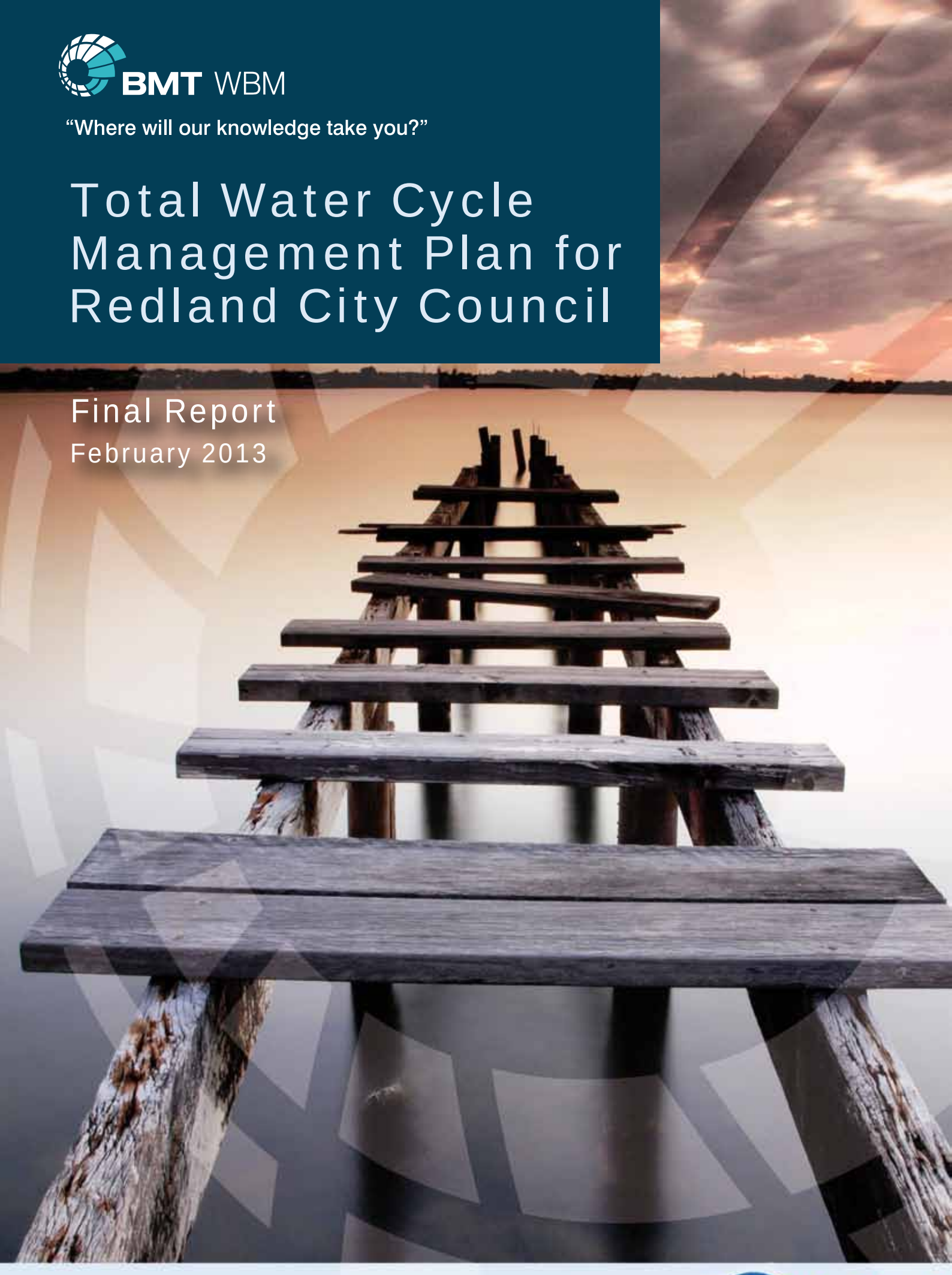
BMT WBM

"Where will our knowledge take you?"

Total Water Cycle Management Plan for Redland City Council



Final Report

February 2013

Redland CITY COUNCIL

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“at a Glance ....”

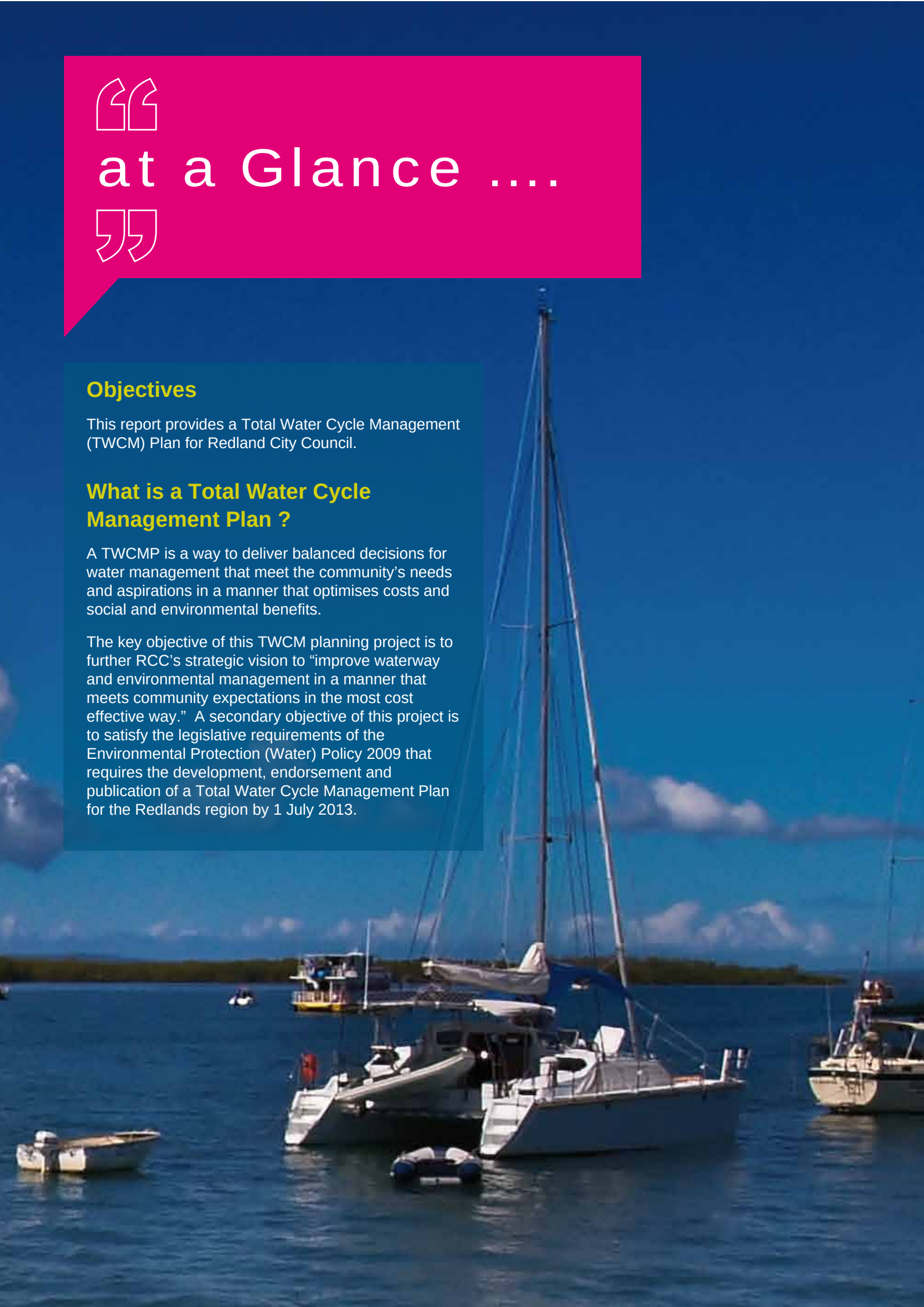
Objectives

This report provides a Total Water Cycle Management (TWCM) Plan for Redland City Council.

What is a Total Water Cycle Management Plan ?

A TWCMP is a way to deliver balanced decisions for water management that meet the community’s needs and aspirations in a manner that optimises costs and social and environmental benefits.

The key objective of this TWCM planning project is to further RCC’s strategic vision to “improve waterway and environmental management in a manner that meets community expectations in the most cost effective way.” A secondary objective of this project is to satisfy the legislative requirements of the Environmental Protection (Water) Policy 2009 that requires the development, endorsement and publication of a Total Water Cycle Management Plan for the Redlands region by 1 July 2013.



Methodology

The following tasks have been completed as part of this project.

- Identification of key water cycle management pressures
- Determination of water cycle management issues for detailed planning
- Development of a TWCM vision and objectives for the Redlands
- Development and high level assessment of solutions to address water cycle management issues
- Preparation of an implementation plan

These tasks have been undertaken by BMT WBM with significant involvement with key stakeholders, particularly Council and Redland Water. The stakeholders involved in this project are shown below.

Key Issues

The existing and future condition of waterways within the region has been identified as a key pressure throughout the Redlands region – with monitoring data showing that waterways are generally in poor condition and do not satisfy given water quality objectives.

Other water cycle issues identified witin the Redlands region identified for further detailed planning studies include environmentally sensitive areas, population growth, sewage treatment plant capacity, water supply constraints, flooding, storm tide indundation, landfill leachate and sewage overflows.

Solutions

RCC are already implementing a wide range of actions that are significantly improving waterway health within the region, and it is recommended that these existing actions be continued. However, without additional actions aimed at improving waterway health, it is highly likely that waterway health (and associated values, e.g. economic, social, cultural, ecosystem health) will decline.

In consultation with key stakeholders, a suite of actions have been identified for implementation – with cost and timeframe estimates provided within the implementation plan. These actions include further investigation of high performance solutions such as waterway rehabiliation, pollution hot spot management, education and capacity building, water supply infrastructure and demand management improvements, sewerage infrastructure improvements, flooding and storm tide investigations/ works, and imroved funding mechanisms to implement TWCM solutions.

Where to from here ?

The implementation of actions identified within this TWMP is required to satisfy the legislative requirements of the Environmental Protection (Water) Policy 2009. It is, however, recommended that further detailed planning be undertaken to identify the most cost-effective solutions to meet the legislative requirements and achieve RCC's aforementioned strategic vision.

Total Water Cycle Management Plan for Redland City Council

Prepared For:	Redland City Council
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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Client Reference	

Title :	Total Water Cycle Management Plan for Redland City Council
Author :	Nicole Ramilo
Synopsis :	This Total Water Cycle Management Plan identifies the key water cycle management planning issues in the Redlands region and potential solutions to address these issues. It also includes an implementation plan outlining the detailed planning studies and actions required for achieving TWCM objectives.

REVISION/CHECKING HISTORY

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Executive Summary

EXECUTIVE SUMMARY

This Total Water Cycle Management (TWCM) Plan identifies the key water cycle management issues within the Redland City Council (RCC) region, and develops solution sets to address these issues that will be further investigated through detailed planning studies. It also includes an implementation plan that sets out required strategies and actions to achieve RCC's TWCM vision.

The key objective of this project is to further RCC's strategic vision to "*improve waterway and environmental management in a manner that meets community expectations in the most cost effective way*." A secondary objective of the TWCM planning project is to meet the legislative requirements of the *Environmental Protection (Water) Policy 2009* that requires the development, endorsement and publication of a Total Water Cycle Management Plan for the Redlands region by 1 July 2013. The EPP Water and *TWCM Planning Guideline for South East Queensland* (WBD,2010a) describe the matters that must be taken into account when a Local Government is preparing a TWCM Plan. The RCC TWCM plan has been developed in accordance with the aforementioned legislation and Guidelines. The primary intent of the EPP Water is to use TWCM Plans to enable equitable and informed decisions to be made about the use of water in a way that results in water quality improvements.

The SEQ Regional Plan 2009-2031 also supports the use of TWCM Plans as the preferred method for ensuring land use and infrastructure planning is environmentally sustainable, and to ensure reliable water supplies to cater for forecast population growth.

This Executive Summary provides an outline of the key findings and processes undertaken to develop the RCC TWCM Plan including:

- Identification of key water cycle management pressures
- Determination of water cycle management issues for detailed planning
- Development of a TWCM Vision and objectives for the Redlands
- Development and high level assessment of solutions to address water cycle management issues
- Preparation of an implementation plan

Water Cycle Management Pressures

The key water cycle management planning pressures identified for the Redlands region are summarised below:

Waterway Health

Both the existing and future condition of waterway health has been identified as a key pressure to be addressed in all catchments within the Redlands region, with EHMP monitoring and Council freshwater monitoring indicating all waterways require improvement to satisfy water quality objectives. No sustainable load estimates exist, however it is apparent that as receiving waters are currently in generally poor condition, any future increase in pollutant loads will only worsen compliance with water quality objectives. In particular, future increases in nutrient loads from Sewage Treatment Plants (STPs) will place significant additional pressure on receiving waters.

Environmentally Sensitive Areas

Within the Redlands region, there exist a number of environmentally sensitive receiving waters, including waterways of High Ecological Value (HEV) and wetlands of state and regional significance. These areas are important for several reasons including species richness and diversity, habitat quality, and aesthetic values. Waterways within the Redlands region provides habitat for the locally rare and potentially threatened Ornate Sunfish (*Rhadinocentrus ornatus*) as well as the vulnerable and nationally endangered Oxleyan pygmy perch (*Nannoperca oxleyana*). The Redlands region drains to and has island located within the Moreton Bay Marine Park, which is listed as a Ramsar site with wetlands of international significance. All catchments within the Redlands have been identified as having environmentally sensitive areas.

The environmental values associated with these areas require protection from current environmental stressors and (in particular) potential impacts of future development and population growth.

Population Growth

Population growth pressures were identified for catchments where there was expected to be a significant increase in urban population by 2031. Table E-1 outlines the key catchments identified as having population growth pressures.

Table E-1 Population Growth Pressures

Catchment	Population Growth Pressure
Hilliards Creek	Kinross Road development
Eprapah Creek	South East Thornlands development
South Eastern Creeks	Development around Double Jump Road, and subdivisions around Weinam Creek
Coochiemudlo & Southern Moreton Bay Islands (SMBIs)	Population growth on the SMBIs will be a significant pressure to manage, as the SMBIs are not sewered, and current on site wastewater management practices are unsustainable
North Stradbroke Island	Significant population growth is expected within the small residential communities of Amity, Dunwich and Point Lookout

Development pressures in these catchments will need to be carefully managed to ensure sustainable least cost provision of water supply, wastewater and stormwater infrastructure.

Wastewater Infrastructure

Redlands catchments in which STPs were identified to present key future management pressures and a short description of the key pressures are summarised in Table E-2 below.

Table E-2 STP Management Pressures

Catchment	STP Management Pressure
Hilliards Creek	Cleveland STP licence is currently under renewal. It is likely that nutrient load limits will be imposed that reflect existing loads, which may require significant investment in additional treatment and/or reuse of wastewater to comply with licence conditions
Eprapah Creek	Victoria Point STP currently has licenced total nitrogen (TN) load limits. These limits may be exceeded as early as 2022, with future 2031 discharges predicted to significantly exceed licence limits. Investment in additional treatment and/or reuse of wastewater will be required to comply with licence conditions for TN loads.
North Stradbroke Island	Dunwich STP is currently exceeding TN licence conditions, which stipulate that concentrations must be within 10% of background levels (from groundwater monitoring). This issue and potential management measures are currently being investigated by Allconnex[1]. Dunwich STP is also predicted to marginally exceed its licenced EP capacity by 2031. If required, a new licence may trigger new nutrient load limit conditions.

Sewage overflows, particularly during wet weather, were also identified to be a key pressure throughout the region. Sewage overflows pose potential pressures to the environment, public health, waterway use and amenity values as well as to Council's reputation.

In addition to the above specific STP operational issues, it is recognised that STP discharges are currently placing significant pressure on waterway health, and this will need to be addressed to ensure sustainable management of waterways.

Water Supply

Key pressures for the provision of water supply within the Redlands are identified in Table E-3.

Table E-3 Water Supply Management Pressures

Catchment	Water Supply Management Pressure
Upper Tingalpa Creek Catchment	Drinking water quality was identified as an issue at Capalaba Water Treatment Plant (from Leslie Harrison Dam), with high organic loadings in the raw water source, and potentially elevated levels of Trihalomethanes in treated water. Upgrades to the treatment process are required to ensure public health is protected.
North Stradbroke Island	Future security of water supply sources on NSI is a potential issue, as the implications of the indigenous land use agreement (ILUA) is unknown. However it is noted that discussion with Councillors (9/10/12) suggests that the ILUA is unlikely to affect water supply.

Despite the fact that water supply has not been identified as a significant pressure in most catchments, water conservation principles are considered a fundamental component of total water cycle management planning in all catchments.

[1] Note that during the development of this Plan, Allconnex was disbanded and Redland Water has resumed the role for delivery of water and wastewater services within Redland City Council.

Flooding

There are currently limited areas which are at serious risk from flooding throughout the Redland City Council area. This has been as a result of appropriate development standards and controls being applied throughout, ensuring that development which may be at risk of flooding has adequate preventative measures in place. These controls should continue to be applied to any new development to ensure that the flood risk is low and should be reviewed when additional information becomes available about the climate change. This is to ensure that developments are protected from potential impacts of climate change.

Storm Tide

Storm tide inundation currently impacts on some properties throughout the Redlands region. Storm Tide Inundation Mapping has recently been undertaken for the area that incorporates potential impacts of climate change (Cardno, 2011). This mapping has been used to identify key problem areas within the Redlands, which are generally located around foreshore communities and on the islands.

Landfill Leachate

Landfill leachate management was raised as a pressure to be considered during the risk assessment workshop. The key pressures associated with landfill leachate included:

- The ability and capacity of STPs to effectively treat landfill leachate generated in the Redlands region. This was identified as the most significant pressure associated with landfill leachate management. Currently landfill leachate is pumped as trade waste to Capalaba STP under a conditional trade waste permit issued by Allconnex. The ability of the STP to effectively treat leachate contaminants is unknown and places pressure on the treatment ability of the STP, with the potential to detrimentally affect the water quality treatment performance during dry weather flows, and also incur fines. Further analysis of trade waste and high contamination risks is important to better understand the effectiveness of STP treatment of trade waste and any potential non-compliance issues. In addition, landfill leachate is in some cases tankered and treated outside of the Redlands region (e.g. at Caboolture STP) at great expense, and the future viability of this method of disposal is uncertain.
- Increased likelihood of sewage overflows at pump stations (refer to wastewater infrastructure), particularly during wet weather, as pump stations are not sized to accommodate leachate.
- Direct impacts to surface and groundwater quality from landfill leachate seepage. This is considered to be a secondary issue of concern.
- Potential for increased sea levels and storm tide to compromise the capping system on coastal landfills. This could result in water contamination and risks to public health.

<u>Water Cycle Management Issues</u>

Using the water cycle management planning pressures identified, a risk assessment was undertaken with key stakeholder representatives (Council and Allconnex) to identify the key water cycle management issues within the Redlands region that will require further detailed planning studies to address. The issues were identified as the high to extreme risk rating water cycle management

issues from the risk assessment process. A summary of the broad water cycle management issues that will require detailed planning studies to address is summarised in Table E-4. Specific issues are documented in Section 4.

Table E-4 Water Cycle Management Issues identified for Detailed Planning

Broad Water Cycle Management Issue	Catchment Requiring Detailed Planning									
	Tarradarrapin Creek	Hilliards Creek	Eprapah Creek	Cleveland & Thornlands	South Eastern Creeks	Southern Creeks	Upper Tingalpa	Lower Tingalpa	Coochiemudlo & Southern Moreton Bay Islands	North Stradbroke Island
Deterioration of waterway health	■	■	■	■	■	■	■	■	■	■
Potential to impact on environmentally sensitive waters	■	■	■	■	■	■		■	■	■
Population growth		■	■		■				■	■
Sewage treatment plant capacity constraints			■							■
Water supply constraints							■			■
Flooding				■	■	■		■	■	
Storm Tide	■	■	■	■	■			■	■	■
Landfill leachate	■				■			■		■
Dry weather sewage overflows		■								
Wet weather sewage overflows	■	■	■	■	■	■	■	■	■	■

TWCM Vision and Objectives for the Redlands

A key component of developing a TWCM strategy is ensuring clear principles and objectives are defined. Redland City Council has undertaken substantial consultation with the community during the development of the *Redlands 2030 Community Plan*. In recognition of this, the vision outlined in Council's Community Plan has been adopted as the vision for this TWCM Plan, as outlined below:

> *"In 2030, the Redlands will be a well-designed, vibrant city of mainland and island communities, each with distinctive character, heritage and lifestyles. Our shared values will shape the way we care for each other and how we protect the land, seas and waters where we choose to be."*

The Total Water Cycle Management objectives were developed through a workshop and in consultation with key stakeholders. The objectives are outlined in Table E-5.

Table E-5 Total Water Cycle Management Objectives

Long Term TWCM Strategy	Specific TWCM Objective
1. Improve Waterway Health	1.1 Rehabilitation of riparian zones to protect waterway health and improve habitat and amenity.
	1.2 Protect the values of waterways and wetlands through the Redlands Planning Scheme.
	1.3 Retain sediment on-site and prevent sediment moving into waterways.
	1.4 Reduce nutrient and sediment pollution by engaging with local landholders (businesses and private) through the Waterway Extension Program.
	1.5 Identify and eliminate unregulated water quality (or contamination) hotspots in the landscape
	1.6 Better management of trunk urban stormwater.
	1.7 Use and reuse contaminated water.
2. Protect Environmentally Sensitive Areas	2.1 Maintenance of HEV waterways and ecological processes.
3. Plan and facilitate Sustainable Population Growth	3.1 Investigate and future proof water resources in the land through innovation.
	3.2 New development to meet alternative water supply targets set by Queensland Development Code MP 4.2 and 4.3.
	3.3 Plan and articulate our future water supply needs.
4. Manage Wastewater Treatment Systems to protect receiving waters and public health	4.1 Meet and go beyond licence conditions by reducing effluent flows and pollutant loads within the wastewater system.
	4.2 Minimise trade waste.
	4.3 Sustainably manage biosolids, through beneficial reuse (i.e. agriculture).
	4.4 Reduce number of overflows caused by blockages, inflow and infiltration.
	4.5 To encourage waste minimisation and cleaner production, including waste prevention, recycling, and pre-treatment.
	4.6 To safeguard public health and the environment.
	4.7 To equitably recover the cost of services to commerce and industry including the cost of conveyance, treatment and disposal and, maintenance and repair of damage to the sewerage system.

Long Term TWCM Strategy	Specific TWCM Objective
5. Sustainably Manage Water Resources to protect the environment and provide reliable, least cost supply	5.1 Maximise efficient use of water through demand management measures and water saving devices. (Water conservation measures to target daily consumption of less than 200L/p/day as per SEQ Water Supply Strategy)
	5.2 Use water that's 'fit for purpose' i.e. using a quality of water no better than what is required (e.g. alternative source of water for landscape irrigation, toilet flushing, industry, construction).
	5.3 Investigate opportunities to use alternative water sources such as ground water, recycled water and stormwater (EPP Water s19).
6. Safeguard the community and increase resilience to the impacts of Flooding & Storm Tide	6.1 Manage flood and storm tide risk to the community and property.

Solutions Development & High Level Assessment

Solutions were developed to address the key water cycle management issues identified in each catchment (i.e. those issues identified as having high to extreme risks). A workshop with key stakeholders was facilitated to review and screen the solutions identified for each catchment.

The costs and benefits associated with implementing the solutions nominated for each catchment were then broadly evaluated using information from existing Council planning studies, literature values, and consultation with Council. The information collated was used to make a qualitative performance assessment of the costs and benefits of each solution. Key solutions from each catchment solution set were then identified. The key solutions were identified through the following:

- Stakeholder consultation during the solutions workshop
- Solutions that were identified to have a high overall level of performance from the broad assessment of costs and benefits
- Solutions that are required to address key TWCM issues and legislative requirements of the EPP Water.

The solutions sets and key solutions for each catchment are detailed in Section 5.3 of this report.

Preparation of an Implementation Plan

A TWCM implementation plan has been developed that outlines the key strategies and actions to achieve RCC's TWCM vision and objectives over the planning period. The implementation plan identifies the key actions, responsible groups and stakeholders, timing and high level costs estimates for implementing the actions. The implementation plan is contained in Section 6 of this report.

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1.0

Introduction

1 INTRODUCTION

This Total Water Cycle Management (TWCM) Plan identifies the key water cycle management issues within the Redland City Council (RCC) region, and develops solution sets to address these issues that will be further investigated through detailed planning studies. It also includes an implementation plan that sets out required strategies and actions to achieve RCC's TWCM vision.

The key objective of this project is to further RCC's strategic vision, as outlined in the *Redlands 2030 Community Plan* and the *Corporate Plan 2010-15*, to "*improve waterway and environmental management in a manner that meets community expectations in the most cost effective way*." There are a number of water related objectives in the Community Plan and as an example, the first target is "*To halt and then reverse the declining trend in the health of Redlands waterways and Moreton Bay*."

A secondary objective of the TWCM planning project is to meet the legislative requirements of the *Environmental Protection (Water) Policy 2009* that requires the development, endorsement and publication of a Total Water Cycle Management Plan for the Redlands region by 1 July 2013. The EPP Water and *TWCM Planning Guideline for South East Queensland* (WBD,2010a) describe the matters that must be taken into account when a Local Government is preparing a TWCM Plan. The RCC TWCM plan has been developed in accordance with the aforementioned legislation and Guidelines. The primary intent of the EPP Water is to use TWCM Plans to enable equitable and informed decisions to be made about the use of water in a way that enhances or protects the environmental values of receiving waters.

The *South East Queensland (SEQ) Regional Plan 2009-2031* also supports the use of TWCM Plans as the preferred method for ensuring land use and infrastructure planning is environmentally sustainable, and to ensure reliable water supplies to cater for forecast population growth. The SEQ Regional Plan further identifies the requirement for sub-regional TWCM Plans to be developed for key development areas in SEQ. The primary focus of a S-R TWCM Plan is to investigate water supply options in a TWCM planning context in large greenfield developments. Although there are a couple of future greenfield development sites in the Redlands region, they are not identified as key development areas in SEQ, and as such do not require a S-R TWCM Plan.

2.0

Catchment Descriptions & Water Cycle Accounts

2 CATCHMENT DESCRIPTIONS & WATER CYCLE ACCOUNTS

The Redlands region has been divided into 10 primary planning units for investigation, referred to herein as catchments. The planning units have been defined to align with catchment groupings used for the *Redlands Waterway Recovery Report – Condition Summary 2010* (RCC 2010).

Key catchment characteristics are summarised in the following section, in addition to existing and future water cycle accounts. These water accounts attempt to quantify, as much as practicable, the inputs and outputs of water in the water cycle, and assist to identify where water related issues, such as water shortages and water quality impacts, may exist currently and in the future (i.e. 2031).

The methodology and assumptions for developing water cycle accounts is included in Appendix A (Existing Accounts) and Appendix B (Future Accounts).

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Tarradarrapin Creek Catchment

Tarradarrapin Creek catchment is a fully urbanised catchment that is approximately 1,310 ha in size. The catchment largely encompasses the suburb of Birkdale, and also includes some fringing urban areas of Alexandra Hills and Wellington Point. Aquatic Paradise canal estate and Sovereign Waters lake estate are located adjacent to the foreshore.

The urban population in Tarradarrapin Creek catchment is approximately 21,061 people currently, and is expected to increase to about 22,561 people in 2031. This is an increase of 1,500 people which represents a growth of 7%. This growth is expected to be predominantly through brownfield development and densification of existing land use.

Tarradarrapin Creek is the key waterway in this catchment, and includes the RAMSAR listed Tarradarrapin wetland. The catchment drains to Waterloo Bay, which is declared as a High Ecological Value (HEV) area as per the EPP Water.

Potable water is sourced predominately from Capalaba Water Treatment Plant, supplied by Leslie Harrison Dam.

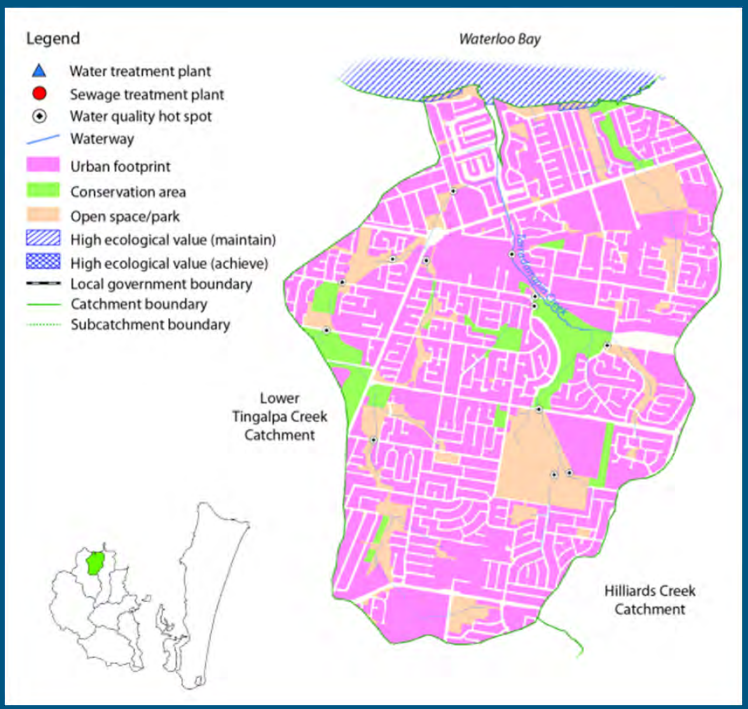
Wastewater from this catchment is treated at Thorneside and Capalaba STPs, in the neighboring Lower Tingalpa Creek Catchment, so there are no STP discharges to waterways within this catchment. However there are a number of pump stations where wet weather sewage overflows to waterways may occur. Leachate management issues have been identified at closed landfill sites in Birkdale (Judy Holt Park and adjoining property) and Wellington Point (upstream of Sovereign Waters). Leachate is treated within the Redlands, and also tankered outside of the Redlands for treatment. A number of water quality monitoring hotspots have also been identified along Tarradarrapin Creek.

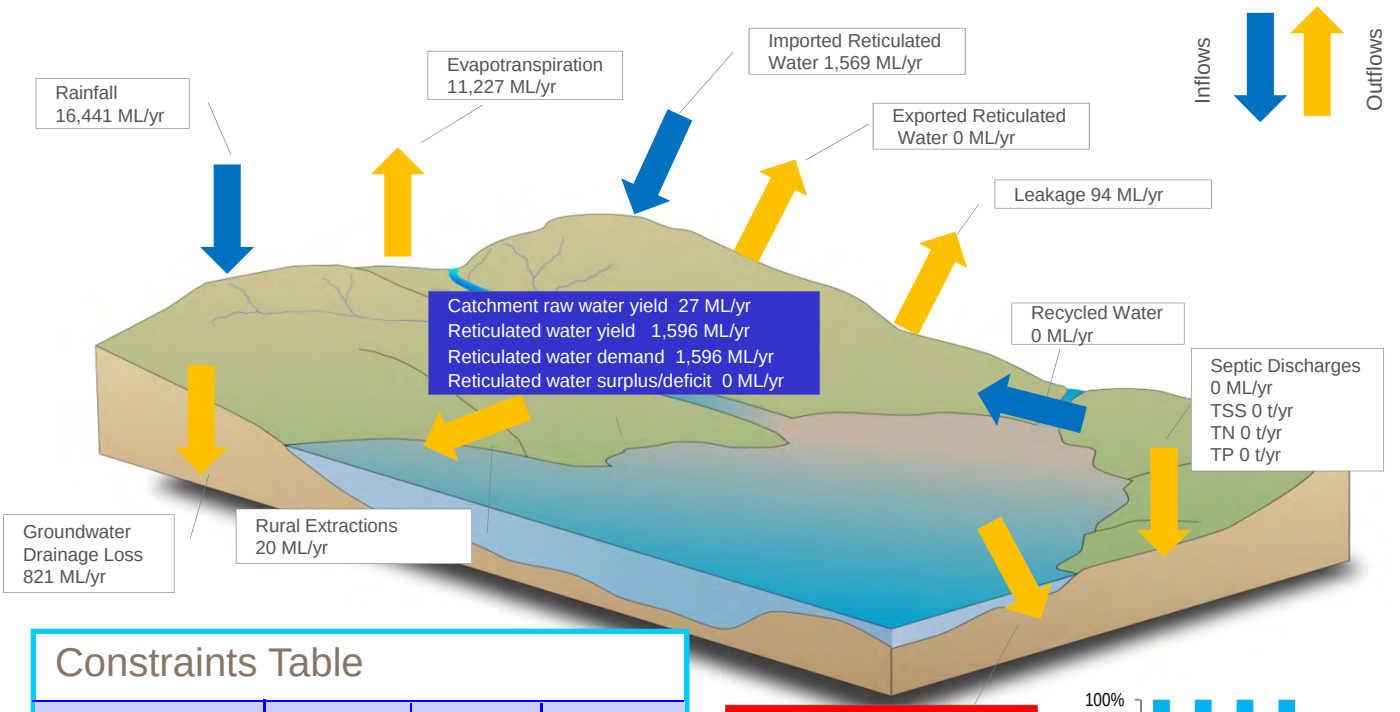
Stormtide inundation is an issue particularly around the foreshore areas of Birkdale. Council flood mapping also indicates some property inundation from flooding along the western branch of Tarradarrapin Creek.

Catchment Facts

- **Area: 1,310 ha**
- **Current Population: 21,061**
- **Future Population: 22,561**
- **Future Pop. Growth: 7%**
- **Wastewater treated at Thorneside STP (majority) & Capalaba STP.**
- **EHMP Score 2011:**

  B+ (Waterloo Bay)
- **High Priority catchment for waterway management**

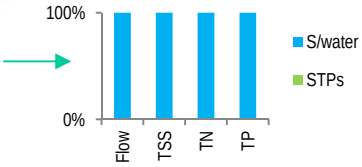




Constraints Table

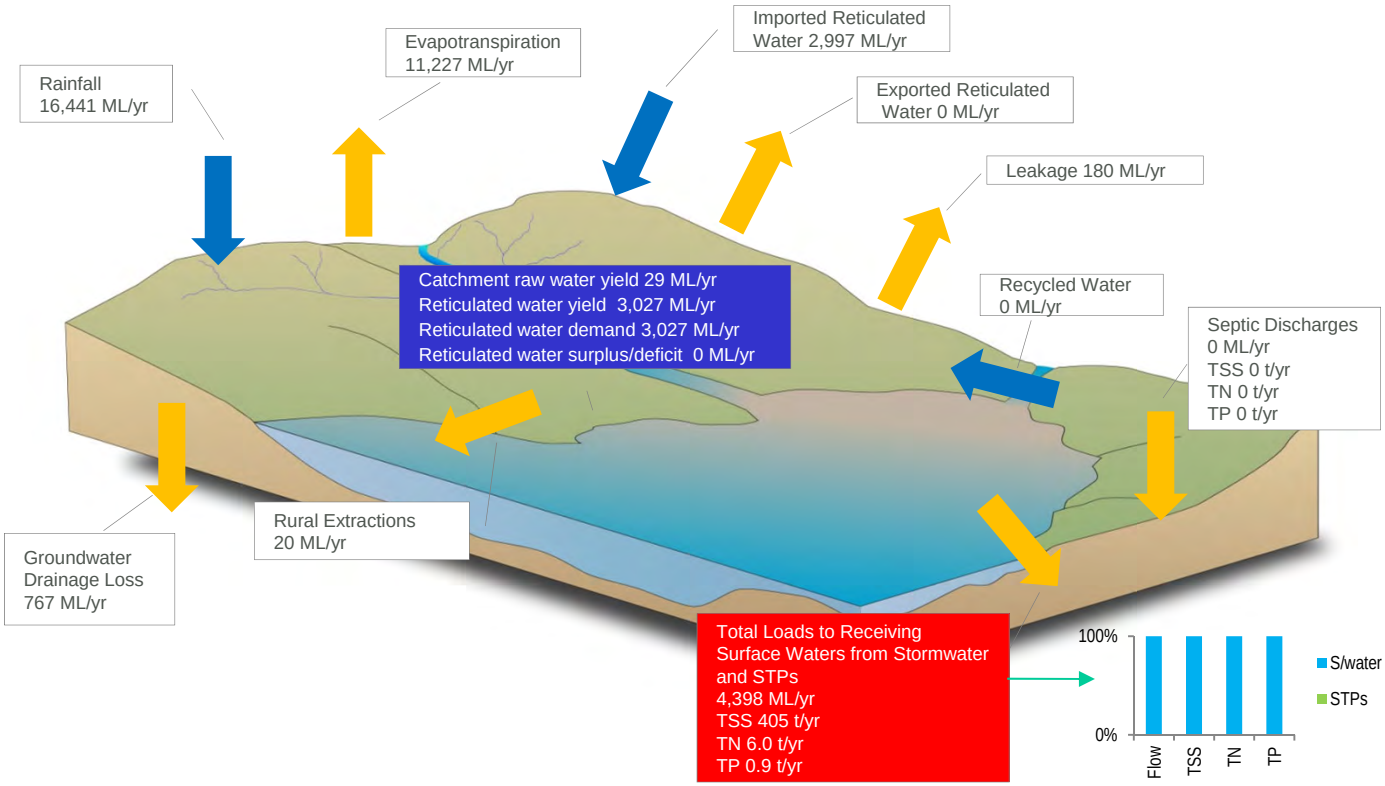
	Constraint	2012	2031
Storage Yield	N/A	N/A	N/A
Water Treatment Plant	N/A	N/A	N/A
Sewage Treatment Plant	N/A	N/A	N/A
Recycled Water Reuse	N/A	N/A	N/A
Sustainable Loads - TSS	?	398 t/yr	405 t/yr
Sustainable Loads – TN	?	5.9 t/yr	6.0 t/yr
Sustainable Loads - TP	?	0.9 t/yr	0.9 t/yr
Environmental Flow	N/A	4,346 ML/yr	4,398 ML/yr

Total Loads to Receiving Surface Waters from Stormwater and STPs
4,346 ML/yr
TSS 398 t/yr
TN 5.9 t/yr
TP 0.9 t/yr



Population 21,061

2012



Total Loads to Receiving Surface Waters from Stormwater and STPs
4,398 ML/yr
TSS 405 t/yr
TN 6.0 t/yr
TP 0.9 t/yr

Population 22,561

2031

Hilliards Creek Catchment

Hilliards Creek catchment is 2,812 ha in size. The urban population in Hilliards Creek catchment is currently 18,500 people, and is expected to increase to about 25,000 people by 2031. This is an increase of 6,500 people which represents a 35% increase. Most of this growth will be located in key developments around the Thornlands region.

Urban residential land use is dominant in the north of the catchment around Wellington Point, Ormiston and part of Alexandra Hills. In the centre of the catchment around Alexandra Hills, there exists a large conservation area, as well as some general industry area around Cleveland.

Rural land use dominates in the south of the catchment around Thornlands and Sheldon, with some low density/park residential development around Thornlands and Capalaba. Future development pressures exist in the Thornlands region, with the planned Kinross Road residential development.

Hilliards Creek is the major waterway in this catchment, which flows from the upper catchment areas and divides the lower suburbs of Wellington Point (west bank) and Ormiston (east bank). Hilliards Creek flows into Central (Moreton) Bay, which is declared as a High Ecological Value (HEV) area under the EPP Water. Wetlands of state significance are located around the mouth of Hilliards Creek and foreshore of Wellington Point.

Water quality hot spots have been identified in the catchment. Poultry farms and a number of small water bodies exist that may be point sources of contamination within the catchment.

Council water quality monitoring in freshwaters indicates TSS is the key parameter of concern. EHMP monitoring indicates nutrients exceed Water Quality Objectives (WQOs) at both freshwater and estuarine monitoring sites in Hilliard's Creek.

Most wastewater from this catchment is treated at Thorneside STP, in the neighboring Lower Tingalpa Creek Catchment.

Cleveland STP is located within Hilliards Creek catchment, and services small areas in the south of the catchment (Alexandra Hills, Thornlands) as well as the majority of wastewater from neighbouring urban areas in the Cleveland and Thornlands catchments.

Catchment Facts

- **Area: 2,812 ha**
- **Current Population: 18,500**
- **Future Population: 25,000**
- **Future Pop. Growth: 35%**
- **Future development pressures: Kinross Road**
- **Wastewater in north of catchment treated at Thorneside STP (in neighbouring catchment)**
- **Wastewater in south treated at Cleveland STP, which discharges to Hilliards Creek and via land disposal.**
- **EHMP Score 2011:**
  - **F (Redland freshwater)**
  - **D+ (Central Bay)**
- **Medium Priority catchment for waterway management**

Hilliards Creek Catchment

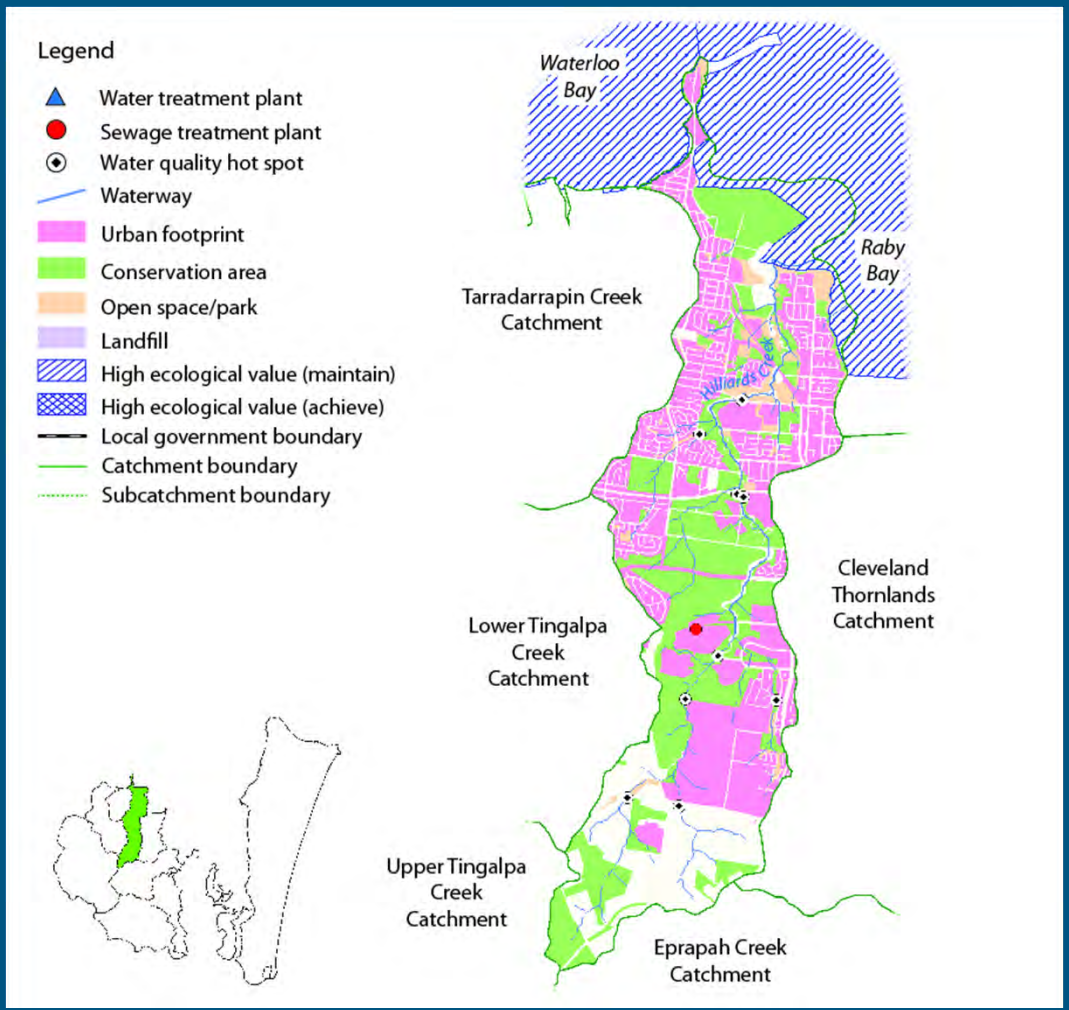
As the majority of land in the south of Hilliards Creek catchment is rural, these properties are serviced by septic/on site wastewater treatment systems.

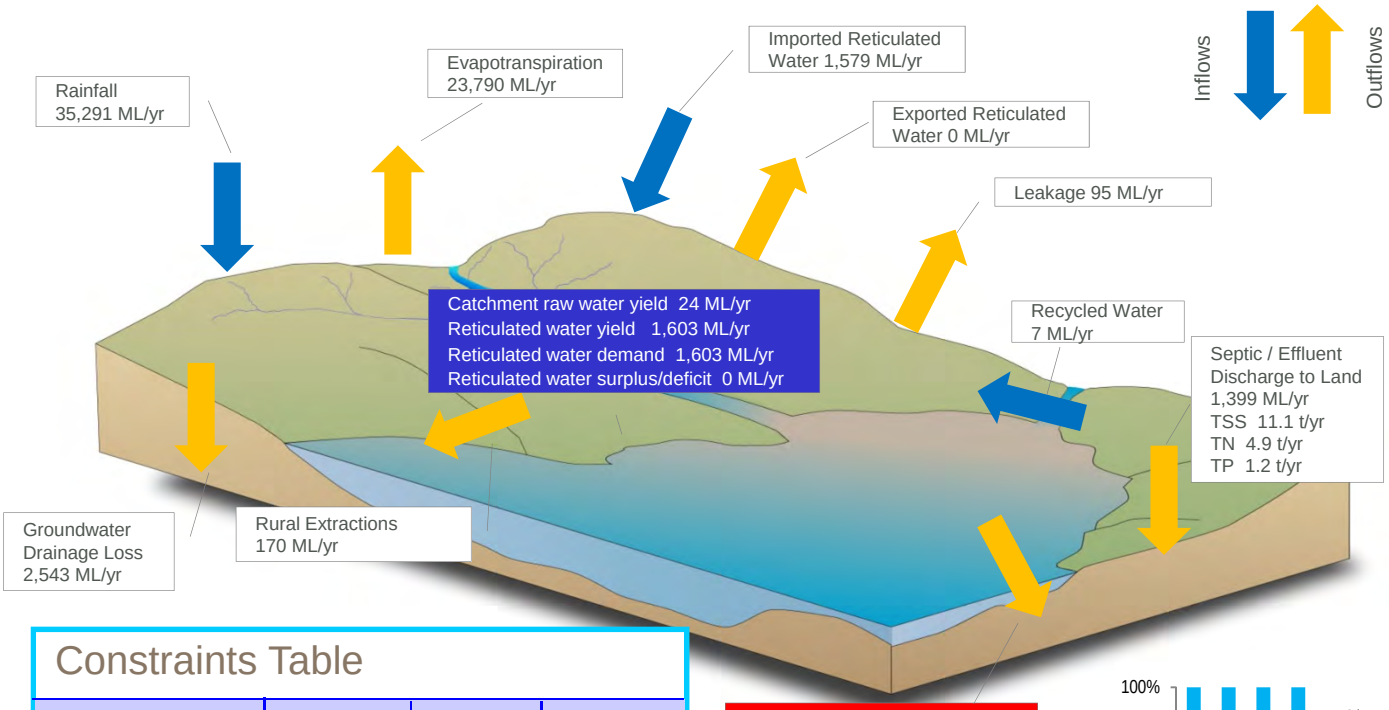
Future development in Hilliards Creek catchment as well as the South East Thornlands development area (Eprapah Creek Catchment) is likely to be serviced by the Cleveland STP. Wastewater from Cleveland STP is discharged to freshwater reaches of Hilliards Creek and also via land disposal. Currently, STP discharges make up a small proportion of the total flows and pollutant loads discharged to receiving waters. However future STP discharges present a key pressure in the catchment, contributing to a major proportion of the total nitrogen (46%) and phosphorus (56%) loads to receiving waters.

The Cleveland STP license is currently under renewal, and is likely to have nutrient load discharge limits imposed.

Potable water is sourced predominately from Capalaba Water Treatment Plant, supplied by Leslie Harrison Dam, with some water also sourced from North Stradbroke Island Water Treatment Plant.

Properties in the Hilliards Creek catchment are at a low risk of flooding. However, there is the potential for some properties being isolated, due to many roads having a low flood immunity. Storm tide inundation causes some issues within the catchment, predominantly at Wellington Point.

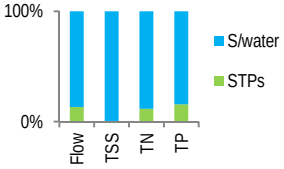




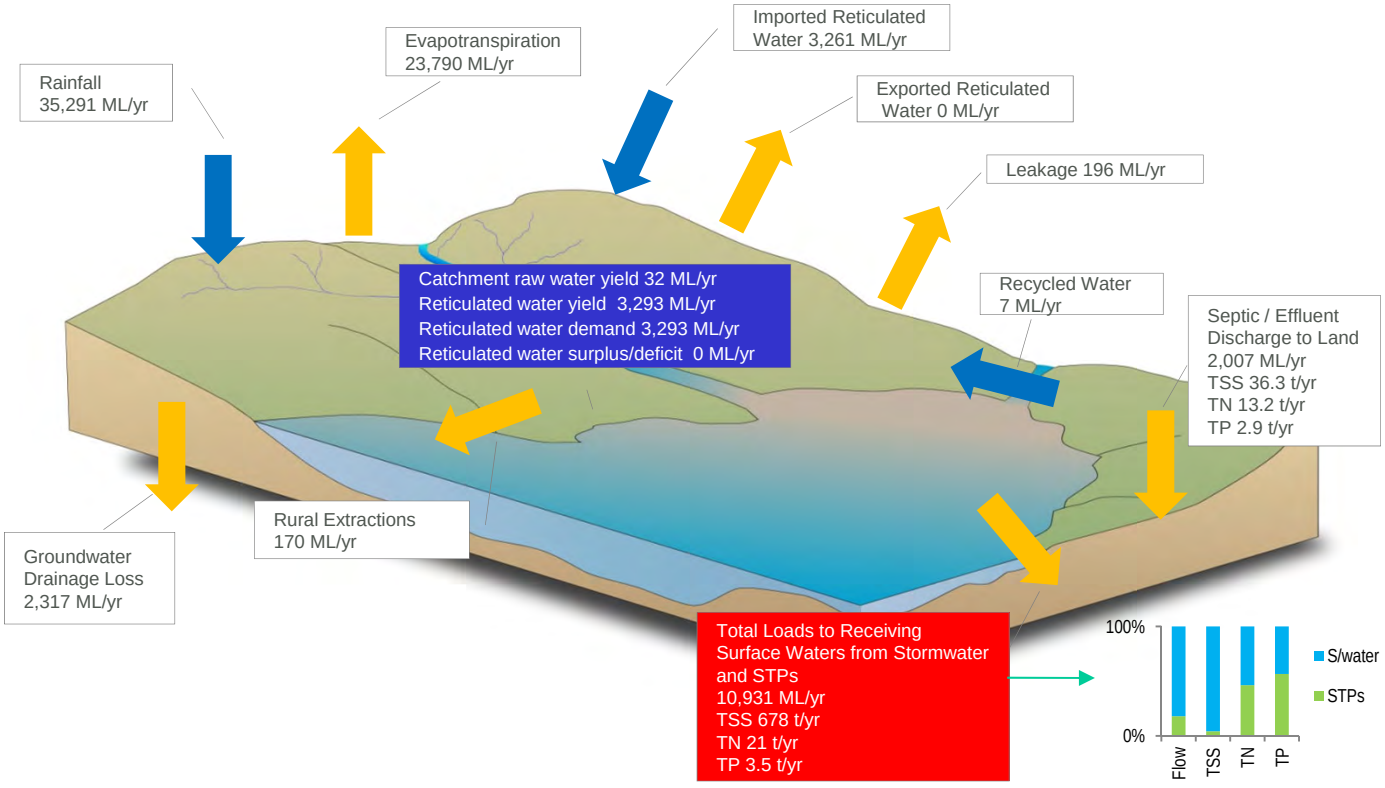
Constraints Table

	Constraint	2012	2031
Storage Yield	N/A	N/A	N/A
Water Treatment Plant	N/A	N/A	N/A
Sewage Treatment Plant (Cleveland)	38,000 EP (Design) 50,000 EP (Licence)	34,588 EP	46,644 EP
Recycled Water Reuse	3,898 ML/yr	7 ML/yr	7 ML/yr
Sustainable Loads - TSS	?	634 t/yr	678 t/yr
Sustainable Loads – TN	?	12.7 t/yr	21.0 t/yr
Sustainable Loads - TP	?	1.7 t/yr	3.5 t/yr
Environmental Flow	N/A	10,105 ML/yr	10,931 ML/yr

Total Loads to Receiving Surface Waters from Stormwater and STPs
10,105 ML/yr
TSS 634 t/yr
TN 12.7 t/yr
TP 1.7 t/yr



Population 18,500 **2012**



Total Loads to Receiving Surface Waters from Stormwater and STPs
10,931 ML/yr
TSS 678 t/yr
TN 21 t/yr
TP 3.5 t/yr

Population 25,000 **2031**

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Cleveland and Thornlands Catchment

The Cleveland and Thornlands Catchment encompasses the subcatchments of Cleveland (north) and Thornlands (south). In total, the catchment is 2,150 ha in size. Existing land use is dominated by urban residential, with park residential and some rural areas located in the south of the catchment. Raby Bay canal estate is located at the northern extend of the catchment in Cleveland.

The urban population in the Cleveland and Thornlands catchment is approximately 24,900, and is expected to increase by 18% to reach approximately 29,500 people by 2031.

Key future development pressures in this catchment include the fringing South East Thornlands development.

There are no major waterways within this catchment. Ross Creek is a highly modified channel that drains the Cleveland sub-catchment through the canals and into Raby Bay. A small area of the Cleveland catchment drains directly to High Ecological Value receiving waters in Central Bay. Minor unnamed waterways drain east through the Thornlands sub-catchment into Central Moreton Bay. Wetlands of state significance fringe the eastern foreshore area of the catchment.

Council monitoring indicates nitrogen is the key pollutant of concern in freshwater reaches of the catchment. Water quality hot spots have also been identified throughout the catchment, primarily in urban areas. A couple of poultry farms and a number of small water bodies in the catchment are potential point sources of contamination.

Wastewater from this catchment is treated at the Cleveland STP, in the neighboring Hilliards Creek Catchment. There are number of pump stations where wet weather sewage overflows to waterways may occur. Park residential properties around Thornlands are serviced by septic/on site wastewater systems.

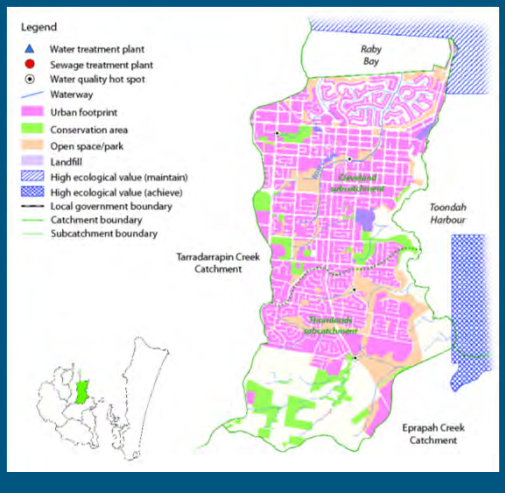
Potable water is sourced predominately from Capalaba Water Treatment Plant, supplied by Leslie Harrison Dam, with some water also sourced from North Stradbroke Island Water Treatment Plant.

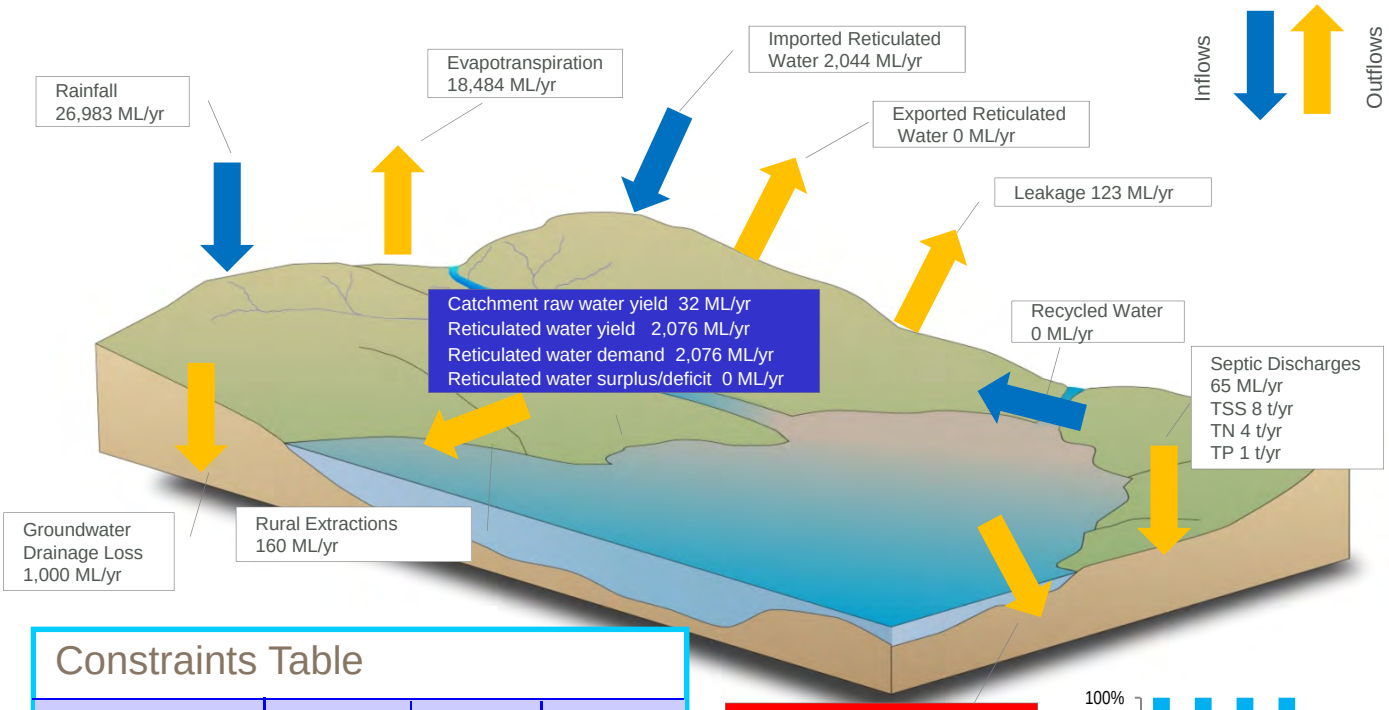
Flooding affects numerous properties within this catchment, as a result of overland flooding and storm tide inundation. The overland flooding in this area is due to inadequately sized stormwater pipes in some locations. This catchment is likely to have more properties impacted as a result of climate change.

Catchment Facts

- **Area: 2,150 ha**
- **Current Population: 24,934**
- **Future Population: 29,535**
- **Future Pop. Growth: 18%**
- **Future development pressures: South East Thornlands**
- **Wastewater treated at Cleveland STP (in adjoining catchment)**
- **EHMP Score 2011:**

  D+ (Central Bay)
- **Cleveland is a high priority catchment for waterway management**
- **Thornlands is a medium priority catchment for waterway management**

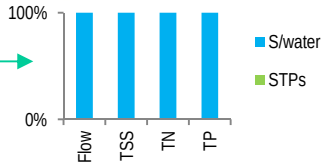




Constraints Table

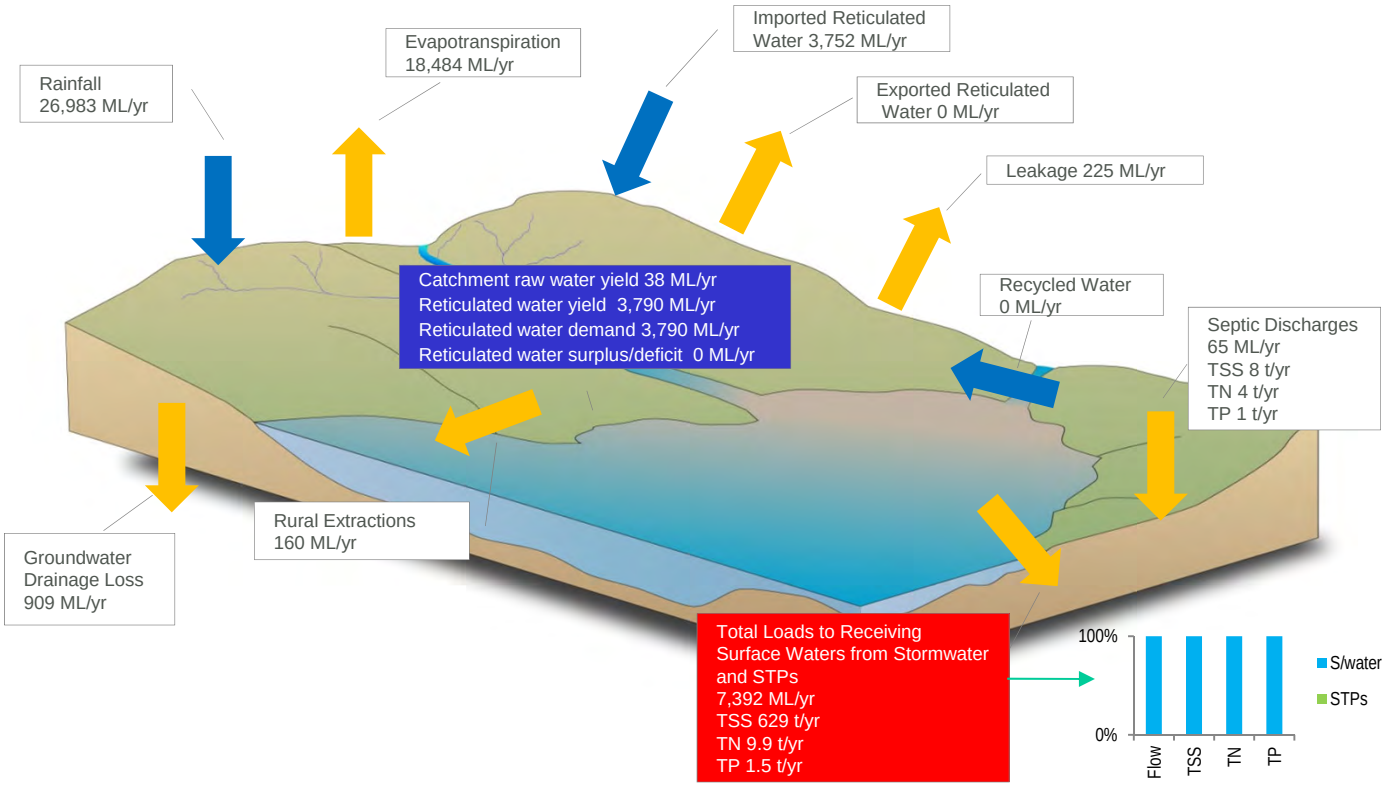
	Constraint	2012	2031
Storage Yield	N/A	N/A	N/A
Water Treatment Plant	N/A	N/A	N/A
Sewage Treatment Plant	N/A	N/A	N/A
Recycled Water Reuse	N/A	N/A	N/A
Sustainable Loads - TSS	?	612 t/yr	629 t/yr
Sustainable Loads – TN	?	9.8 t/yr	9.9 t/yr
Sustainable Loads - TP	?	1.4 t/yr	1.5 t/yr
Environmental Flow	N/A	7,307 ML/yr	7,392 ML/yr

Total Loads to Receiving Surface Waters from Stormwater and STPs
7,307 ML/yr
TSS 612 t/yr
TN 9.8 t/yr
TP 1.4 t/yr



Population 24,934

2012



Total Loads to Receiving Surface Waters from Stormwater and STPs
7,392 ML/yr
TSS 629 t/yr
TN 9.9 t/yr
TP 1.5 t/yr

Population 29,535

2031

Eprapah Creek Catchment

Eprapah Creek catchment is 3,891 ha in size. Existing land use is dominated by urban residential areas in the lower catchment (around Victoria Point) and rural non urban and environmental protection areas in the upper catchment (Mount Cotton area).

The urban population in Eprapah Creek catchment is currently approximately 11,706 people and is expected to increase to about 17,915 people by 2031. This is an increase of approximately 6,209 people, representing a 53% increase.

Key future development pressures in this catchment include South East Thornlands, Bunker Road Emerging Community Area and residential development around Double Jump Road.

Eprapah Creek is the major waterway that drains this catchment, and provides habitat for the locally rare and potentially threatened Ornate Sunfish (*Rhadinocentrus ornatus)*. Significant waterway barriers for fish passage have been identified and documented in this catchment.

Sandy Creek and Little Eprapah Creek are tributaries of Eprapah Creek. Eprapah Creek flows into a designated High Ecological Value (HEV) area in the Western Bay (HEVa1284). The EPP water prescribes Water Quality Objectives for this area to be achieved, rather than simply maintained. Wetlands of state significance are also located around the mouth of Eprapah Creek and foreshore area. A high level of intact riparian vegetation cover remains around Eprapah Creek estuary (90%).

Council monitoring indicates TSS and nutrients are key pollutants of concern in freshwater reaches of the catchment. Water quality hot spots have also been identified throughout the catchment. A number of poultry farms and small water bodies present potentially significant point sources of contamination.

Wastewater is treated within the catchment at the Victoria Point STP, which discharges into the upper estuary of Eprapah Creek. Victoria Point STP also treats wastewater from neighbouring catchments (Coochiemudlo Island and South Eastern Creeks Catchment).

Rural and park residential properties around Mount Cotton and Thornlands are serviced by septic/on site wastewater systems.

Catchment Facts

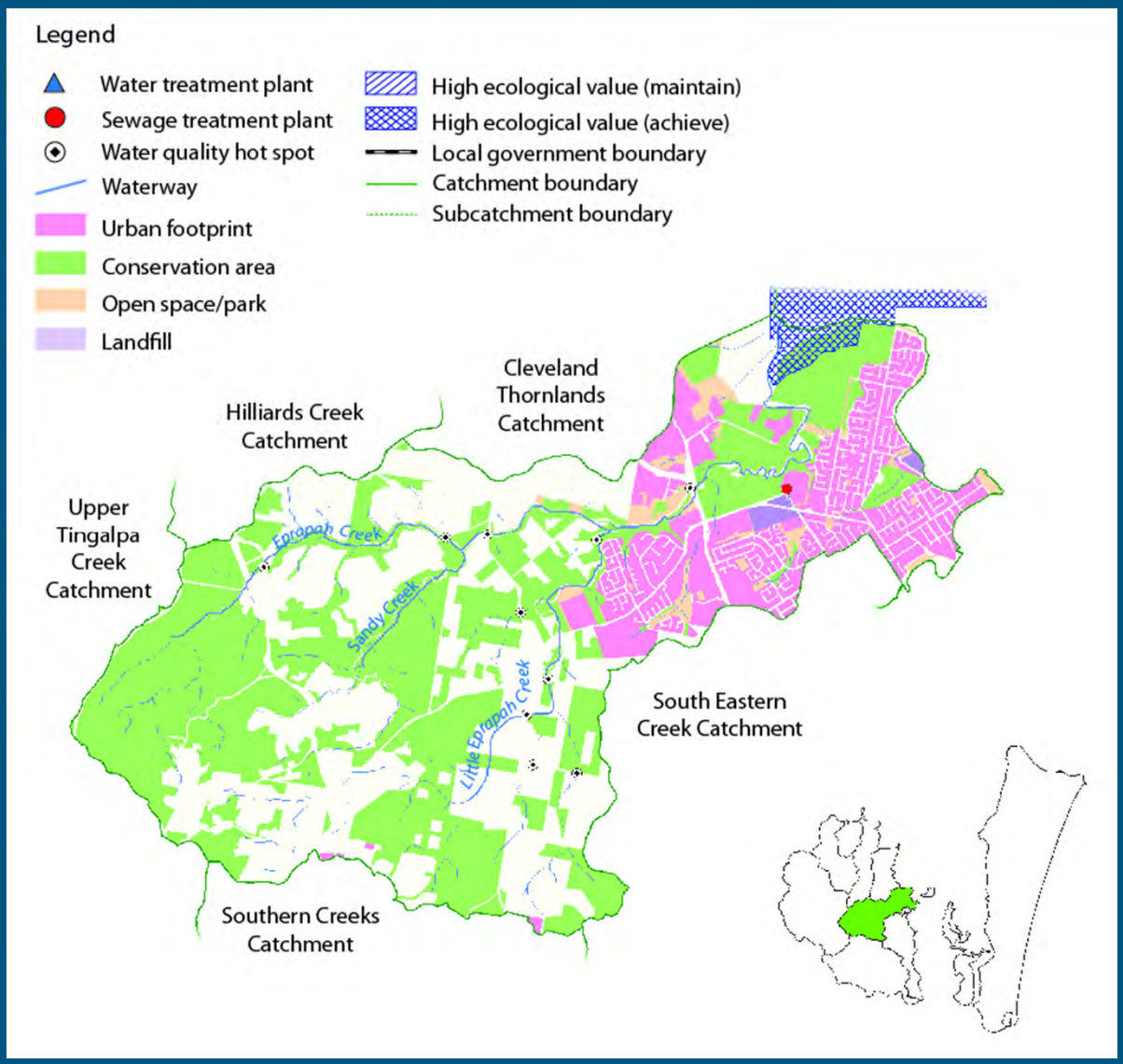
- **Area: 3,891 ha**
- **Current Population: 11,706**
- **Future Population: 17,915**
- **Future Pop. Growth: 53%**
- **Future development pressures: South East Thornlands, Bunker Road Emerging Community Area, Double Jump Road**
- **Wastewater treated at Victoria Point STP, discharging to Eprapah Creek**
- **Eprapah Creek habitat for the Ornate Sunfish**
- **EHMP Score 2011:**
  - **F (Redland freshwater)**
  - **C (Eprapah Estuary)**
  - **D+ (Central Bay)**
- **High Priority catchment for waterway management**

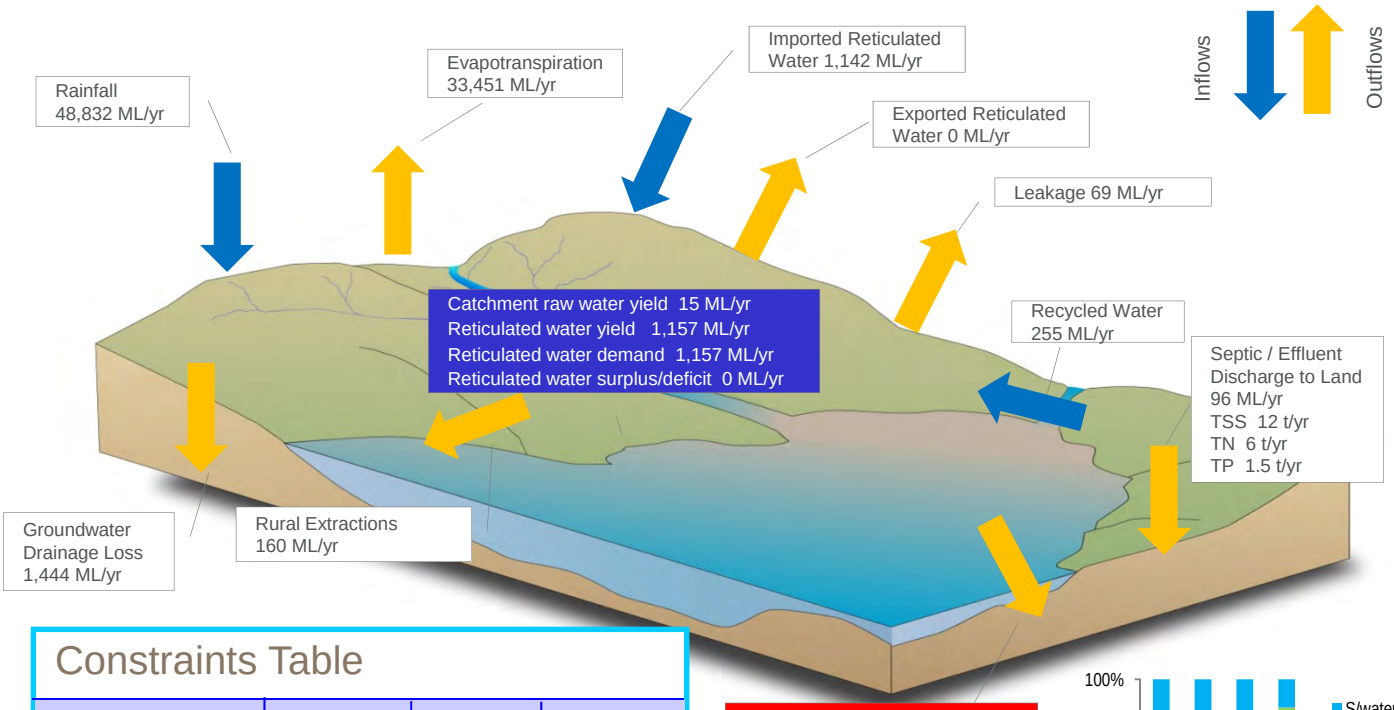
Eprapah Creek Catchment

Future development pressures around Bunker Road and Double Jump Road are likely to be serviced by the Victoria Point STP. Victoria Point STP presents a key existing and future pressure on waterway health. Currently, total phosphorus loads from Victoria Point STP constitute a major proportion of the total pollutant loads discharged to receiving waters (74%), and this is expected to increase to 86% of total loads by 2031. Future nitrogen loads from STP discharges are also likely to increase substantially to make up approximately 34% of total loads to receiving waters. Victoria Point STP is predicted to exceed its licensed nitrogen load limit by as early as 2022 and therefore additional treatment and/or reuse of wastewater will be required to meet legislative requirements.

Potable water is sourced predominately from North Stradbroke Island Water Treatment Plant, with some water also sourced from Capalaba Water Treatment Plant, supplied by Leslie Harrison Dam.

Flooding is not considered a major issue in this catchment. Most development within the area is relatively new and appropriate planning and development controls have been in place to minimise flood impacts. Storm tide inundation is likely to cause issues in the catchment, predominantly at Victoria Point.

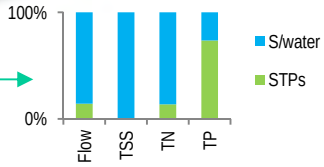




Constraints Table

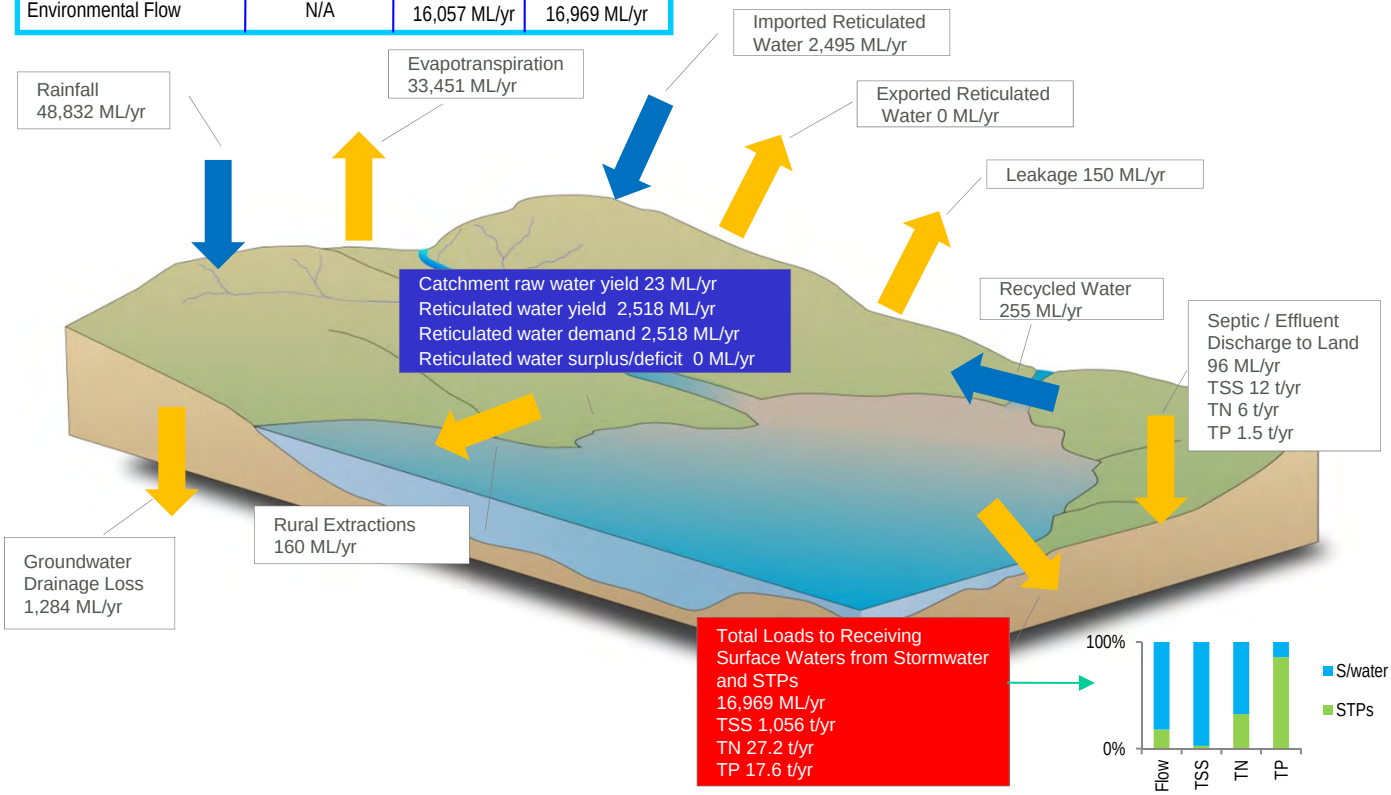
	Constraint	2012	2031
Storage Yield	N/A	N/A	N/A
Water Treatment Plant	N/A	N/A	N/A
Sewage Treatment Plant (Victoria Point)	34,000 EP (Design) 50,000 EP (Licence) TN 13.5kg/day	30,374 EP 8.2 kg/day TN	40,592 EP 25.1 kg/day TN
Recycled Water Reuse	N/A	255 ML/yr	255 ML/yr
Sustainable Loads - TSS	?	1,094 t/yr	1,056 t/yr
Sustainable Loads – TN	?	21.8 t/yr	27.2 t/yr
Sustainable Loads - TP	?	9.2 t/yr	17.6 t/yr
Environmental Flow	N/A	16,057 ML/yr	16,969 ML/yr

Total Loads to Receiving Surface Waters from Stormwater and STPs
16,057ML/yr
TSS 1,094 t/yr
TN 21.8 t/yr
TP 9.2 t/yr



Population 11,706

2012



Total Loads to Receiving Surface Waters from Stormwater and STPs
16,969 ML/yr
TSS 1,056 t/yr
TN 27.2 t/yr
TP 17.6 t/yr

Population 17,915

2031

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South Eastern Creeks Catchment

The South Eastern Creeks Catchment encompasses the sub-catchments of Moogurrapum Creek (north) and Southern Redland Bay (south). In total, the catchment is 3,004 ha in size, and largely encompasses the suburb of Redland Bay. Land use is dominated by urban residential areas in the north east of the catchment, with fringing park residential and rural areas predominately located to the west and south of the catchment. A large mining tenement is located at the far western extent of the catchment

The urban population in the South Eastern Creeks catchment is currently approximately 12,100 people, and is expected to increase to about 19,400 people by 2031. This is an increase of approximately 7,300 people which represents a 60% growth. There are potential future development pressures from subdivisions around Weinam Creek and Double Jump Road.

Moogurrapum Creek is the largest waterway in the Southern Creeks catchment, and drains the northern extent of this catchment (Moogurrapum sub-catchment) to Redland Bay. Weinam and Torquay Creeks are the key waterways in the southern extents of the catchment (Redland Bay sub-catchment) that drain from the west and into Redland Bay. Receiving waters form part of central and southern Moreton Bay Marine Park habitat protection zone.

Council monitoring indicates TSS and nutrients are key pollutants of concern in freshwater reaches of the catchment. Water quality hot spots have also been identified throughout the catchment. A number of poultry farms and small water bodies present potential point sources of contamination.

Wastewater from urban areas is treated at Victoria Point STP, located in the adjoining Eprapah Creek Catchment. There are, however, a number of pump stations located throughout the catchment where wet weather sewage overflows to waterways may occur. Landfill leachate generated from the closed Redland Bay landfill site is collected in sumps and ponds and tankered outside the Allconnex catchment.

Rural non urban properties around Redland Bay are serviced by septic/on site wastewater systems.

Catchment Facts

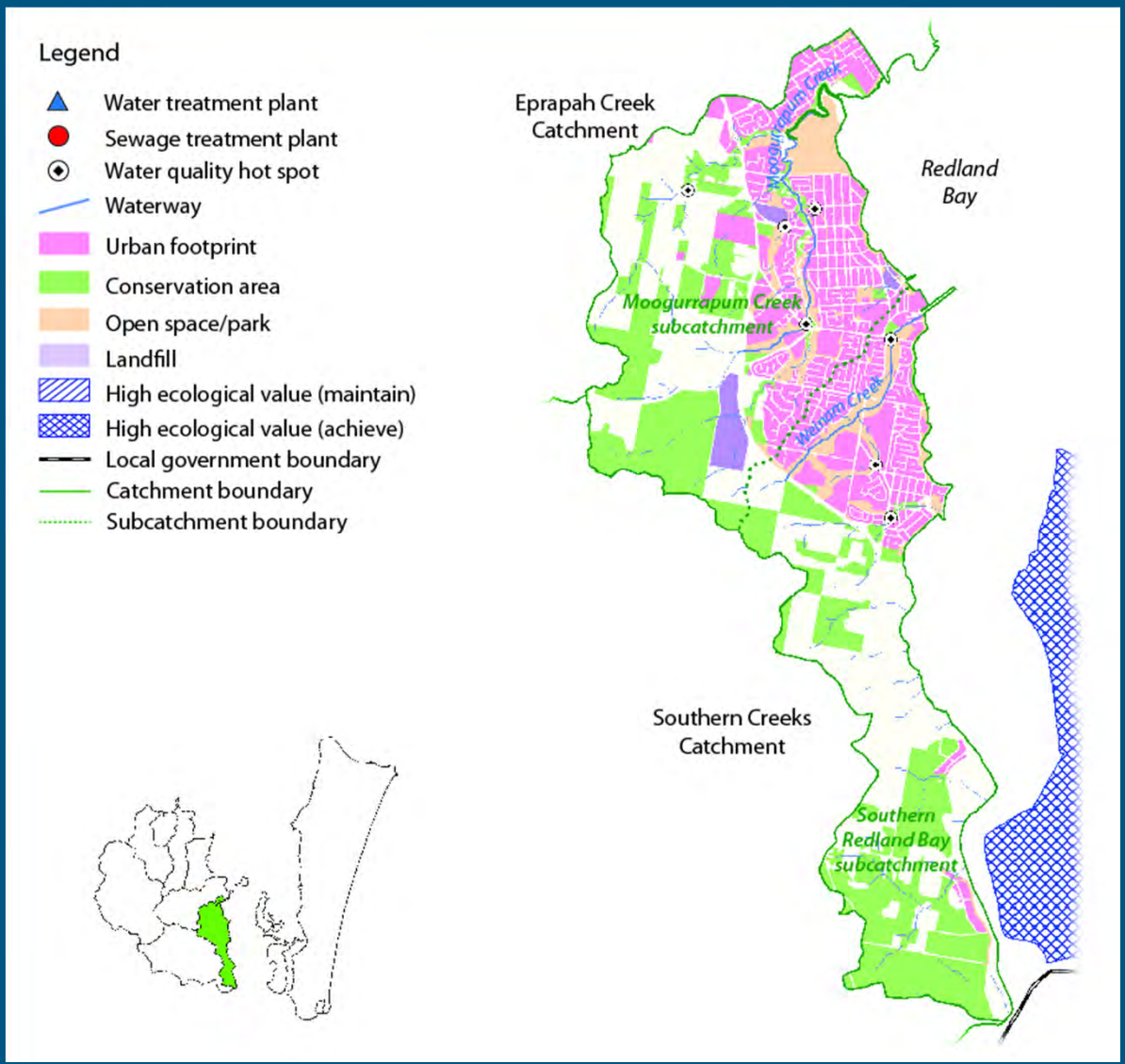
- **Area: 3,004 ha**
- **Current Population: 12,142**
- **Future Population: 19,374**
- **Future Pop. Growth: 60%**
- **Development Pressures around Weinam Creek & Double Jump Road**
- **Wastewater treated at Victoria Point STP (in adjoining Eprapah Creek catchment)**
- **EHMP Score 2011:**

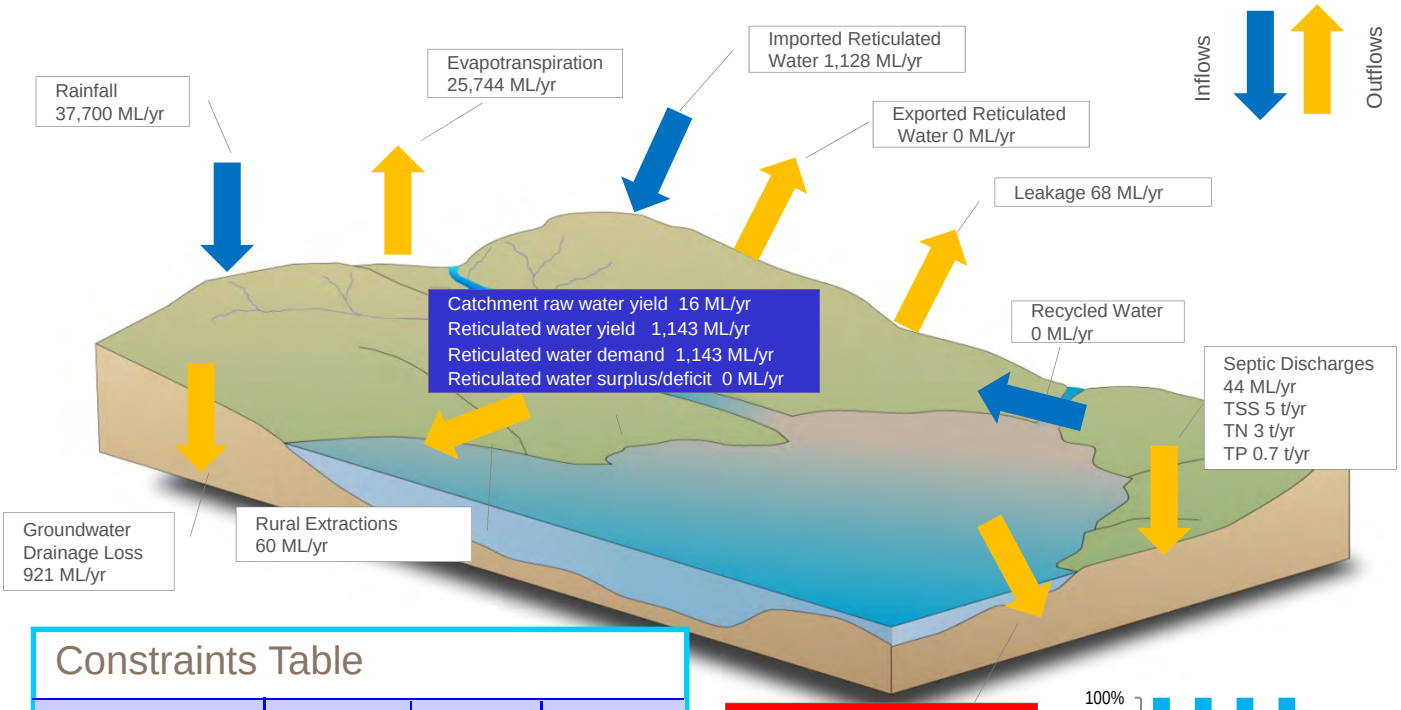
  D+ (Central Bay)
- **High Priority catchment for management**

South Eastern Creeks Catchment

Potable water is sourced predominately from North Stradbroke Island Water Treatment Plant.

Some roads within this catchment have a low flood immunity, which results in some properties becoming isolated during a flood event, particularly within the Torquay Creek catchment (part of Southern Redland Bay catchment). Property inundation is an issue particularly within the Weinam Creek Catchment (within Southern Redland Bay catchment). Under sizing of culverts in some areas can also increase the flooding. Storm tide inundation also impacts on this catchment, causing property inundation and isolation.

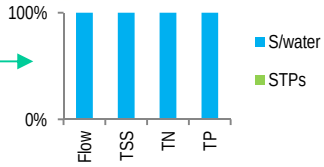




Constraints Table

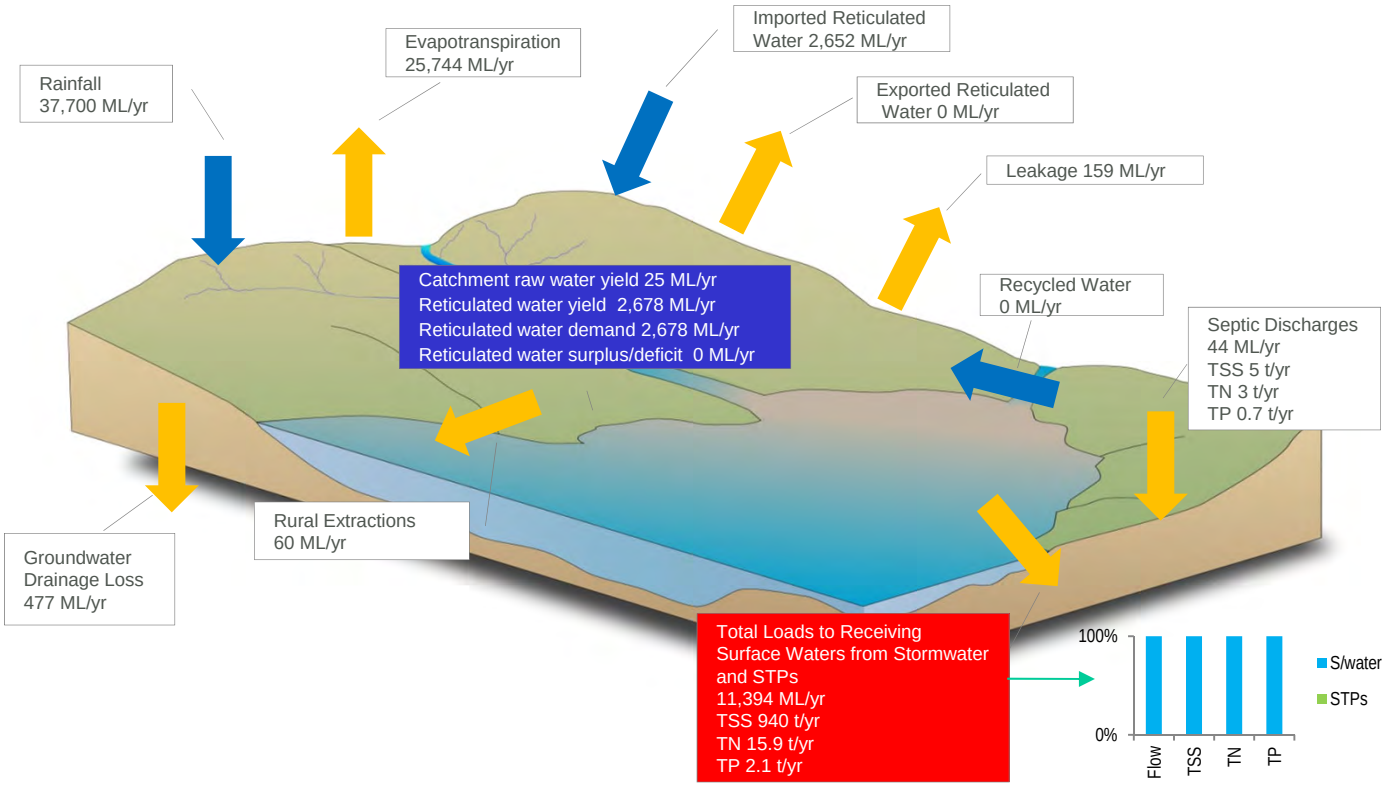
	Constraint	2012	2031
Storage Yield	N/A	N/A	N/A
Water Treatment Plant	N/A	N/A	N/A
Sewage Treatment Plant	N/A	N/A	N/A
Recycled Water Reuse	N/A	N/A	N/A
Sustainable Loads - TSS	?	846 t/yr	940 t/yr
Sustainable Loads – TN	?	15.3 t/yr	15.9 t/yr
Sustainable Loads - TP	?	1.9 t/yr	2.1 t/yr
Environmental Flow	N/A	11,035 ML/yr	11,394 ML/yr

Total Loads to Receiving Surface Waters from Stormwater and STPs
11,035 ML/yr
TSS 846 t/yr
TN 15.3 t/yr
TP 1.9 t/yr



Population 12,142

2012



Total Loads to Receiving Surface Waters from Stormwater and STPs
11,394 ML/yr
TSS 940 t/yr
TN 15.9 t/yr
TP 2.1 t/yr

Population 19,374

2031

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Southern Creeks Catchment

The Southern Creeks catchment encompasses the sub-catchments of Serpentine Creek, Native Dog Creek and California Creek. In total, the catchment is 6,395 ha in size, however only 2,790 ha is located within Redland City Council. The remaining area falls within Logan City Council's jurisdiction. The following description is for the area within RCC.

The urban population in the Southern Creeks catchment is currently approximately 7,430 people, and is expected to grow by about 22% to reach approximately 10,000 people by 2031.

Land use within the catchment is dominated by forested conservation areas, particularly in the east of the catchment around Redland Bay (Serpentine Creek sub-catchment). Urban and some park residential development is located within the Native Dog Creek sub-catchment around Mount Cotton. Rural non urban areas are fringed by forested conservation areas in the west of the catchment (within California and Native Dog Creek sub-catchments). A quarry is located at the western extent of the catchment, within California Creek sub-catchment. This quarry may expand its operations in the future.

Key waterways within the Southern Creek catchments include Native Dog Creek, Serpentine Creek and California Creek. All these Creeks flow south, discharging into the Logan River and eventually Moreton Bay. Wetlands of regional significance (Carbrook Wetlands) are also located around Native Dog and Serpentine Creek.

Council monitoring within Serpentine and Native Dog Creek Catchments indicates TSS is the primary pollutant of concern, in addition to phosphorus in Serpentine Creek. Water quality hot spots have also been identified along Native Dog Creek. A number of poultry farms and small water bodies present potential point sources of contamination. Some poultry farms are located within Logan City Council's jurisdiction.

Wastewater is treated within the catchment at the Mount Cotton STP, which is discharged to an impoundment on the Carbrook Golf Course, which then discharges into the upper Logan River.

Park residential and rural non urban properties around Mount Cotton (within Native Dog Creek catchment) are serviced by septic/on site wastewater systems.

Catchment Facts

- **Area: 2,790 ha (RCC)**
- **Current Population: 7,430**
- **Future Population: 9,096**
- **Future Pop. Growth: 22%**
- **Development Pressures: Possible quarry expansion**
- **Wastewater treated at Mt Cotton STP and discharges to the Logan River.**
- **EHMP Score 2011:**

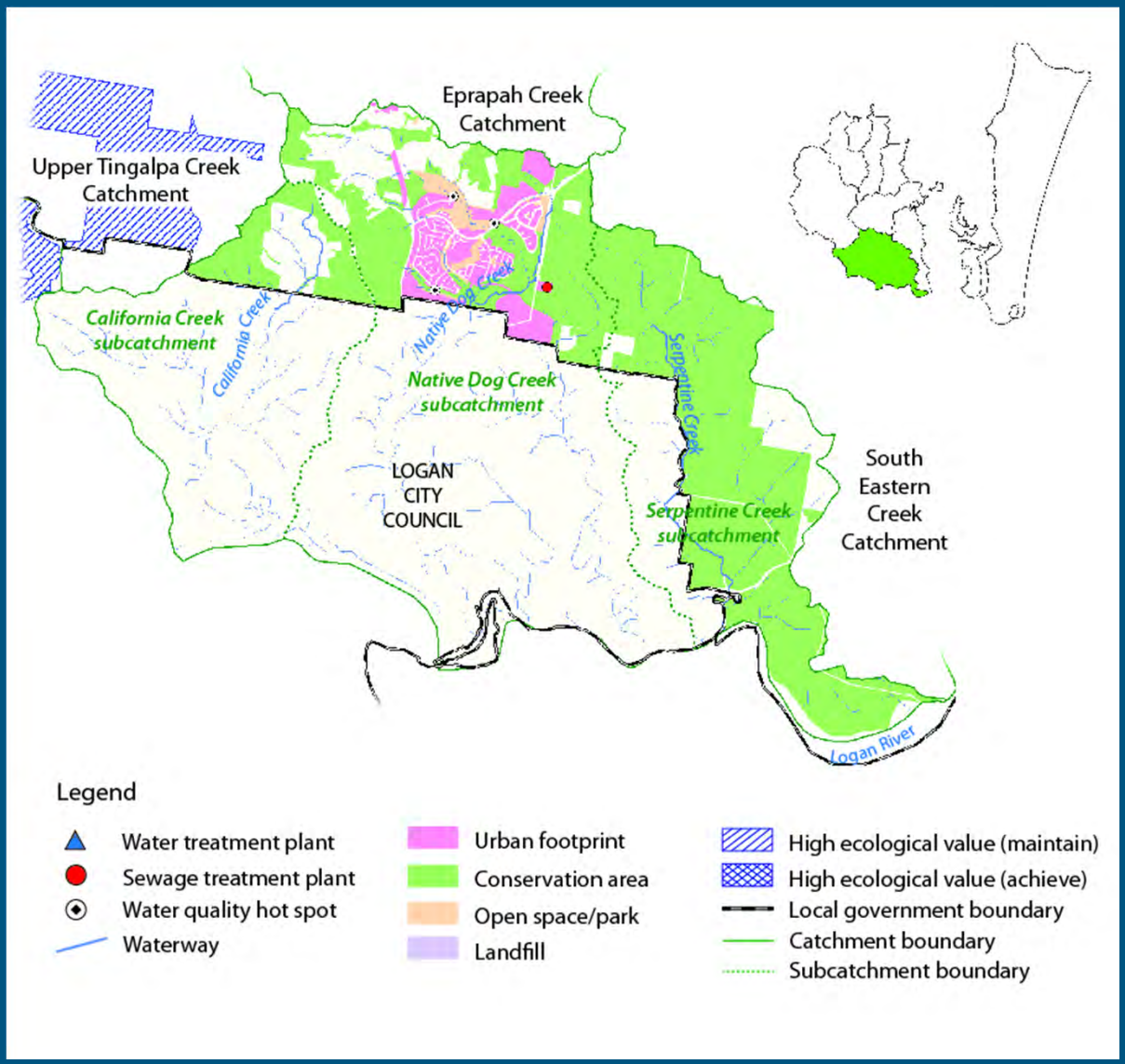
  C- (Logan River Estuary)
- **Low priority catchment for management**

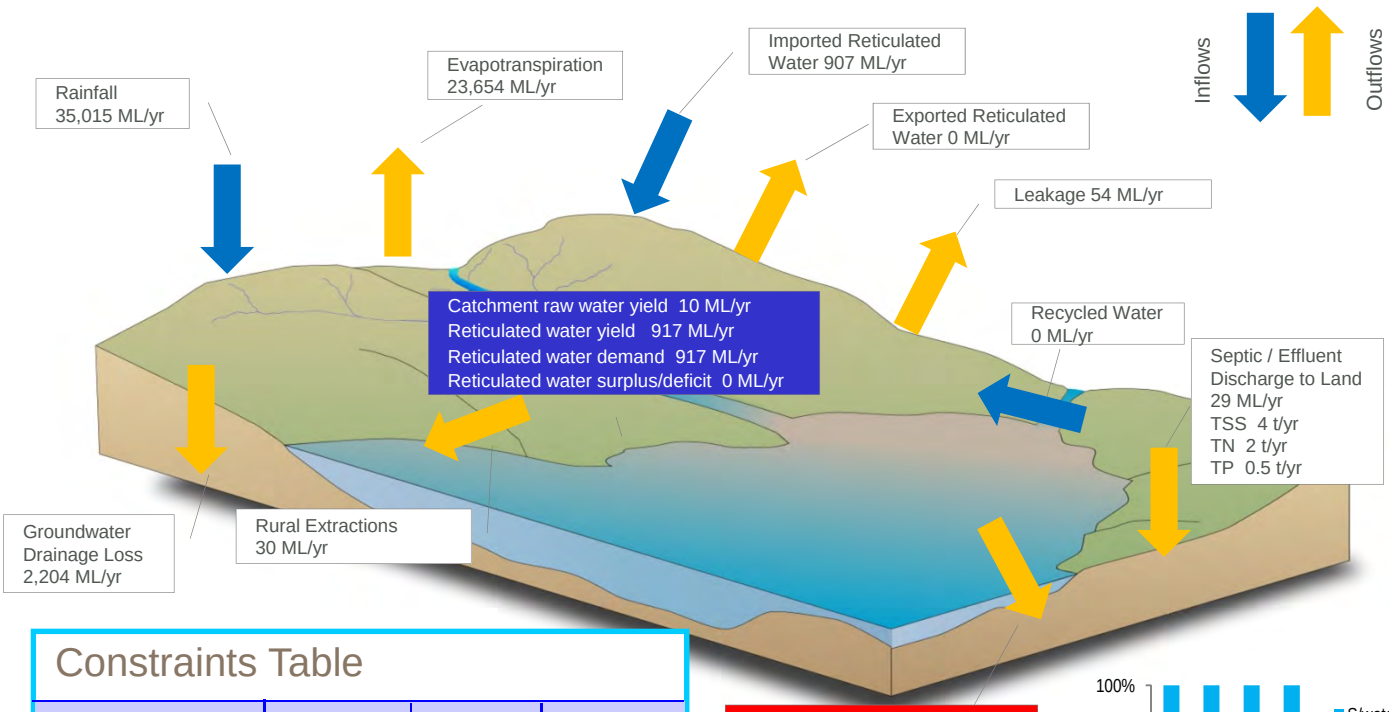
Southern Creeks Catchment

Mount Cotton STP presents a key future pressure on waterway health. Currently, STP total loads constitute a small (<10%) proportion of the total pollutant loads discharged to receiving waters. However this is expected to increase by 2031, with total phosphorus contributing up to 45%, and total nitrogen contributing up to 18% of total loads to receiving waters.

Potable water is sourced predominately from North Stradbroke Island Water Treatment Plant.

There is limited property flooding within the area, particularly for Native Dog Creek Catchment. Properties are at risk of isolation during a flood event, due to the low flood immunity of some of the roads. Storm tide inundation causes at least one property to become inundated, and can bisect Beenleigh-Redland Bay Road.

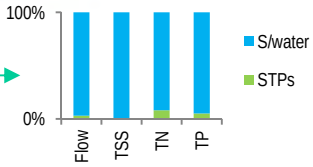




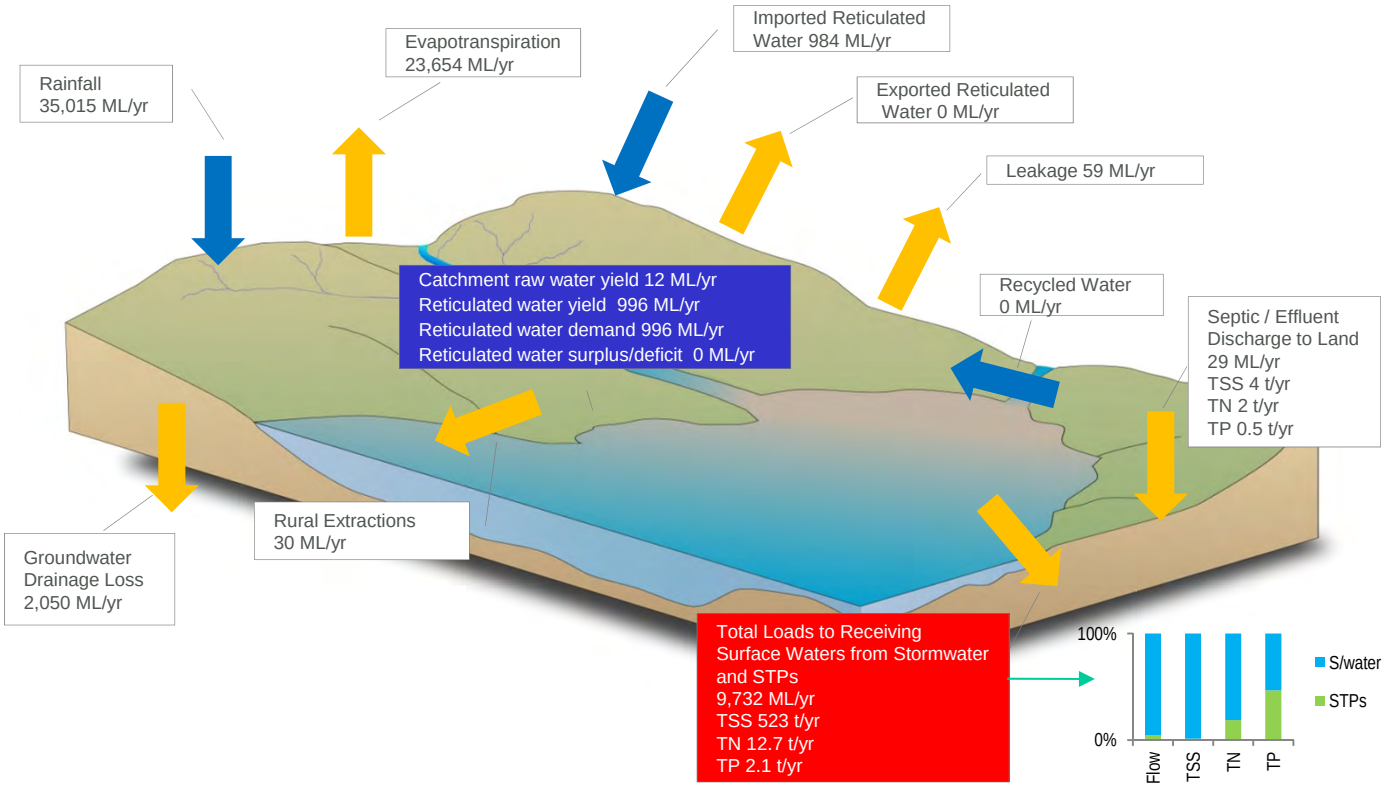
Constraints Table

	Constraint	2012	2031
Storage Yield	N/A	N/A	N/A
Water Treatment Plant	N/A	N/A	N/A
Sewage Treatment Plant (Mt Cotton)	6,400 EP (Design) 50,000 EP (Licence)	3,433 EP	5,520 EP
Recycled Water Reuse	464 ML/yr	0 ML/yr	0 ML/yr
Sustainable Loads - TSS	?	462 t/yr	523 t/yr
Sustainable Loads – TN	?	10.8 t/yr	12.7 t/yr
Sustainable Loads - TP	?	1.1 t/yr	2.1 t/yr
Environmental Flow	N/A	9,393 ML/yr	9,732 ML/yr

Total Loads to Receiving Surface Waters from Stormwater and STPs
9,393 ML/yr
TSS 462 t/yr
TN 10.8 t/yr
TP 1.1 t/yr



Population 7,430 **2012**



Total Loads to Receiving Surface Waters from Stormwater and STPs
9,732 ML/yr
TSS 523 t/yr
TN 12.7 t/yr
TP 2.1 t/yr

Population 9,096 **2031**

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Upper Tingalpa Creek Catchment

The Upper Tingalpa Creek catchment is 8,886 ha in size, however only 3,320 ha is located within Redland City Council. The remaining area falls within Brisbane and Logan City Council's jurisdiction. The following description is for the area within RCC.

The urban population in the Upper Tingalpa Catchment is approximately 1,570 people and is not expected to grow any more by 2031.

The urban population in this catchment consists of largely rural residential type living around the suburbs of Sheldon and Capalaba. These areas are also zoned as environmental protection areas, being located in a water supply catchment. Conservation areas dominate this catchment, with small areas of rural land use. Karreman Quarry is located in the south of the catchment, and is expected to expand over the future. The quarry is a potential point source of manganese.

Tingalpa Creek is the major waterway in this catchment, which flows from the upper catchment areas and is impounded at Leslie Harrison Dam/Tingalpa Reservoir, a regional water supply source. Water from the reservoir is treated at the Capalaba Treatment Plant (in adjoining catchment) and distributed to the Redlands mainland region. An existing pressure on the water treatment plant is elevated naturally organic loading and waterweed management. The treatment process also requires upgrading.

A small area of the catchment (Capalaba) is sewered, with wastewater treated at Capalaba STP (in adjacent catchment). Most rural properties are serviced by septic/on site wastewater systems.

The EPP water designates High Ecological Value receiving waters in the south of the catchment around key conservation areas of Venman Bushland National Park, Ford Road Conservation Area, Neville Lawrie Reserve, and Daisy Hill Conservation Park (the later two within Logan City Council).

Freshwaters of Tingalpa Creek are also habitat to the locally rare and potentially threatened Ornate Sunfish (*Rhadinocentrus ornatus)*.

Catchment Facts

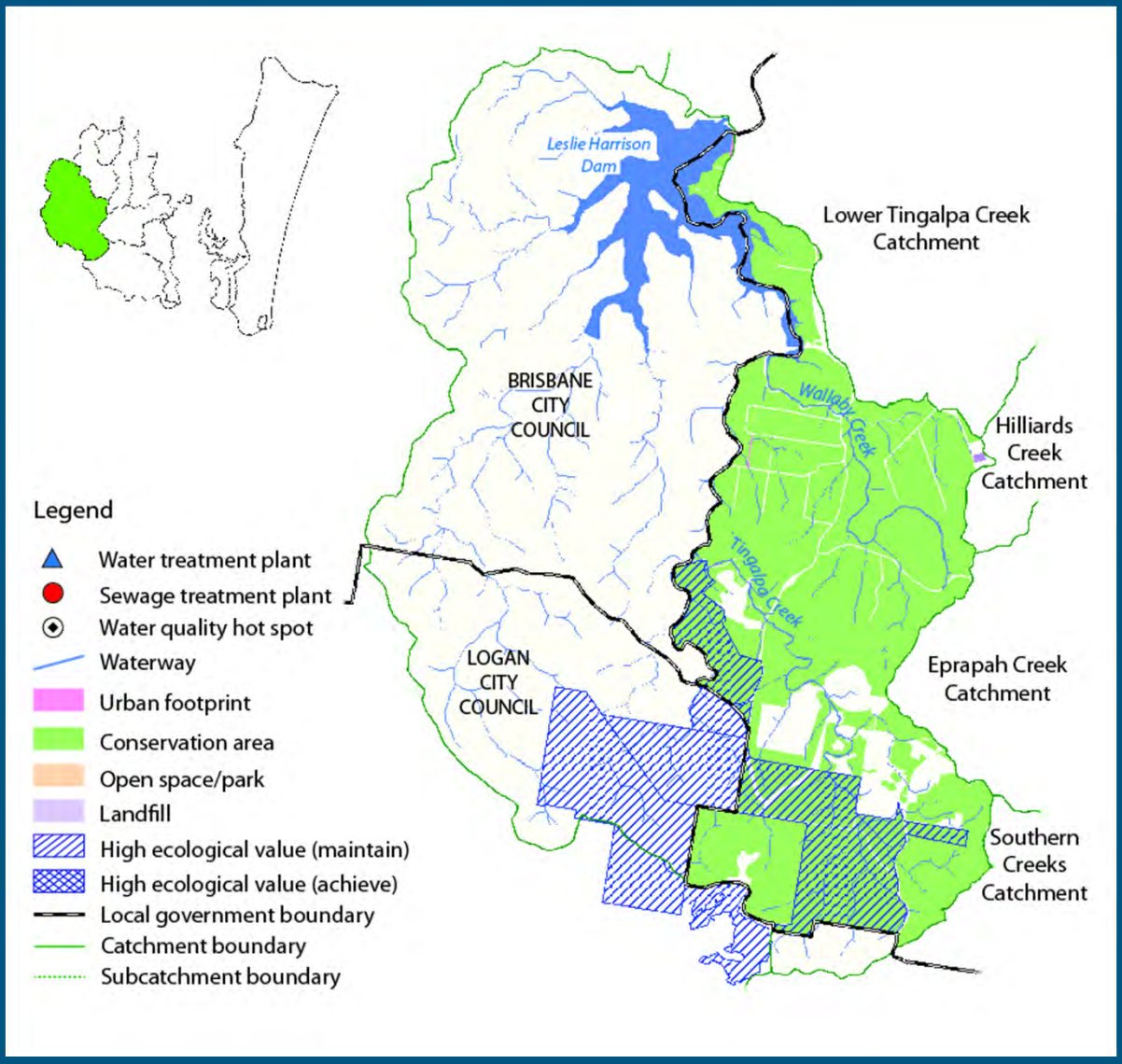
- **Area: 3,320 ha**
- **Current Population: 1,573**
- **Future Population: 1,556**
- **Future Pop. Growth: -1%**
- **Development Pressures: Potentially from BCC & LCC**
- **Drinking water catchment**
- **Majority of wastewater treated on site. Small amount treated at Capalaba STP in adjoining Lower Tingalpa Creek catchment.**
- **Tingalpa Creek habitat for the Ornate Sunfish**
- **Waterway Recovery Report Score 2011:**
  - **Overall Water Quality: C**
  - **Native Fish: C**
  - **Bugs: A**
- **Low priority catchment for management**

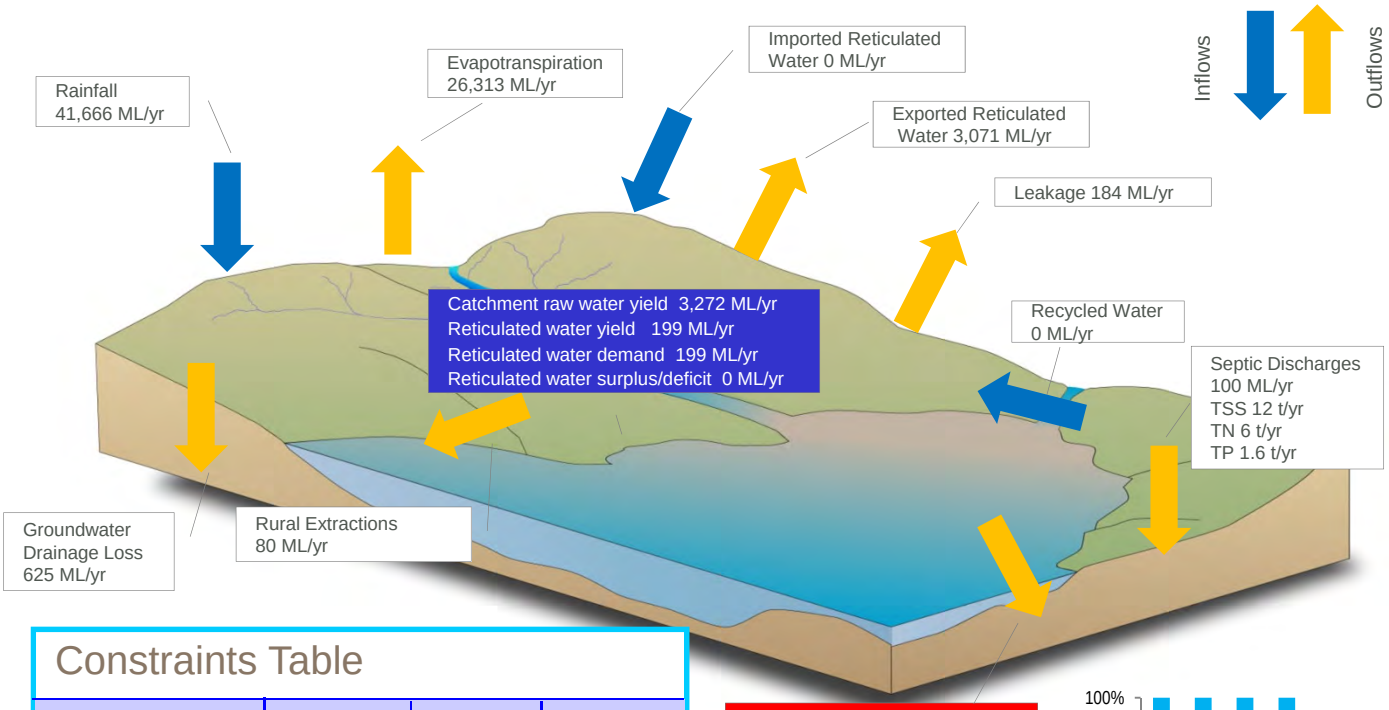
Upper Tingalpa Creek Catchment

Council water quality monitoring indicates TSS and nitrogen are key pollutants of concern in the catchment. No water quality hot spots have been identified. Farm dams in the catchment present potential point sources of contamination.

Potable water is sourced from Capalaba Water Treatment Plant, supplied by Leslie Harrison Dam.

Flooding and storm tide inundation is not considered a major issue in this catchment.

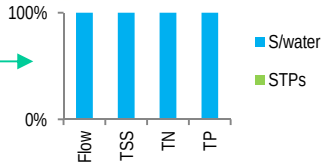




Constraints Table

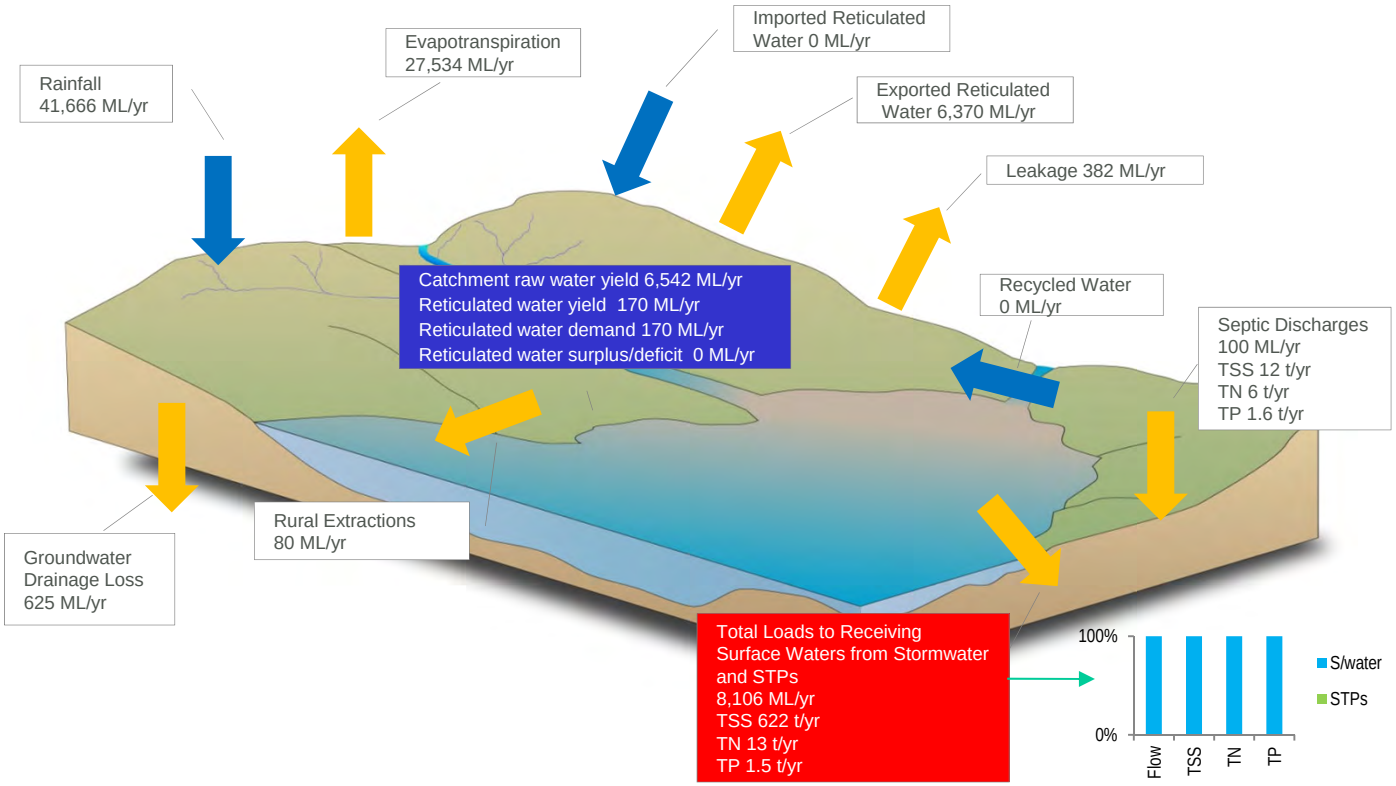
	Constraint	2012	2031
Storage Yield (Leslie Harrison Dam/ Tingalpa Reservoir)	18,980 ML/yr	3,270 ML/yr	6,540 ML/yr
Water Treatment Plant (Capalaba)	7,640 ML/yr	3,270 ML/yr	6,540 ML/yr
Sewage Treatment Plant	N/A	N/A	N/A
Recycled Water Reuse	N/A	N/A	N/A
Sustainable Loads - TSS	?	664 t/yr	622 t/yr
Sustainable Loads – TN	?	14 t/yr	13 t/yr
Sustainable Loads - TP	?	1.7 t/yr	1.5 t/yr
Environmental Flow	N/A	11,376 ML/yr	8,106 ML/yr

Total Loads to Receiving Surface Waters from Stormwater and STPs
7,307 ML/yr
TSS 612 t/yr
TN 9.8 t/yr
TP 1.4 t/yr



Population 1,573

2012



Total Loads to Receiving Surface Waters from Stormwater and STPs
8,106 ML/yr
TSS 622 t/yr
TN 13 t/yr
TP 1.5 t/yr

Population 1,556

2031

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Lower Tingalpa Creek Catchment

Lower Tingalpa Creek catchment is 3,440 ha in size, with 2,880 ha located within Redland City Council. The remaining area on the west bank of Tingalpa Creek falls within Brisbane City Council's jurisdiction, and is largely forested with some rural residential development. The following description is for the area within RCC.

The urban population in this catchment is currently 28,543 people, and is expected to grow by 8% to reach approximately 30,770 people in 2031. Existing land use is dominated by urban residential areas around Capalaba, Alexandra Hills, Thornside and Birkdale. A large commercial precinct is also located in Capalaba, in addition to park residential, rural non urban and environmental protection areas in the upper catchment.

The key waterway in this catchment is Lower Tingalpa Creek, which is tidal up to Leslie Harrison Dam wall. Coolnwynpin Creek is a freshwater tributary of lower Tingalpa Creek. Lower Tingalpa Creek flows into a designated High Ecological Value (HEV) area Waterloo Bay. Wetlands of state significance are also located around lower Tingalpa Creek. A high level of intact riparian vegetation cover remains around Eprapah Creek estuary (90%). Freshwaters of Tingalpa Creek are also habitat to the locally rare and potentially threatened Ornate Sunfish (*Rhadinocentrus ornatus)*.

Council monitoring indicates TSS and nutrients are key pollutants of concern in freshwater reaches of the catchment. Water quality hot spots have also been identified throughout the catchment. A couple of poultry farms and small water bodies present potential point sources of contamination. Landfill leachate has also been detected at closed landfill sites at Duncan Road (Baseball site) and John Fredericks Park, Capalaba. The latter landfill area is continually subject to high groundwater levels, minor tidal influences and regular flooding by the release of water from the Leslie Harrison Dam.

Wastewater is treated within the catchment at Capalaba and Thorneside STPs, which discharges into the Tingalpa Creek estuary. Thorneside STPs also treats the majority of wastewater generated from Tarradarrapin and Hilliards Creek catchments.

Rural and park residential properties around Capalaba are serviced by septic/on site wastewater systems.

Catchment Facts

- **Area: 3,440 ha**
- **Current Population: 28,543**
- **Future Population: 30,770**
- **Future Pop. Growth: 8%**
- **Tingalpa Creek habitat for the Ornate Sunfish**
- **Wastewater treated at Capalaba and Thorneside STPs, discharging to Tingalpa Creek estuary**
- **EHMP Score 2011:**
  - **C (Tingalpa Estuary)**
  - **B+ (Waterloo Bay)**
- **High Priority catchment for waterway management**

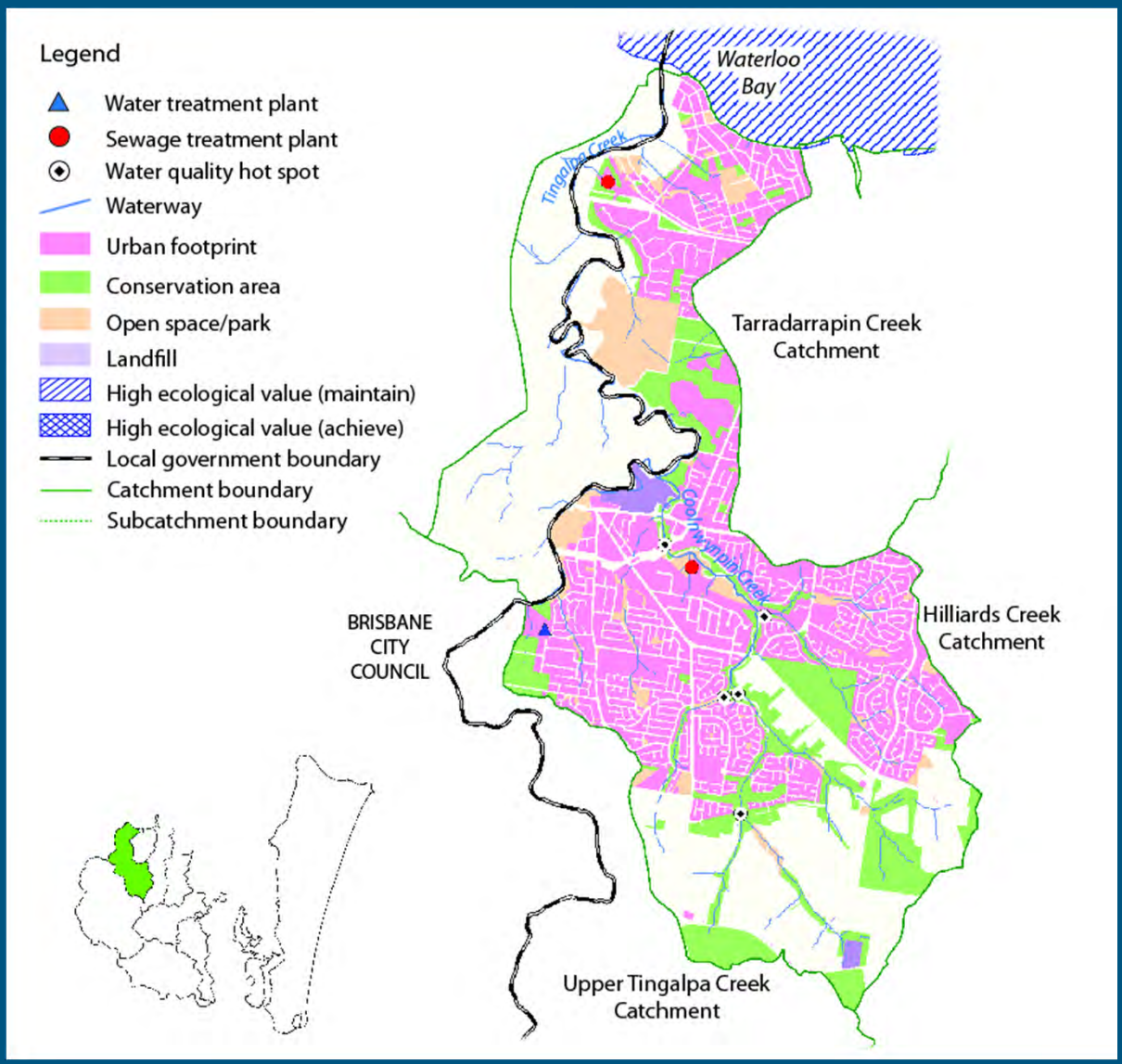
Lower Tingalpa Creek Catchment

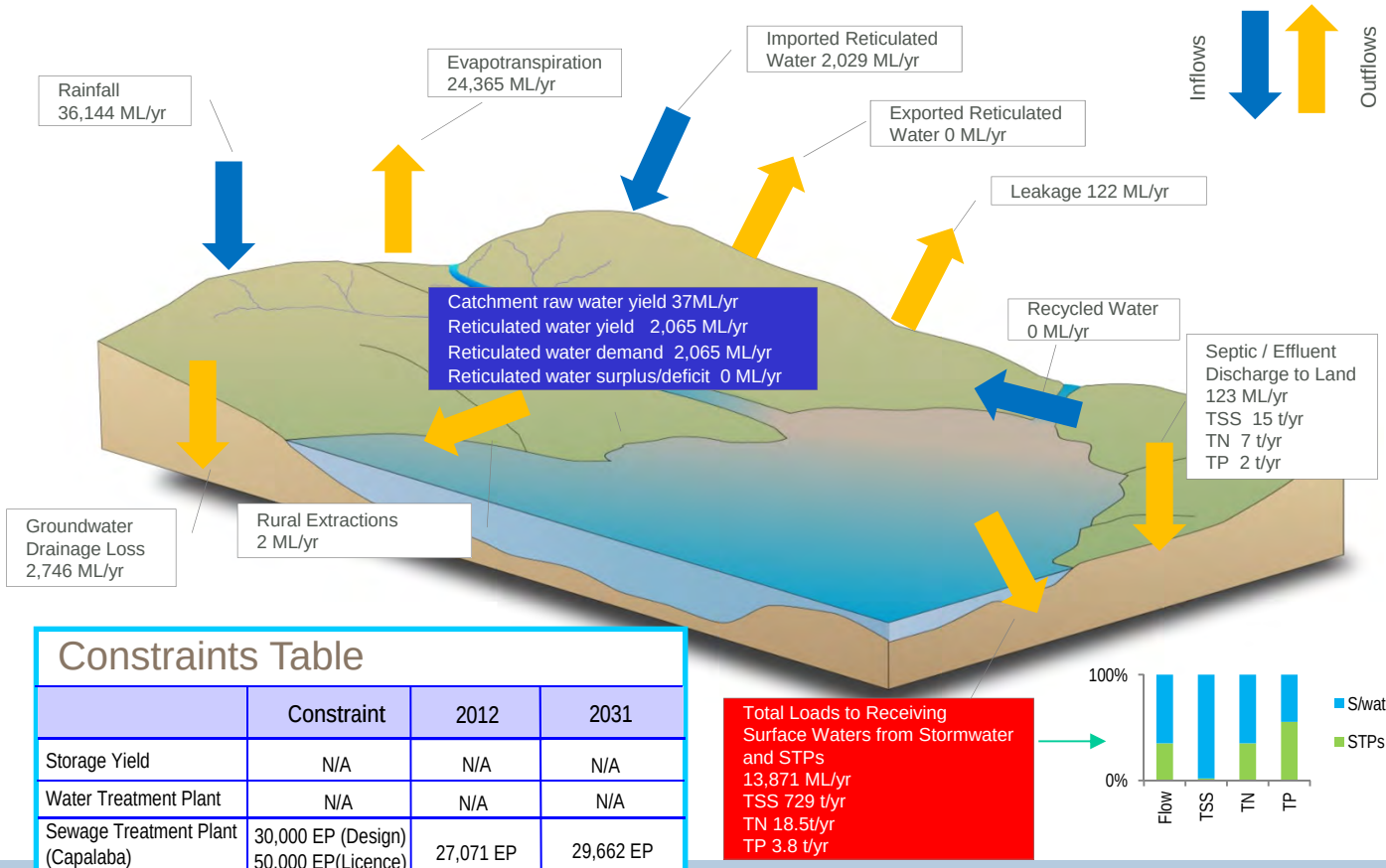
Thorneside and Capalaba STPs present a key existing and future pressure on waterway health. Currently, STPs contribute to 35% of the total flows discharged to receiving waters, and constitute a major proportion of the total phosphorus (TP) loads (55%). Total nitrogen (TN) loads from STPs currently contribute to 35% of pollutant loads discharged to receiving waters.

Future STP flows and loads are expected to significantly increase, contributing approximately 40%, 88% and 72% of total flows, TP and TN loads to receiving waters respectively. Thorneside STP contributes a greater proportion of this load. A recycled water plant has recently been commissioned at Capalaba STP, however is currently not in use.

Potable water is sourced predominately from Capalaba Water Treatment Plant, supplied by Leslie Harrison Dam, with some water also sourced from North Stradbroke Island Water Treatment Plant.

There is limited flooding impacting on properties within the catchment. The drainage system causes some flooding issues, as parts of the network are under sized. Storm tide inundation causes some issues within the catchment.



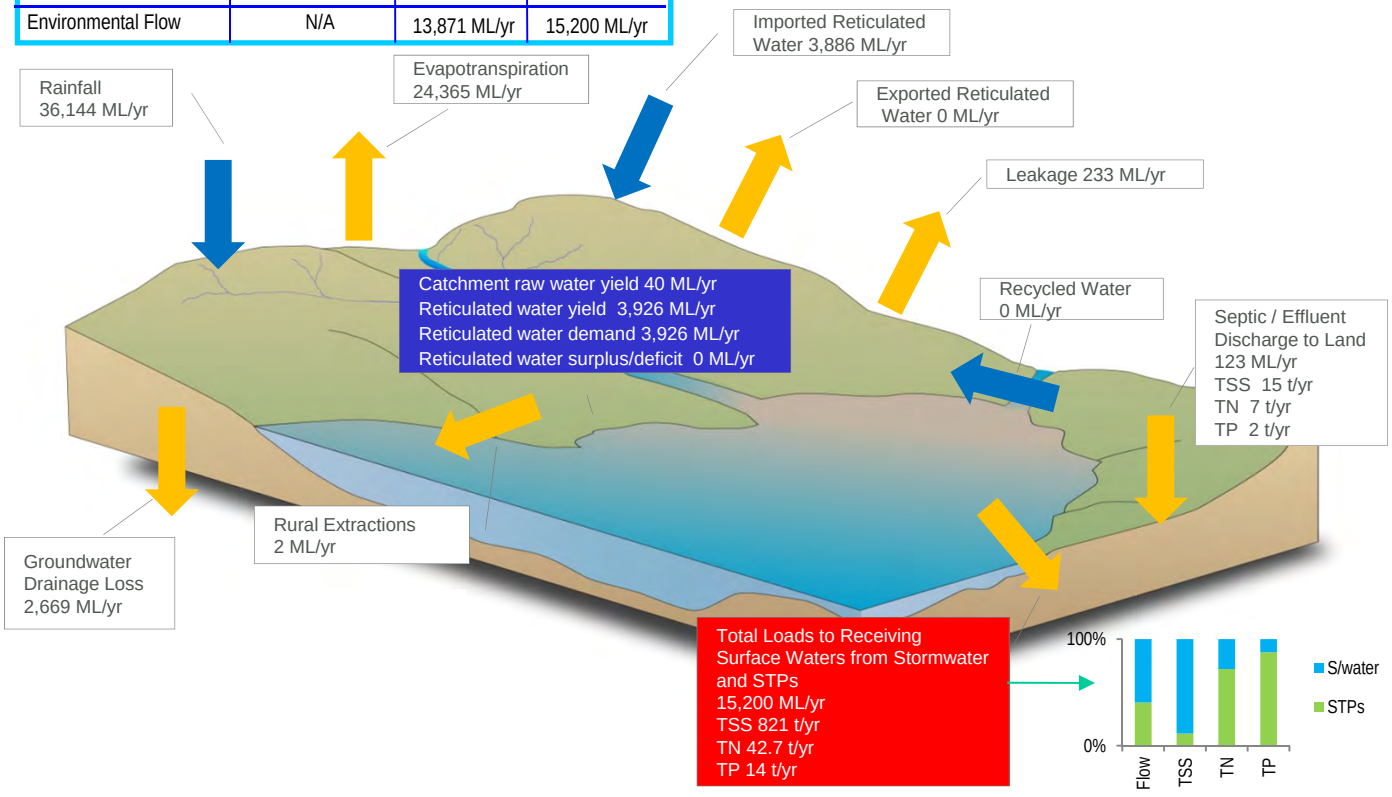


Constraints Table

	Constraint	2012	2031
Storage Yield	N/A	N/A	N/A
Water Treatment Plant	N/A	N/A	N/A
Sewage Treatment Plant (Capalaba)	30,000 EP (Design) 50,000 EP(Licence)	27,071 EP	29,662 EP
Sewage Treatment Plant (Thorneside)	30,000 EP (Design) 50,000 EP(Licence)	42,380 EP	47,572 EP
Recycled Water Reuse (Capalaba Class A)	88 ML/yr	0 ML/yr	0 ML/yr
Sustainable Loads - TSS	?	729 t/yr	821 t/yr
Sustainable Loads – TN	?	18.5 t/yr	42.7t/yr
Sustainable Loads - TP	?	3.8 t/yr	14 t/yr
Environmental Flow	N/A	13,871 ML/yr	15,200 ML/yr

Total Loads to Receiving Surface Waters from Stormwater and STPs
13,871 ML/yr
TSS 729 t/yr
TN 18.5t/yr
TP 3.8 t/yr

Population 28,543 **2012**



Total Loads to Receiving Surface Waters from Stormwater and STPs
15,200 ML/yr
TSS 821 t/yr
TN 42.7 t/yr
TP 14 t/yr

Population 30,770 **2031**

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Coochiemudlo & Southern Moreton Bay Islands Catchment

The Coochiemudlo and Southern Moreton Bay Islands (SMBI) catchment is 2,380 ha in size, with existing land use consisting of a mixture of residential and conservation areas/green space.

The urban population is approximately 14,100 people currently, and is expected to increase to about 24,100 people in 2031. This is an increase of approximately 10,000 people which represents a 72% increase.

Coochiemudlo and SMBIs are located within Moreton Bay Marine Park, which is listed as a Ramsar wetland of international significance. There are also designated High Ecological Value (HEV) areas adjoining Lamb Island and adjacent to Russell Island.

Wastewater from Coohiemudlo Island is treated at Victoria Point STP, within the adjacent Eprapah Creek catchment. The SMBIs are unsewered, and are serviced by on site wastewater systems. These systems are primarily septic, however due to recent development pressures on the island, future systems are required to provide at least secondary treatment of effluent. Future urban development and on site wastewater systems on the SMBIs present a significant pressure to waterway health.

Catchment Facts

- **Area: 2,380 ha**
- **Current Population: 14,053**
- **Future Population: 24,121**
- **Future Pop. Growth: 72%**
- **Wastewater from Coohiemudlo treated at Victoria Point STP in adjoining Eprapah Creek catchment**
- **SMBIs unsewered, serviced by on site wastewater systems**
- **EHMP Score 2011:**

  Waterloo Bay (Coochie): B+

  Southern Bay: F

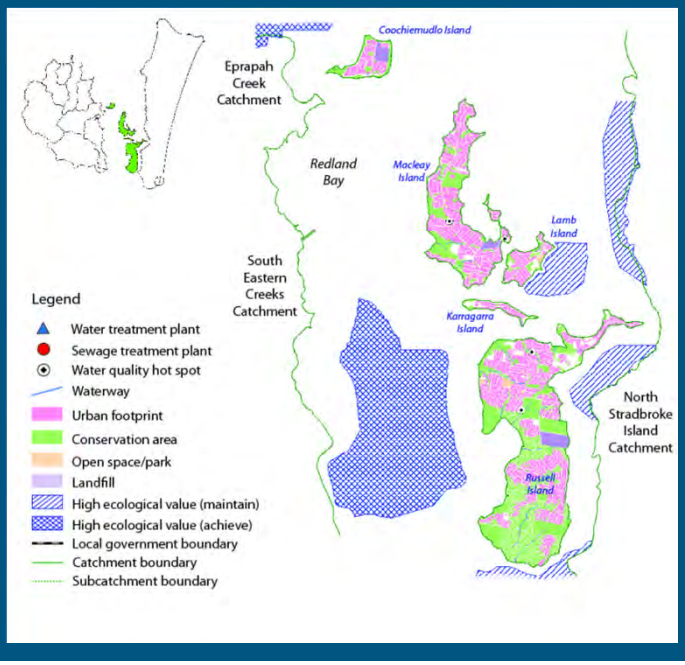
  Eastern Bay: B-

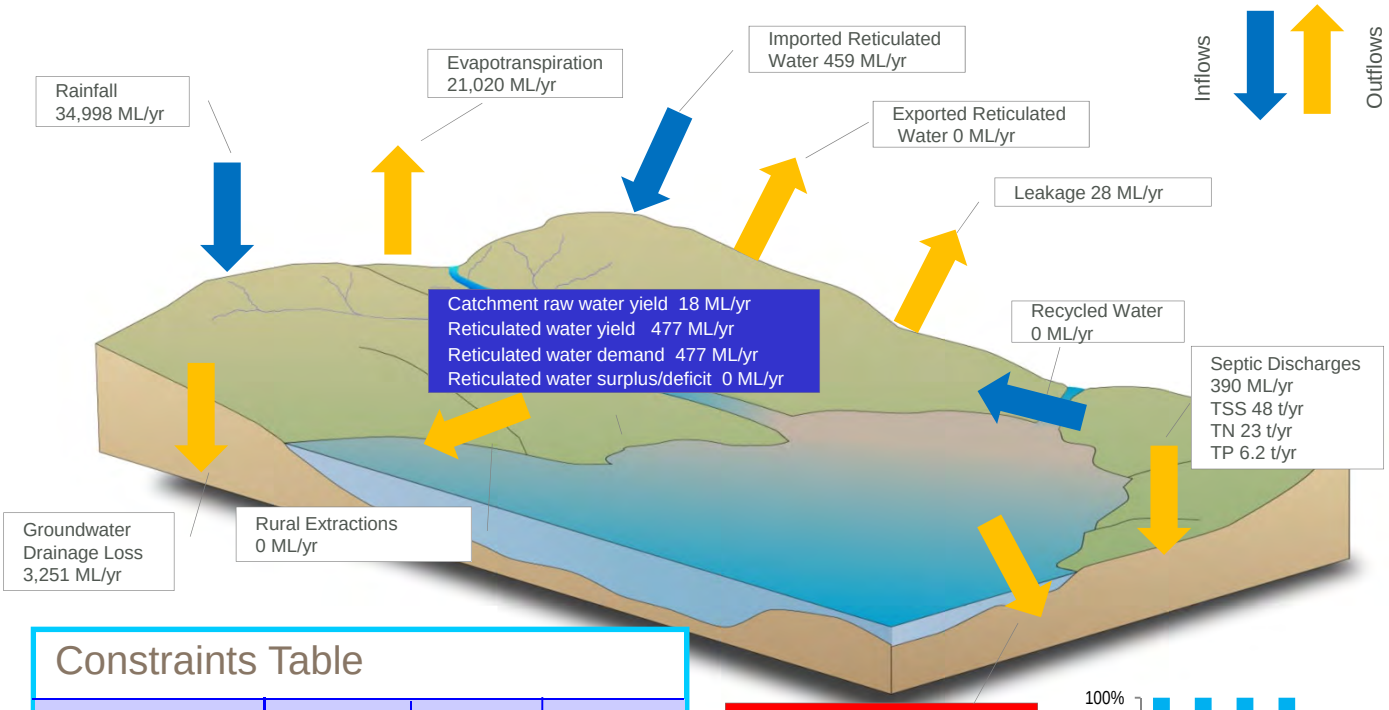
Council monitoring of SMBIs indicates very poor total suspended solids in freshwaters on Karragarra, Macleay and Lamb Island; very poor to poor total phosphorus on Russell, Karragarra and Lamb Island, and poor total nitrogen on Macleay Island.

Water quality hot spots have also been identified on Russell and Macleay Islands.

Potable water is sourced predominately from North Stradbroke Island Water Treatment Plant via the pipeline to the mainland.

Flooding and storm tide issues exist, and impact on Coochiemudlo and SMBIs to varying degrees. Future implications of climate change on storm tide impacts are significant.

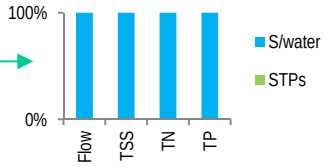




Constraints Table

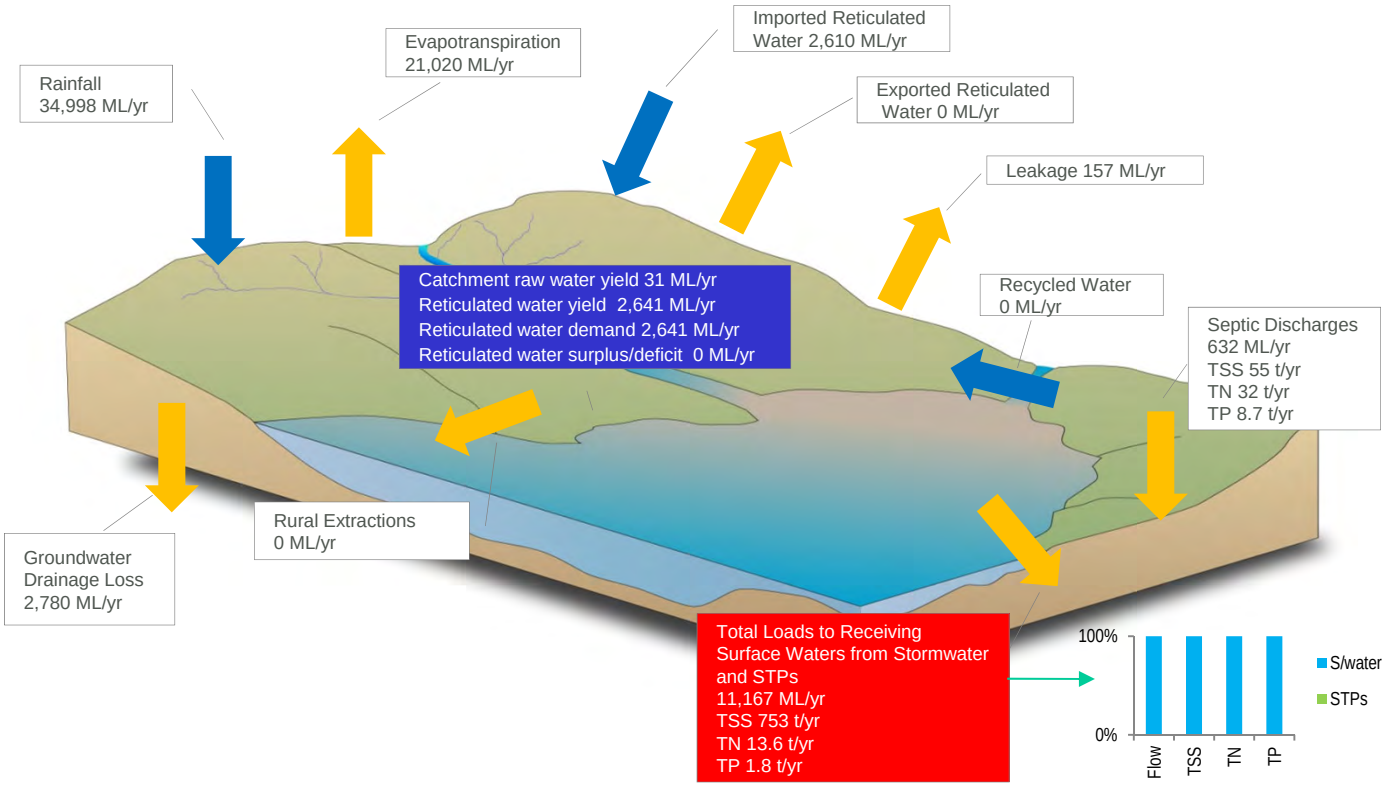
	Constraint	2012	2031
Storage Yield	N/A	N/A	N/A
Water Treatment Plant	N/A	N/A	N/A
Sewage Treatment Plant	N/A	N/A	N/A
Recycled Water Reuse	N/A	N/A	N/A
Sustainable Loads - TSS	?	558 t/yr	753 t/yr
Sustainable Loads – TN	?	12.7 t/yr	13.6 t/yr
Sustainable Loads - TP	?	1.4 t/yr	1.8 t/yr
Environmental Flow	N/A	10,709 ML/yr	11,167 ML/yr

Total Loads to Receiving Surface Waters from Stormwater and STPs
10,709 ML/yr
TSS 558 t/yr
TN 12.7 t/yr
TP 1.4 t/yr



Population 14,053

2012



Total Loads to Receiving Surface Waters from Stormwater and STPs
11,167 ML/yr
TSS 753 t/yr
TN 13.6 t/yr
TP 1.8 t/yr

Population 24,121

2031

North Stradbroke Island

North Stradbroke Island (NSI) catchment is 27,190 ha in size. Existing land use is dominated by conservation areas (over 50% is national park), with a few large mining tenements and small pockets of urban residential areas around Amity Point, Dunwich and Point Lookout.

The urban population in the catchment is currently approximately 5,900 people and is expected to increase to about 8,500 people by 2031. This is an increase of approximately 2,600 people, representing a 44% increase.

North Stradbroke Island is located within the Moreton Bay Marine Park, which is listed as a Ramsar wetland of international significance. There are many designated High Ecological Value (HEV) waters adjoining and on the island, including Eastern & Southern Bay areas, Brown Lake, Blue Lake and 18 Mile Swamp. NSI is also habitat to the vulnerable and nationally endangered Oxleyan pygmy perch.

A snapshot ecological assessment undertaken in 2011 indicated poor to moderate condition of waterways (FRC 2011). Waterway health pressures currently exist from large mining operations, and wastewater generation in urban areas. The Queensland government may cease all mining operations by 2025, and designate up to 80% of the island as National Park.

Wastewater in the catchment is treated at Dunwich and Point Lookout STPs, which discharge treated effluent to groundwaters. Residential areas in Amity and approximately half of the urban areas in Dunwich and Point lookout are unsewered, with effluent treated by septic / on-site wastewater treatment systems.

Currently, Total Nitrogen license conditions are being exceeded at Dunwich STP and management measures are under investigation to resolve this issue.

STP effluent flows to groundwater are currently similar to effluent flows from septic systems, however the proportion of pollutant loads from STPs are significantly less than septic systems. Future population pressures are likely to see effluent discharges to groundwater from STPs significantly increase to constitute approximately 80% of total flows, and 40-50% of total effluent loads from STPs and septic systems.

Catchment Facts

- **Area: 27,190 ha**
- **Current Population: 5,932**
- **Future Population: 8,548**
- **Future Pop. Growth: 44%**
- **Water supply catchment, with WTPs at Herring Lagoon, Dunwich and Amity Point**
- **Wastewater treated at Dunwich and Point Lookout STPs, discharging to groundwaters**
- **Habitat for the endangered Oxleyan pygmy perch**
- **EHMP Score 2011:**

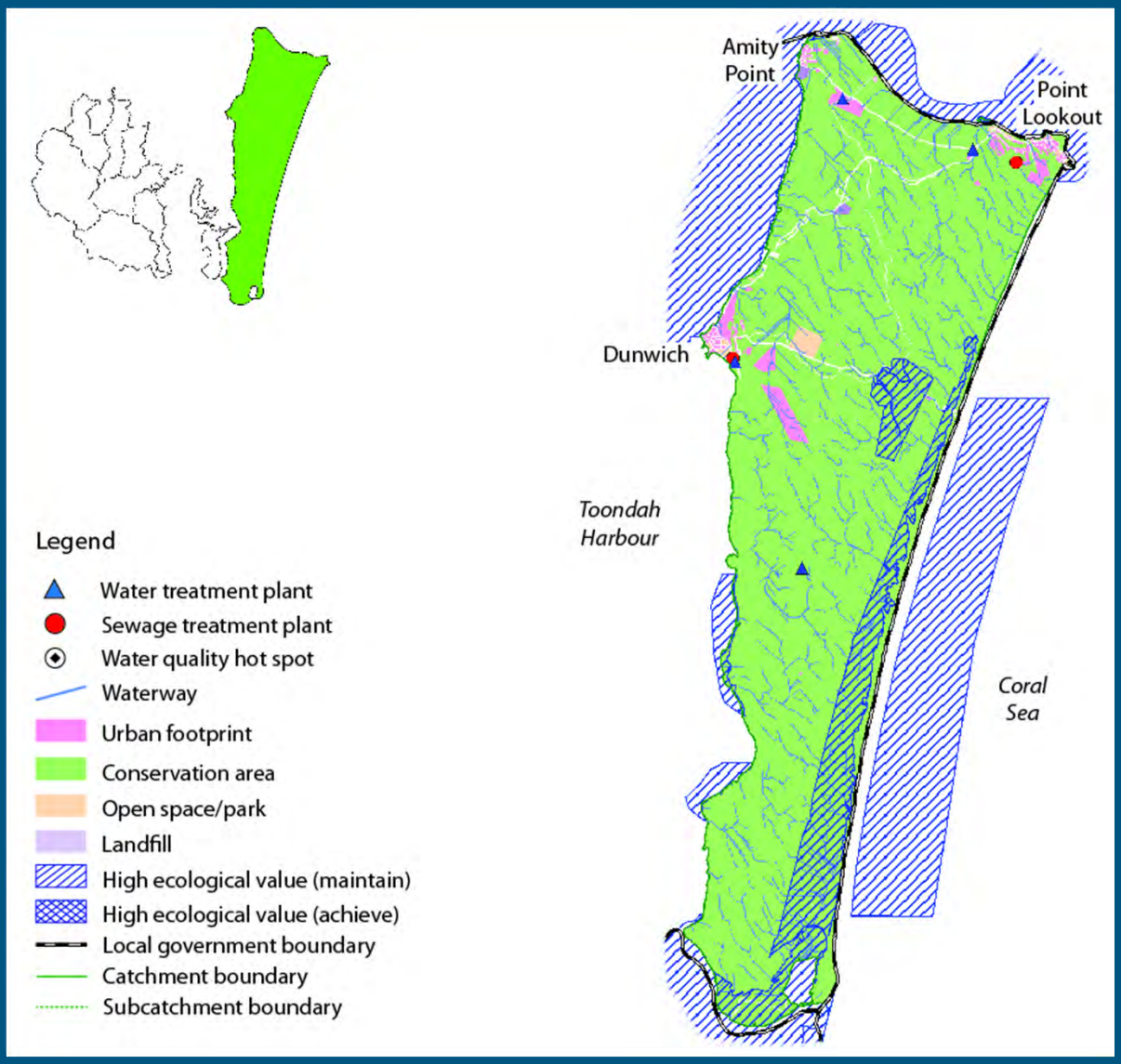
  Eastern Bay: B-

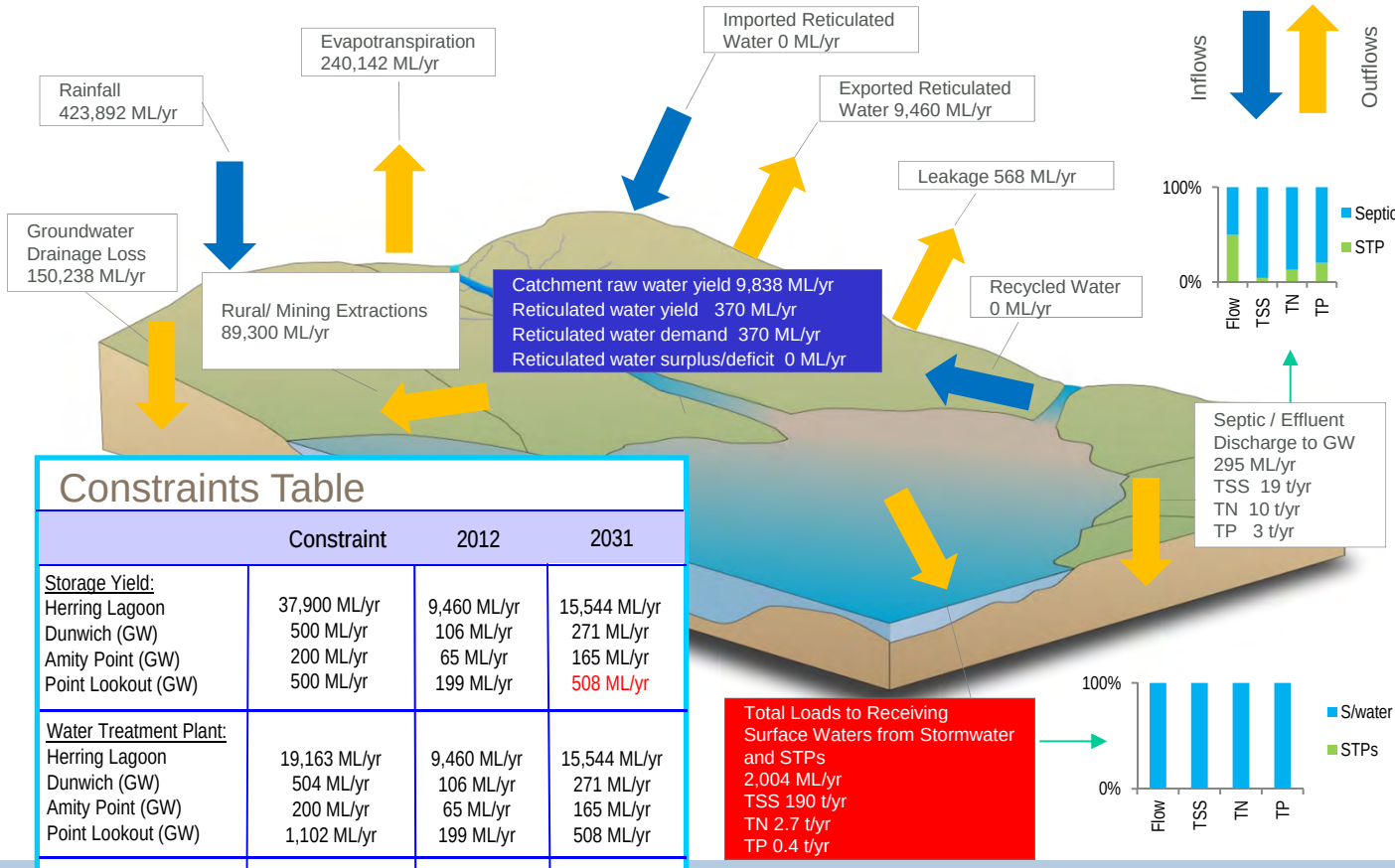
  Eastern Banks: A-

North Stradbroke Island Catchment

Potable water on the Island is supplied via a reticulated water network, with water at the main townships of Dunwich, Amity Point and Point Lookout being supplied by local groundwater resources and treated at the Dunwich, Amity Point and Point Lookout Water Treatment Plants. Water from a major groundwater resource in the middle of the island, along with a surface water source at Herring Lagoon, is treated at the NSI Water Treatment Plants and distributed to the mainland, with some water used locally for mining operations on the island. The water from NSI supplements mainland water supplies, and is connected to the Eastern Pipeline Interconnector. Future security of water supply sources on NSI is a potential issue, as the implications of the indigenous land use agreement (ILUA) is unknown. However discussions with Councillors indicates that the ILUA is unlikely to affect water supply sources on NSI.

North Stradbroke Island is affected by storm tide inundation, particularly in Amity and Point Lookout. Climate change poses significant implications for storm tide inundation.





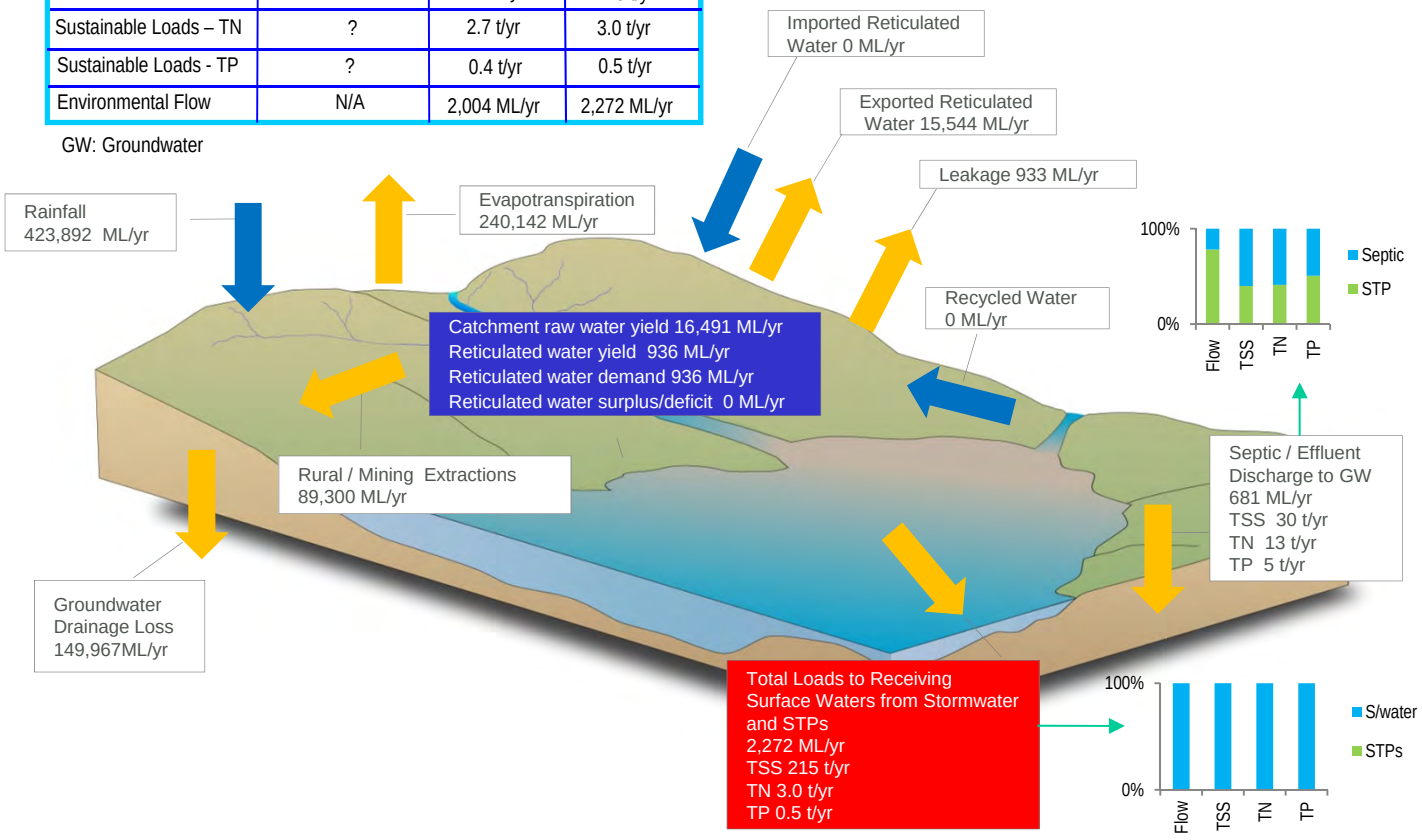
Constraints Table

	Constraint	2012	2031
Storage Yield: Herring Lagoon Dunwich (GW) Amity Point (GW) Point Lookout (GW)	37,900 ML/yr 500 ML/yr 200 ML/yr 500 ML/yr	9,460 ML/yr 106 ML/yr 65 ML/yr 199 ML/yr	15,544 ML/yr 271 ML/yr 165 ML/yr 508 ML/yr
Water Treatment Plant: Herring Lagoon Dunwich (GW) Amity Point (GW) Point Lookout (GW)	19,163 ML/yr 504 ML/yr 200 ML/yr 1,102 ML/yr	9,460 ML/yr 106 ML/yr 65 ML/yr 199 ML/yr	15,544 ML/yr 271 ML/yr 165 ML/yr 508 ML/yr
STP (Dunwich) STP(Point Lookout)	1,000 EP (Design) 1,500 EP (Licence) 1,750 EP (Design) 4,000 EP(Licence)	898 EP 2,931 EP	1,531 EP 3,710 EP
Recycled Water Reuse (Total All)	533 ML/yr	0 ML/yr	0 ML/yr
Sustainable Loads - TSS	?	190 t/yr	215 t/yr
Sustainable Loads – TN	?	2.7 t/yr	3.0 t/yr
Sustainable Loads - TP	?	0.4 t/yr	0.5 t/yr
Environmental Flow	N/A	2,004 ML/yr	2,272 ML/yr

GW: Groundwater

Population 5,932

2012



Population 8,548

2031

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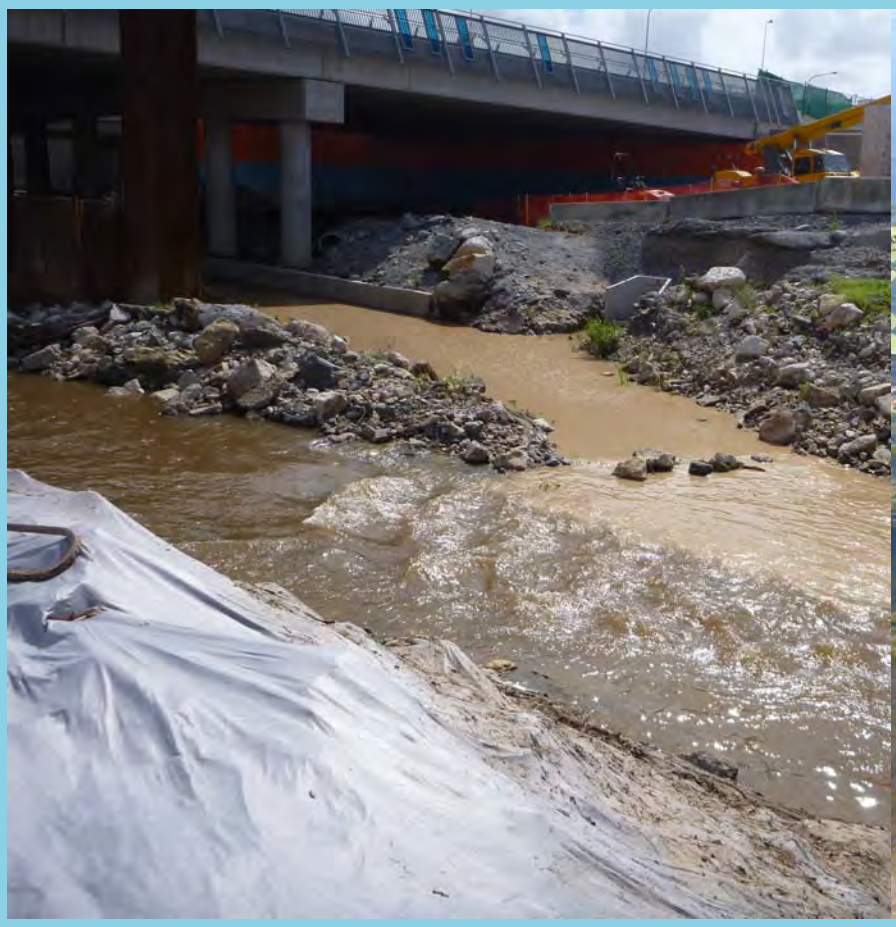

Water Cycle Management Pressures

3 WATER CYCLE MANAGEMENT PRESSURES

Water accounts and existing background information reviewed as part of this study have been used to identify key water cycle management pressures within the Redlands region. Table 3-1 summarises the water cycle pressure identified for each catchment. Cells have been shaded to indicate that the pressure has been identified within that catchment. It is noted that landfill leachate pressures and sewerage system infrastructure pressures (from dry and wet weather overflows) were identified by stakeholders during the risk assessment workshop, and have been included in the table below for completeness. A description of the key water cycle pressure identified is provided in the following sections.

Table 3-1 Summary of Catchment Water Cycle Management Pressures

Catchment	Water Cycle Management Pressure							
	Deterioration of Waterway Health	Potential to Impact to Environmentally Sensitive Waters	Population Growth	STP Capacity/ Infrastructure	Water Supply	Flooding	Storm Tide	Landfill Leachate
Tarradarrapin Creek								
Hilliards Creek				Cleveland STP				
Eprapah Creek				Victoria Pt. STP				
Cleveland & Thornlands Catchment								
South Eastern Creeks Catchment (Moogurrapum, Weinam, Torquay)								
Southern Creeks Catchment (Serpentine, Native Dog, California)								
Upper Tingalpa								
Lower Tingalpa								
Coochiemudlo & SMBI								
North Stradbroke Island				Dunwich STP				

3.1 Deterioration of Waterway Health

In July 2010, Environmental Values (EVs) and concentration-based WQOs for receiving waterways within Redland Creeks and Moreton Bay (including NSI and SMBIs) were introduced under the *Environmental Protection Act 1994*, specifically through Schedule 1 of the *Environmental Protection (Water) Policy 2009* (EPP Water). These WQOs have been set to protect and enhance the Environmental Values of Redlands waterways. Council is currently working to derive more locally

specific WQOs for the Redlands region, which may be used to update the current EPP Water WQOs in the future. A key requirement of TWCM planning is to work towards achieving these WQOs to protect the Environmental Values of Redlands' waterways.

Key existing and future pressures to waterway health in the Redlands region are from diffuse sources such as stormwater from urban and rural areas, large point sources such as STPs and smaller point sources such as poultry farms, poorly functioning water bodies and septic systems. A number of pollutant hot spots and waterway barriers have also been identified throughout the Redlands catchments which place pressures on waterway health and environmental values.

Both the existing and future condition of waterway health has been identified as a key pressure to be addressed in all catchments within the Redlands region. This was determined through assessment of the following key information:

- **EHMP report card scores**. The grades for waterways monitored in the EHMP program are shown in Figure 3-1. Figure 3-1 shows that freshwater reaches have consistently received an 'F'. Eprapah Creek and Tingalpa Creek estuary have improved slightly since monitoring commenced, and received a grade of C in 2011. The 2011 grade is partly attributed to a high level of intact riparian vegetation cover (90%) and thus good Biological Health Rating for both estuaries. However it is noted that Eprapah Creek estuary is very short (which limits flushing) and both estuaries are dominated by excess nutrient loads from large Sewage Treatment Plants. Interrogation of raw EHMP data from Hilliards Creek also indicates poor compliance with EPP WQOs for TN and TP at both estuarine and freshwater monitoring locations.
- **Creek Functional Mapping**. Waterway health was flagged as a pressure where Creek functional mapping identified the catchment as a high priority for management. Creek functional mapping was undertaken for mainland areas only (Hydrobiology 2009) and was based on an assessment of riparian vegetation condition, conservation management, soil stability, fish barriers and existing and future development pressures on water quality. A summary of the results of Creek functional mapping investigations are shown in Table 3-2
- **Redlands Waterway Recovery Report - Condition Summary 2011.** Waterway health in freshwaters was flagged as a pressure where monitoring results did not meet WQOs, or for catchments that water quality hotspots were flagged in. A summary of the key parameters of concern from results of the 2011 monitoring program are shown in Table 3-3.

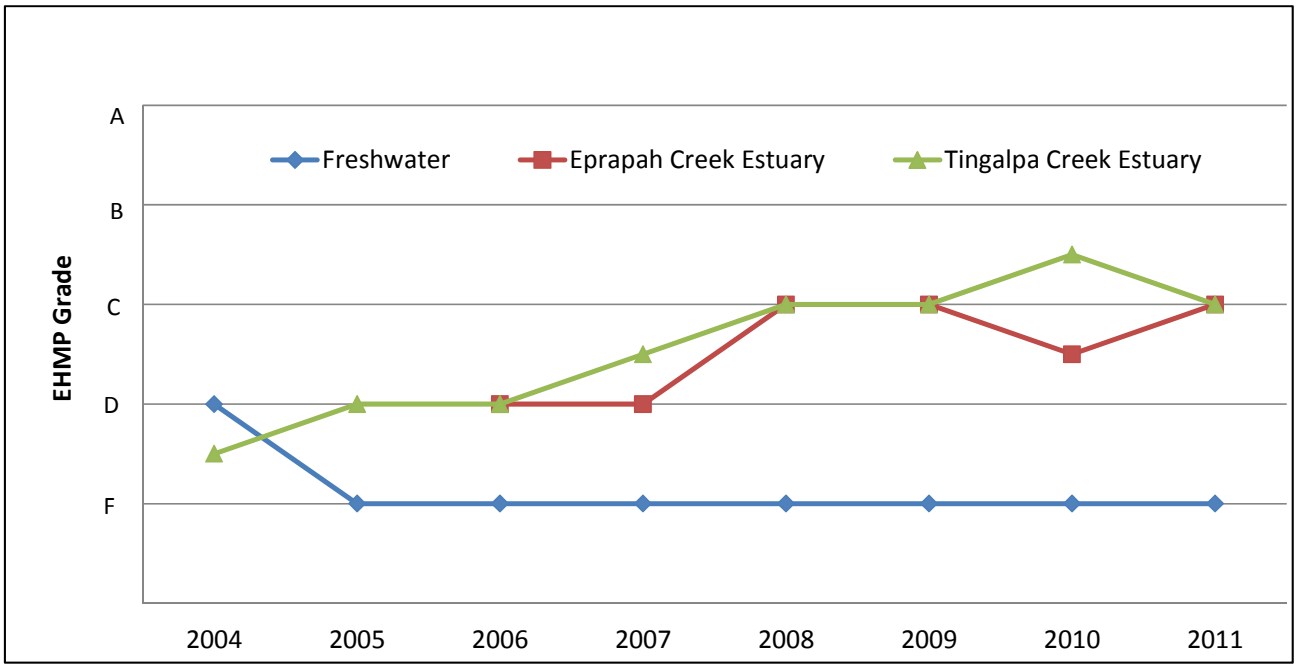

Figure 3-1 Redlands EHMP Report Card Grades

Table 3-2 Summary of Creek Functional Mapping Results

Catchment	Priority for Management & Protection
Tarradarrapin Creek	High
Hilliards Creek	Medium
Cleveland and Thornlands	Cleveland: High Thornlands: Medium
Eprapah Creek	High
South Eastern Creeks	High
Southern Creeks	Native Dog Creek: Medium Serpentine & California Creek: Low
Upper Tingalpa Creek	Low
Lower Tingalpa and Coolnwynpin Creek	High
Coochiemudlo & SMBI	Not assessed
North Stradbroke Island	Not assessed

Table 3-3 Redlands Waterway Recovery Report Freshwater Condition Assessment for Key Parameters in 2011

Catchment	Sites	TSS	TN	TP	DO	Chl-a	Fish	Water Bugs	Hot Spots
Tarradarrapin Creek	7	A	C	C	C	A	D	B	2
Hilliards Creek	11	F	C	C	B	B	C	A	4
Cleveland and Thornlands									
Cleveland	3	A	C	B	B	C	-	-	2
Thornlands	3	A	D	A	C	C	-	-	2
Eprapah Creek	12	F	F	F	A	C	C	A	6
South Eastern Creeks									
Moogurrapum Creek	8	F	D	C	C	B	D	B	4
Weinam Creek	3	F	D	C	C	A	-	-	3
Southern Creeks									
Serpentine Creek	2	F	C	D	-	-	F	B	1
Native Dog Creek	6	F	C	C	B	B	C	B	3
Upper Tingalpa Creek	4	F	D	C	A	F	C	A	-
Lower Tingalpa and Coolnwynpin Creek	10	F	D	F	A	C	C	B	5
Coochiemudlo & SMBI									
Coochiemudlo Is	1	-	-	-	-	-	-	C	-
Russell Is	4	C	C	F	C	C	F	D	2
Karragarra Is	1	F	C	D	B	A	-	-	-
Macleay Is	5	F	D	C	D	F	F	D	2
Lamb Is	4	F	C	D	D	F	-	-	-
North Stradbroke Island	8	-	-	-	-	-	D	B	-

Notes:

All ratings are shown as Dark green=very good, Light green=good, Yellow=Fair, Orange=Poor, Red=very poor

Hot Spots: Water quality hot spots where TSS, TP or TN loads >500% difference to expected loads under DERM (2009)

TSS: Total Suspended Solids TP: Total Phosphorus Chl-a: Chlorophyll-a

TN: Total Nitrogen DO: Dissolved Oxygen Bugs: Macroinvertebrates

It is noted that sustainable load estimates were not available for use in determining whether predicted catchment pollutant loads (both currently and in the future), were sustainable. Sustainable loads can be defined as the annual pollutant load that waterways can assimilate without exceeding concentration based WQOs (as set by the EPP Water). However, as receiving waters are currently in generally poor condition, any future increase in pollutant loads will only worsen compliance with water quality objectives. A summary of the changes to catchment flows and pollutant loads to receiving waters from both diffuse (i.e. stormwater runoff) and large point sources (STPs) is shown in Figure 3-2 to Figure 3-5 below.

It is noted that STP discharges on North Stradbroke Island are to groundwater, and STP discharges within Hilliards Creek catchment (i.e. Cleveland STP) assume 50% of flows are discharged via land disposal (and are therefore not accounted for in the below figures).

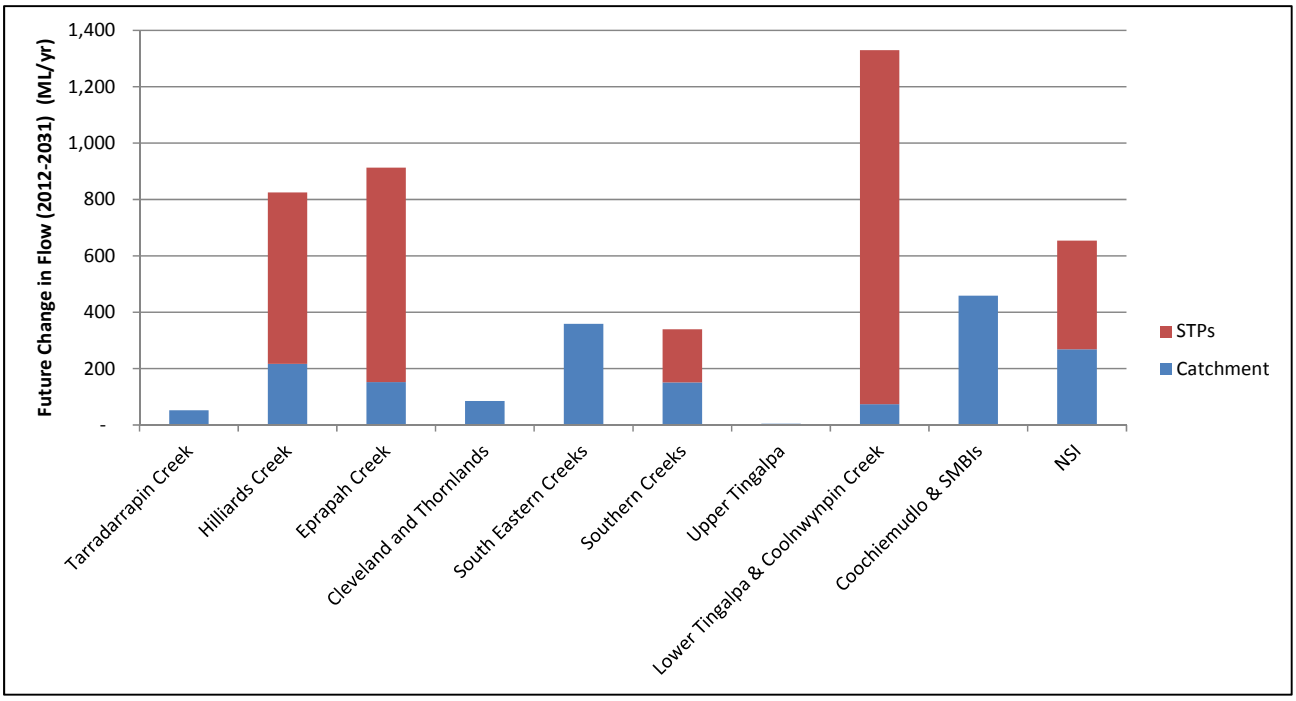

Figure 3-2 Comparison of the Flow to Waterways from STPs and Catchment, 2012 - 2031

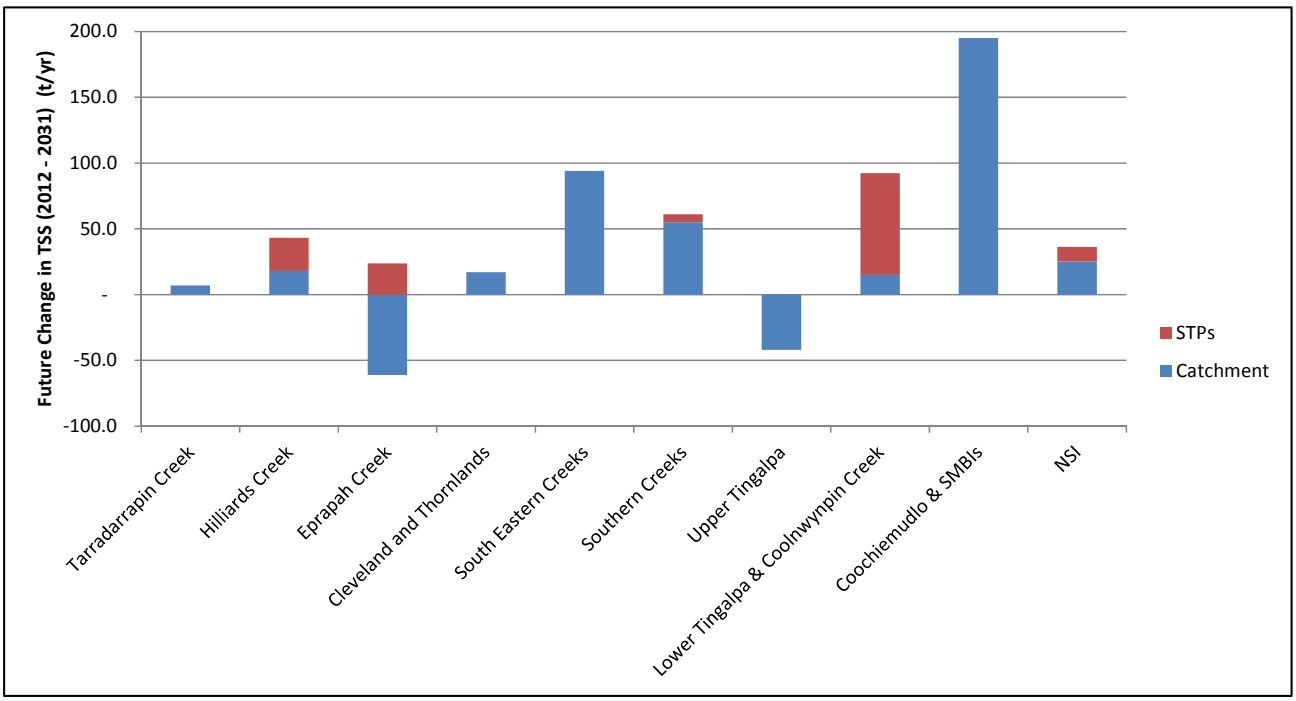

Figure 3-3 Comparison of TSS to Waterways from STPs and Catchment, 2012 - 2031

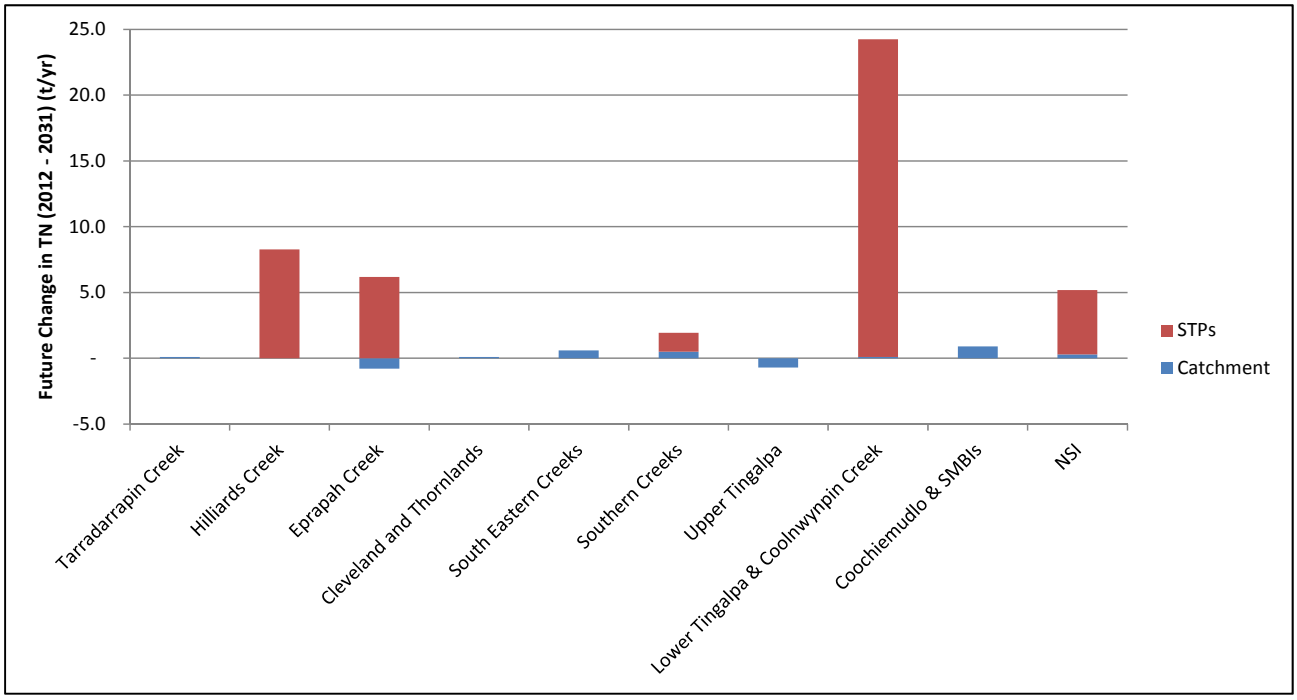

Figure 3-4 Comparison of TN to Waterways from STPs and Catchment, 2012 - 2031

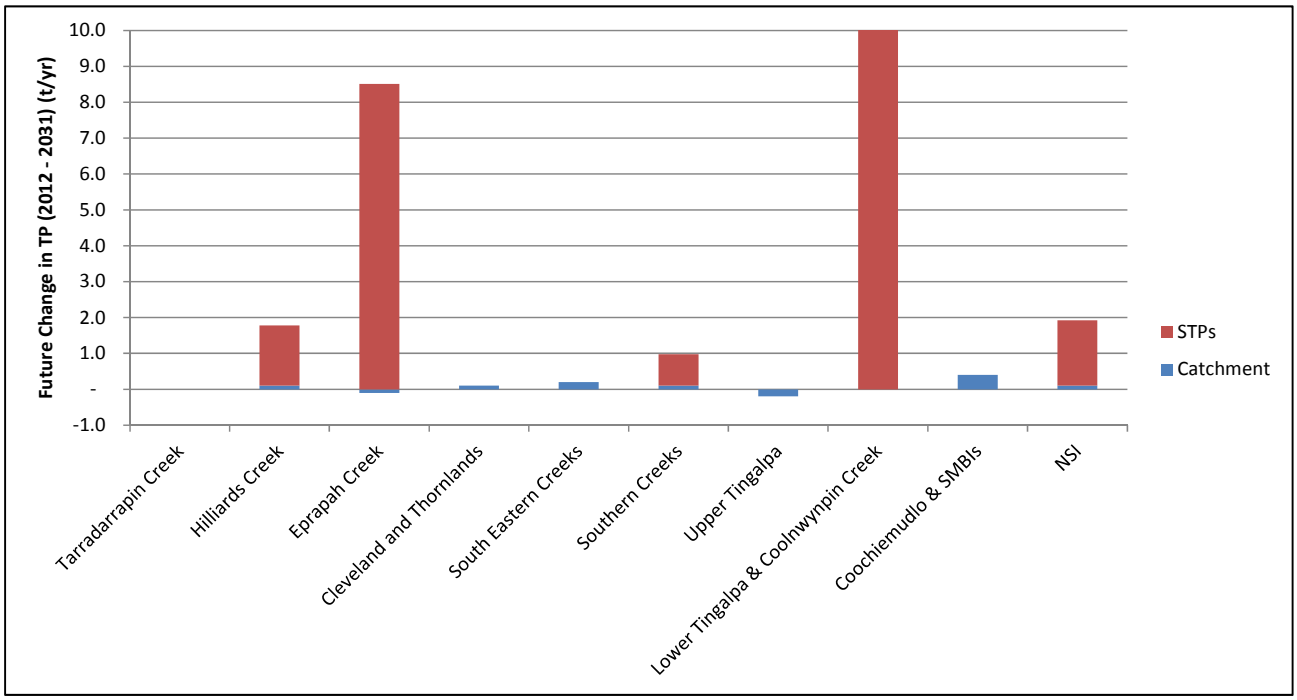

Figure 3-5 Comparison of TP to Waterways from STPs and Catchment, 2012 - 2031

3.2 Impact to Environmentally Sensitive Waters

Within the Redlands region, there exist a number of environmentally sensitive receiving waters, including waterways of High Ecological Value (HEV) and wetlands of state and regional significance. These areas are important for several reasons including species richness and diversity, habitat quality, and aesthetic values. Waterways within the Redlands region also provides habitat for the locally rare and potentially threatened Ornate Sunfish (*Rhadinocentrus ornatus*) as well as the vulnerable and nationally endangered Oxleyan pygmy perch (*Nannoperca oxleyana*). The Redlands region drains to and has islands located within the Moreton Bay Marine Park, which is listed as a Ramsar site with wetlands of international significance.

The environmental values associated with these areas require protection, from current environmental stressors and particularly from potential impacts of future development and population growth.

All catchments within the Redlands region were flagged as containing environmentally sensitive areas that require protection through appropriate waterway management. A summary of the key environmentally sensitive receiving waters identified within each catchment is outlined in Table 3-4.

Table 3-4 Summary of Key Environmentally Sensitive Receiving Waters

Catchment	Environmentally Sensitive Receiving Waters
Tarradarrapin Creek	Drains to Moreton Bay Marine Park and HEV areas within Waterloo Bay. Wetlands of international significance (Ramsar listed Tarradarrapin Wetland).
Hilliards Creek	Drains to Moreton Bay Marine Park and HEV areas within Central Bay. Wetlands of state significance around the mouth of Hilliards Creek and Wellington Point
Cleveland and Thornlands	Wetlands of local, regional & state significance (e.g. Cassim, Cleveland). Drains to Moreton Bay Marine Park and HEV areas within Central Bay.
Eprapah Creek	Freshwaters of Eprapah Creek habitat to Ornate Sunfish, wetlands of state significance around mouth of Eprapah Creek and foreshore area. Drains to Moreton Bay Marine Park and HEV areas (HEVa 1284) within Western Bay.
South Eastern Creeks	Drains to Moreton Bay Marine Park.
Southern Creeks	Wetlands of regional significance (Carbrook Wetlands). Drains to the Logan River and Moreton Bay Marine Park.
Upper Tingalpa Creek	Freshwaters of Tingalpa Creek habitat to Ornate Sunfish, HEV headwaters around Venman Bushland National Park, Ford Road Conservation Area, Neville Lawrie Reserve, and Daisy Hill Conservation Park.
Lower Tingalpa and Coolnwynpin Creek	Freshwaters of Tingalpa Creek habitat to Ornate Sunfish, wetlands of state significance around lower Tingalpa Creek estuary. Drains to Moreton Bay Marine Park and HEV areas in Waterloo Bay.
Coochiemudlo & SMBI	Located within Moreton Bay Marine Park, HEV areas adjoining Lamb Island and adjacent to Russell Island.
North Stradbroke Island	Eastern & Southern Moreton Bay areas, Brown Lake, Blue Lake, 18 Mile Swamp and Myora Springs. Waterways also habitat for the endangered Oxleyan pygmy perch (Little Canalpin Creek). Located within Moreton Bay Marine Park.

3.3 Population Growth

Population growth was estimated using the Allconnex Demand model and PIFU medium growth scenario predictions (refer to Appendix A for further details). Population growth pressures were identified for catchments where there was expected to be a significant increase in urban population by 2031, defined as >30% population increase. Table 3-5 outlines the key catchments identified as having population growth pressures.

Table 3-5 Population Growth Pressures

Catchment	Population Growth Pressures
Hilliards Creek	Kinross Road development
Eprapah Creek	South East Thornlands development. Development around Bunker Road and some development around Double Jump Road (mostly within South Eastern Creeks Catchment)
South Eastern Creeks	Development around Double Jump Road, and subdivisions around Weinam Creek
Coochiemudlo & Southern Moreton Bay Islands (SMBIs)	Population growth on the SMBIs will be a significant pressure to manage, as the SMBIs are not sewered, and current on site wastewater management practices are unsustainable
North Stradbroke Island	Significant population growth is expected within the small residential communities of Amity, Dunwich and Point Lookout

Development pressures in these catchments will need to be carefully managed to ensure sustainable least cost provision of water supply, wastewater and stormwater infrastructure.

3.4 Wastewater Infrastructure

Each Sewage Treatment Plant within the Redlands is operated under DERM development permits with approval conditions which constrain the discharge of treated effluent to receiving waters. The existing development permits all include concentration based discharge limits with a limit to daily discharge volume. Current STP treatment performance and concentration based discharge limits and for key parameters are detailed in Table 3-6. It can be seen that median discharge concentrations in Table 3-6 comply with release limits at all plants. However it is noted by Water Strategies (2011) that groundwater concentrations of TN at Dunwich STP were exceeding approval conditions (>10% of background concentrations). Specific nutrient loads are not conditioned, apart from Victoria Point, which has mass load limits for TN, in addition to concentration based limits. It is also noted that negotiations are currently being undertaken to renew the Cleveland STP licence, and as such it is likely that nutrient mass load limits will be imposed.

A study by Water Strategies (2010) indicated some of the STPs are exceeding maximum daily average dry weather flow (ADWF) conditions both now and in the future. However, discussion with Allconnex indicates that this issue will be resolved with a revised definition of what constitutes dry weather flow (i.e. preceding rainfall). Furthermore, STPs that were highlighted as having potential future design capacity issues already have capital works planned to resolve these future pressures.

Table 3-6 Current STP Treatment Performance and Release Limits for TN and TP

Catchment	STP	Annual Median Concentration[1]		Release Limit[2]	
		TN	TP	TN	TP
Lower Tingalpa and Coolnwynpin Creek	Capalaba	1.6	0.70	5	2
	Thorneside	1.2	0.3	5	2
Hilliards Creek	Cleveland	1.1	0.2	5	1
Eprapah Creek	Victoria Point	1.3	2.95	3[3] 2[4]	5[3] 4[4]
Southern Creeks	Mt Cotton	3.2	0.2	5	2
North Stradbroke Island	Dunwich[5]	2.6	0.75	10	2
	Point Lookout	12.5	6	None	None

[1] Data from 1/01/2011 – 31/12/2011

[2] Long term 50 percentile compliance

[3] Reflects current (2011) discharge limits

[4] Reflects second stage discharge limits. Second stage Nitrogen limits shall come into effect when the long term 50 percentile total effluent Nitrogen load from the plant reaches 13.5 kg N/day. The long term 50 percentile total effluent Nitrogen load from the plant must not exceed 13.5 kg N/day. Second stage Phosphorus limits are based on blend of 6.9 mg P/L from the existing plant and 2 mg P/L from the new plant.

[5] Groundwater in the infusion area must also be within 10% of recorded background levels. Groundwater concentrations were noted to be non-compliant with this criteria by Water Strategies (2011)

The setting of specific water quality objectives for receiving waters (under the EPP Water) has significant potential implications on wastewater discharges from STPs. If STPs within Redlands exceed current approved capacity/licence conditions, upgrades and new licences would be required. This in turn may result in stricter conditions being placed upon STPs to work towards meeting prescribed WQOs. However, as seen in Figure 3-6 and described above, no STPs are predicted to exceed licence capacities for EP (Equivalent Person) loading by 2031, apart from Dunwich STP, which only marginally exceeds its licenced capacity by 2031 (+30 EP).

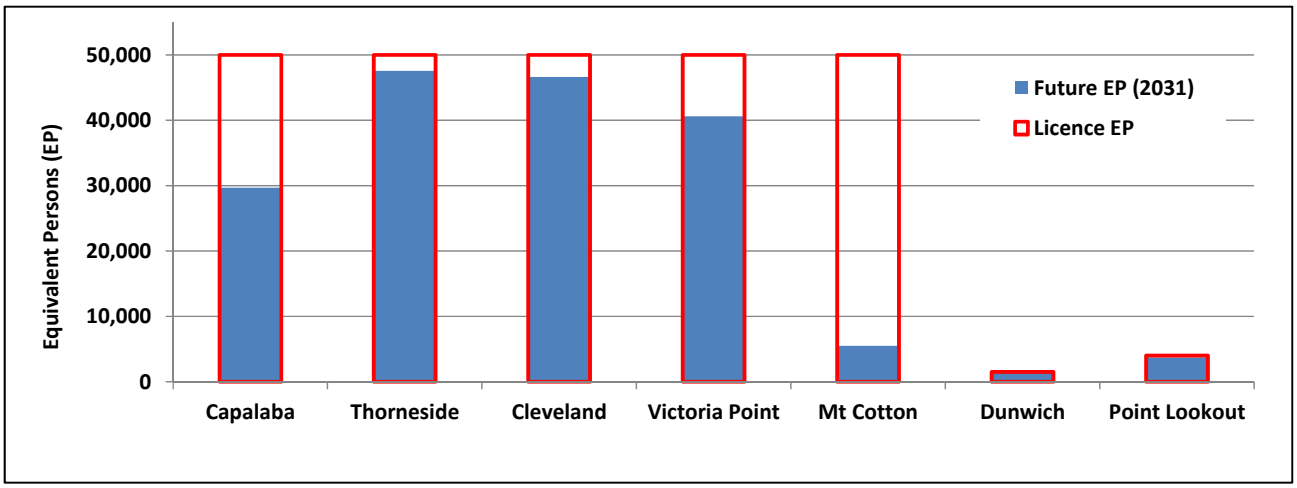

Figure 3-6 Future (2031) predicted STP Loading Compared with Licence Capacity (EP)

Despite most STPs having sufficient licenced EP capacity for future population growth (refer Figure 3-6), there are other licence conditions which present key management issues. Redlands catchments in which STPs were identified to present key future management pressures and a short description of the key pressures are summarised in Table 3-7 below:

Table 3-7 STP Management Pressures

Catchment	STP Management Pressure
Hilliards Creek	Cleveland STP licence is currently under renewal. It is likely that nutrient load limits will be imposed that reflect existing loads, which may require significant investment in additional treatment and/or reuse of wastewater to comply with licence conditions
Eprapah Creek	Victoria Point STP currently has licenced total nitrogen (TN) load limits. These limits may be exceeded as early as 2022, with future 2031 discharges predicted to significantly exceed licence limits. Investment in additional treatment and/or reuse of wastewater will be required to comply with licence conditions for TN loads.
North Stradbroke Island	Dunwich STP is currently exceeding TN licence conditions, which stipulate that concentrations must be within 10% of background levels (from groundwater monitoring). This issue and potential management measures are currently being investigated by Allconnex. Dunwich STP is also predicted to marginally exceed its licenced EP capacity by 2031. If required, a new licence may trigger new nutrient load limit conditions.

Sewage overflows during wet weather were also identified during workshops with Council and Allconnex to be a key pressure throughout the region. This can occur in instances where pump stations receive flows that are greater than their design capacity (i.e. 5 x ADWF) and result in the release of untreated wastewater in times of rain, generally to waterways. Wet weather sewage overflows pose potential pressures to the environment, public health, waterway use and amenity values as well as to Council's reputation.

In addition to the above specific STP operational issues, it is recognised that STP discharges are currently placing significant pressure on waterway health, and this will need to be addressed to ensure sustainable management of waterways.

Section 22 of the EPP (Water) 2009 also specifies that a local government or sewerage service provider should develop and implement an Environmental Plan about Trade Waste Management to control trade waste entering its sewerage services. This plan must be included in its TWCM Plan. Redland City Council currently has a Trade Waste Policy and Environmental Management Plan (RSC, 2004). Recent studies undertaken by Water Strategies (2010) and discussion with Allconnex staff indicate there are no significant trade waste pressures within the Redlands region, apart from managing landfill leachate. Whilst there are a large number of industrial waste contributors, there are only five Category 2 (i.e. high strength and volume) trade waste generators, most of which have additional treatment systems in place to treat wastewater prior to discharging to the sewer.

Similarly, 100% of all biosolids currently generated from STPs within the Redlands region are used for agriculture (i.e. beneficial reuse), and therefore there are no biosolid management issues within the Redlands region.

3.5 Water Supply

Bulk water supply sources within the Redlands region include Leslie Harrison Dam (Upper Tingalpa Creek catchment), groundwater supplies from North Stradbroke Island Basin, as well as surface water supplies at Herring Lagoon (NSI). Bulk water supplies from NSI supplement mainland water supplies, and water from the Redlands mainland is connected to the SEQ Water Grid through the Eastern Pipeline Interconnector. Water in the Redlands mainland can be supplemented through the EPI, with water potentially from Mt Crosby WTP or Molendinar WTP as the most likely sources.

Estimated storage yields from each of these sources are adequate to supply future water demands. Although the groundwater yield from Point Lookout, NSI is predicted to be marginally exceeded in 2031, the sustainable storage yields have been noted to be an estimate only and are considered to be adequate to supply future demands. Groundwater investigations are currently underway to better quantify the sustainable storage yields of groundwater on NSI.

Key pressures identified for the provision of water supply within the Redlands are outlined in Table 3-8.

Table 3-8 Water Supply Management Pressures

Catchment	Water Supply Management Pressure
Upper Tingalpa Creek Catchment	Drinking water quality was identified as an issue at Capalaba Water Treatment Plant (from Leslie Harrison Dam), with high organic loadings in the raw water source, and potentially elevated levels of Trihalomethanes in treated water. Upgrades to the treatment process are required to ensure public health is protected.
North Stradbroke Island	Future security of water supply sources on NSI is a potential issue, as the implications of the indigenous land use agreement (ILUA) is unknown. However it is noted that discussion with Councillors (9/10/12) suggests that the ILUA is unlikely to affect water supply.

Despite the fact that water supply has not been identified as a significant pressure in most catchments, water conservation principles are considered a fundamental component of total water cycle management planning in all catchments.

3.6 Flooding

There are currently limited areas which are at serious risk from flooding throughout the Redland City Council area. This has been as a result of appropriate development standards and controls being applied throughout, ensuring that development which may be at risk of flooding has adequate preventative measures in place. These controls should be applied to any new development to ensure that the flood risk is low and should be reviewed when additional information becomes available about the climate change. This is to ensure that developments are protected from potential impacts of climate change.

However, some areas are impacted by flooding, either through isolation or property inundation. Key flooding pressures that have been identified within Redlands catchments are described in Table 3-9.

Table 3-9 Flooding Pressures

Catchment	Flooding Pressures
Tarradarrapin Creek	Birkdale - some flood affected allotments on Finucane Road, Collingwood Road and Birkdale Road. In addition there is flooding of most of the creek road crossings, the more significant of which are Finucane Road, Collingwood Road, Birkdale Road and Old Cleveland Road.
Hilliards Creek	Low flood immunity of Weippin Street, Flinders Street, Dawson Road McDonald Road culverts – causes overland flows to travel through properties and road when the culverts are overtopped
Cleveland and Thornlands	Joanne Crescent and Blue Water Avenue – shallow property inundation.
South Eastern Creeks	Low flood immunity of Serpentine Creek Road and Oakland Avenue (Torquay Creek) School of Arts Road, Torquay Road West (now Donald Road), Muller Road and Moores Road pose a road and pedestrian safety issue (Weinam Creek). Property inundation of: Meissner Street, Auster Street, Cliftonville Place and Grevilleas Street (Weinam Creek).
Southern Creeks	Low flood immunity of Heinemann Road and Mount Cotton Road (Native Dog Creek).
Lower Tingalpa and Coolnwynpin Creek	Capalaba - some flooding in area of Brewer Street; property inundation along School Road (around the culvert crossing); and significant property inundation upstream of Firtree Street crossing Coolnwynpin Creek. Deagon Road and Melaleuca Drive – road flooding due to inadequate drainage capacity (Coolnwynpin Creek).

This information has been obtained from a range of studies which include some form of flood investigations into these areas. No flood investigations have been undertaken for the Serpentine Creek or California Creek catchments (within Southern Creeks Catchment).

3.7 Storm Tide

Storm tide inundation currently impacts on some properties throughout the Redlands region. Storm Tide Inundation Mapping has recently been undertaken for the area that incorporates potential impacts of climate change (Cardno, 2011). This mapping has been used to identify key problem areas.

Areas and properties likely to be inundated from storm tide (based on the Storm Tide Inundation Mapping) are summarised in Table 3-10.

Table 3-10 Storm Tide Inundation Pressures

Catchment	Storm Tide Inundation Pressures
Tarradarrapin Creek	Mouth of Tarradarrapin Creek – particularly low lying locality between Makaha Drive and Thomas Street; and issues around Dorsal Drive.
Hilliards Creek	Wellington Point – Road and property inundation.
Cleveland and Thornlands	Properties flooded or cut off at Raby Bay and the northern portion of Shore Street North; access cut off to Volunteer Marine Rescue Facility; and Middle Street meeting Emmet Drive – road inundation, potentially cutting of the North Stradbroke Island Ferry Terminal.
Eprapah Creek	Victoria Point – properties facing Moreton Bay and the STW;
South Eastern Creeks	Redland Bay – Moores road; Serpentine Creek Road and property at end of Rocky Passage Road – properties isolated.
Lower Tingalpa and Coolnwynpin Creek	Birkdale and Thorneside at the mouth of Tingalpa Creek – properties facing Moreton Bay, all of Queens Esplanade and a part of the west end of John Street (road and property inundation), most of Thorneside Road and all the development to the east of Railway Parade.
Coochiemudlo & SMBI	Coochiemudlo Island, Macleay Island, Lamb Island, Karragarra Island and North Stradbroke Island are all impacted to some degree.
North Stradbroke Island	Amity Point is affected with several properties flooding. Point Lookout is also affected with up to 20 properties affected.

3.8 Landfill Leachate

During a risk assessment workshop with Council and Allconnex, landfill leachate management was raised as a significant pressure to be considered. The issue was identified in the context that currently landfill leachate is pumped as trade waste to Capalaba STP under a conditional trade waste permit issued by Allconnex. . It was identified that there is need to better characterise the quality of leachate and other trade waste being treated at STPs, and ensure that the treatment performance is meeting requirements for key contaminants. The leachate generated and discharged to the sewer also increases the likelihood of sewage overflows at pump stations (particularly during wet weather).

The ability and capacity of STPs to effectively treat landfill leachate generated in the Redlands region was identified as a primary issue of concern, along with the potential for this to result in fines In some cases, landfill leachate is also tankered and treated outside of the Redlands region at great expense to Council, and the future viability of this method of disposal is uncertain.

Another secondary issue of concern included direct impacts to surface and groundwater quality from minor landfill leachate seepage.

Leachate characteristics discharged from Birkdale closed Landfills (Tarradarrapin Catchment) were noted to comply with current trade waste disposal criteria in most parameters. Noted exceptions during recent monitoring in March and May 2012 included elevated concentrations of ammonia, suspended solids and chlorobenzene.

Council has identified that a Landfill Leachate Management Options and Viability Study has recently been commissioned to identify STP process risks and the recommended management of non-complying parameters.

Table 3-11 summarises the key landfill leachate pressures identified.

Table 3-11 Key Landfill Leachate Pressures

Catchment	Landfill Leachate Pressures
Tarradarrapin Creek	Birkdale Landfill area (collected in underground tanks and pumped to sewer). Judy Holt Park Birkdale (collected in sumps and ponds and tankered outside Allconnex catchment). Anson Road - Wellington Point, upstream of Sovereign Waters
South Eastern Creeks	Redland Bay Closed Landfill area (collected in sumps and ponds and tankered outside Allconnex catchment).
Lower Tingalpa and Coolnwynpin Creek	Duncan Road Baseball site, Capalaba (expect future containment and tankered outside Allconnex catchment). John Fredericks Park, Capalaba. This landfill area is continually subject to high groundwater levels, minor tidal influences and regular flooding by the release of water from the Leslie Harrison Dam Thorneside and Capalaba STPs have limited capacity to treat landfill leachate, and STP treatment processes may be affected.
North Stradbroke Island	Landfill leachate poses potential public health issue if contamination of groundwater occurs (water supply source)

It is noted that smaller landfills (not noted in Table 3-11) were identified in all other catchments apart from Hilliards Creek. Another potential pressure identified for closed coastal landfill sites was the leaching of landfill contaminants during inundation caused by sea level rise and storm surge impacts.

Closed landfill areas throughout the Redlands have been closed to active landfilling for some time. However Council have advised that the quantity of landfill leachate moving into waterways is unknown due to the unknown liner systems, landfill operation and nature of subsurface filling, waste saturation and the unknown interception of groundwater and leachate. Localised water quality monitoring has indicated that waterways have had minor impacts as a result of landfill leachate moving into waterways. Due to the age of most closed landfill areas being approximately 20-30 years old, it is assumed that impacts have already occurred..

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4.0

Key Issues for Detailed Planning

4 KEY ISSUES FOR DETAILED PLANNING

For each water cycle management pressure identified within the planning catchments (and described in Section 3), specific risk issues were further identified during a risk assessment workshop, attended by representatives from Council and Allconnex, held on 19 April, 2012.

The purpose of the risk assessment workshop was to identify any high to extreme risk water cycle management issues which will require future detailed TWCM planning studies to address. The risk assessment was undertaken in accordance with the Australian Standards for risk management (AS/NZ 31000:20009). Appendix C further outlines the methodology used to undertake the risk assessment.

Results of the risk assessment workshop are summarised for each catchment in Table 4-1 to Table 4-10 below. These tables present the specific risk issues (for each water cycle management pressure) that were assessed as having high to extreme risk ratings. Results have been mapped in Figure 4-1 to Figure 4-10 below to show the catchments identified as having key water cycle management issues, either currently or in the future, that will require further detailed planning investigations to address. The mapped results for each water cycle management issue reflect the maximum specific risk rating identified within a catchment for that particularly water cycle management issue.

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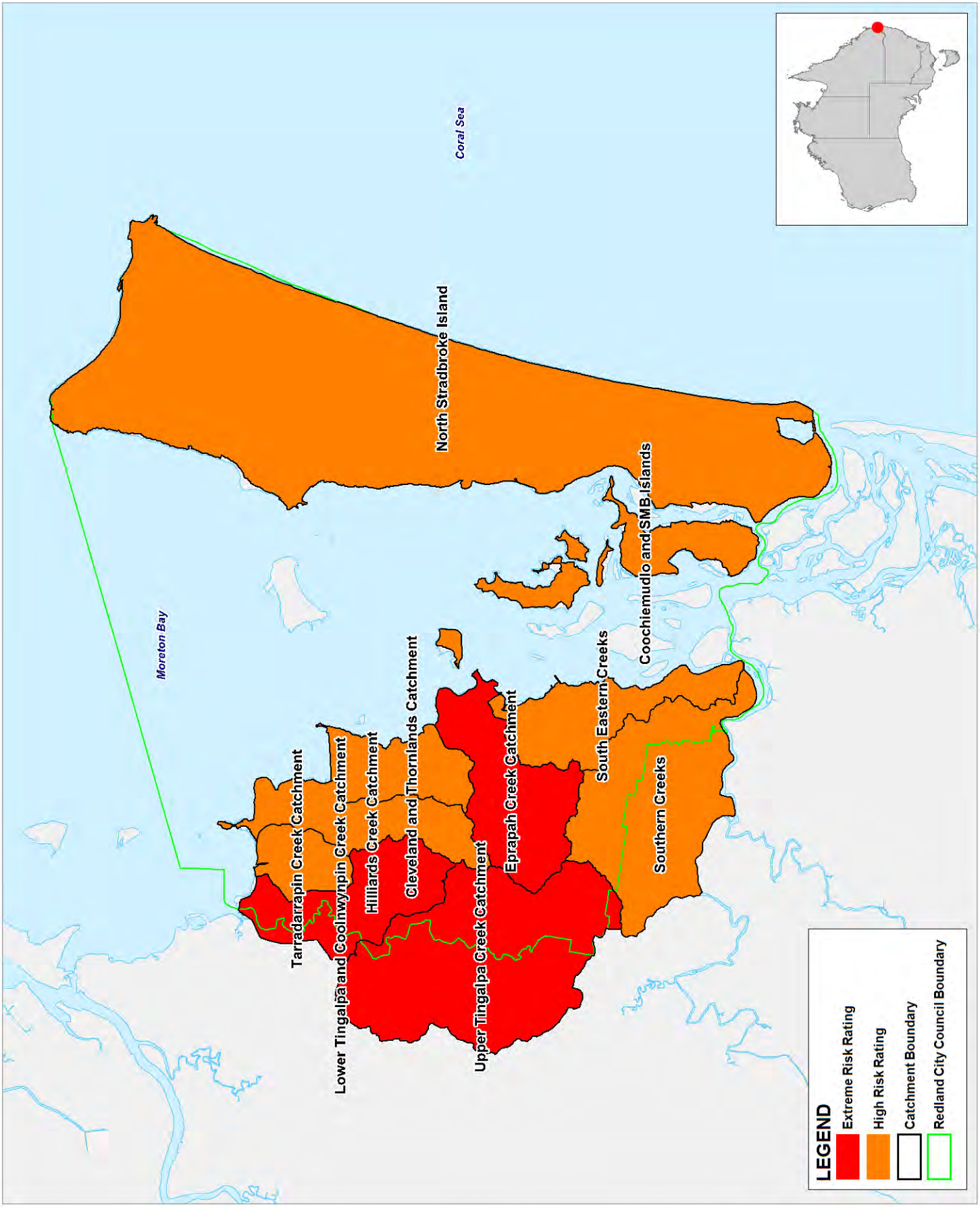
Table 4-1 Specific High & Extreme Risk Issues identified for Deterioration of Waterway Health

Specific Issue	Catchment Risk Rating									
	Tarra	Hilliard	Eprap	Clev & Thorn	South Eastern	South Creeks	Upper Tingal	Lower Tingal	Cooch & SMBI	NSI
Deterioration of ecosystem health resulting from high sediment load	H24	H24	E32	H24	H24	H24	E30	E30		
Deterioration of ecosystem health resulting from high nitrogen load	H30	H24	H24	H24	H24	H24	E30	H24	H24	H24
Deterioration of ecosystem health resulting from high phosphorus load	H24	H24	H24	H24	H24	H24	E30	E30	H24	H24
Deterioration of ecosystem health resulting from overuse of water resource							H24			
Loss of and/or deterioration of riparian condition (% area good riparian condition?)		H24	H24	H24						
Deterioration of ecosystem health from under investment in infrastructure	H24				H24				H24	H24
Investment in ineffective infrastructure										
Decline in aquatic species diversity and abundance	H24	H24	H24	H24		H24		H24	H24	H24
Impact to reputation as Council is perceived as not managing responsibilities	H24	H24	H24	H24	H24	H24		H24	H24	
Public health issues arise from water management (e.g. algal blooms) (important to note that this can be further identified as a containment issue - rural dams overflowing into waterways)	H24	H24	H24	H24	H24	H24		H24		
Management measures are not implemented	H24		H24							
Proposed management measures are ineffective									H24	H24
Impact to public amenity and recreational values	H24	H24	H24	H24						
Economic impacts on tourism, fishing, development										H24
Decline in iconic or significant aquatic species	H24	H24	H24	H24	H24	H24	H24	H24	H24	H24
Maximum Catchment Risk Rating	***H30***	***H24***	***E32***	***H24***	***H24***	***H24***	***E30***	***E30***	***H24***	***H24***

Note: Orange shading indicates high risk rating, red shading indicates extreme risk rating. Higher numbers reflect greater risk ratings. Refer to Appendix C for further detail.
Refer to Section 3.1 of this report for further information on the waterway health catchment pressures, and Section 2 for greater detail on a particular catchment.



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Maximum Risk Ratings for Deterioration of Waterway Health Risk Category

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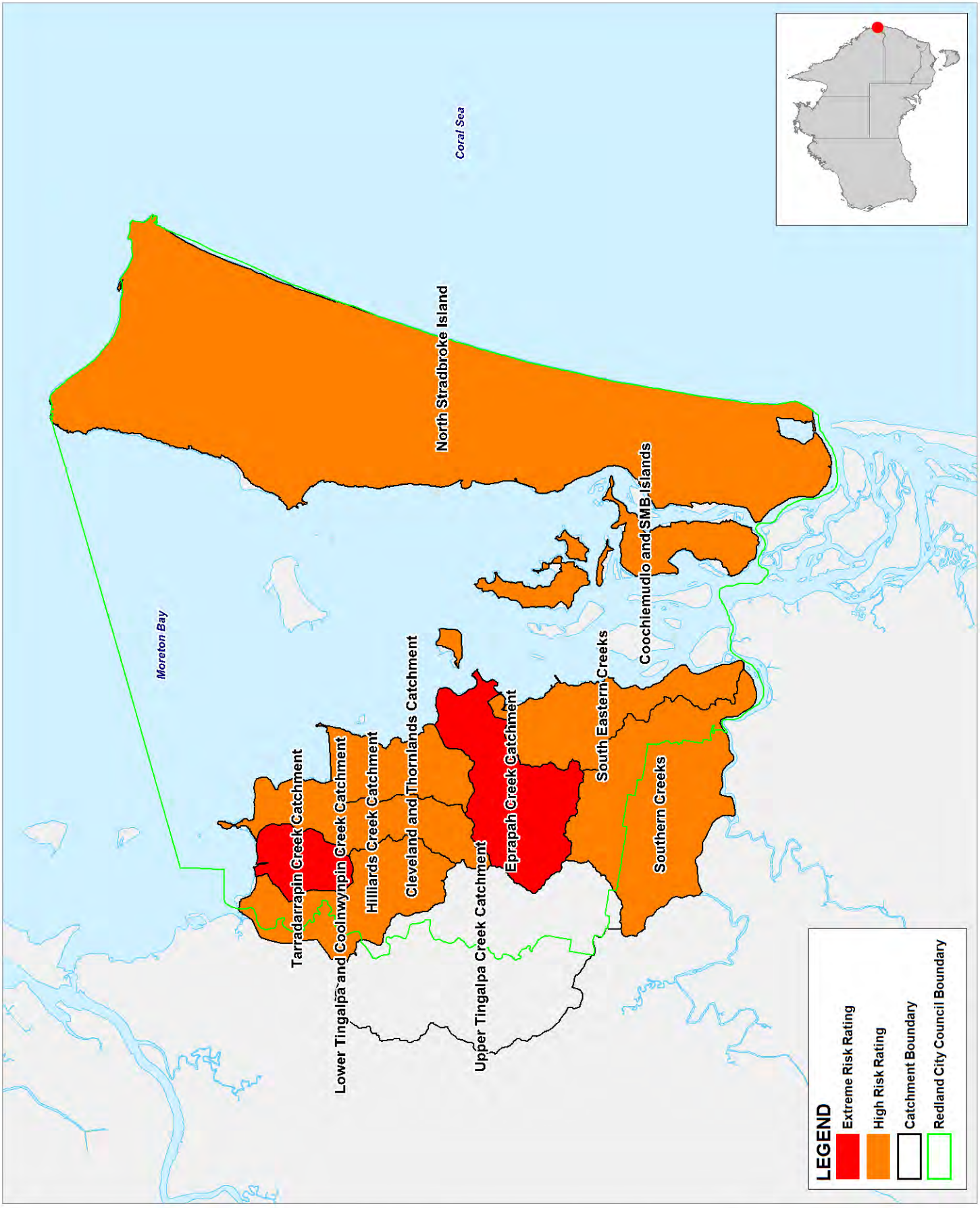
Table 4-2 Specific High & Extreme Risk Issues identified for Impacting Environmentally Sensitive Waters

Specific Issue	Catchment Risk Rating									
	Tarra	Hilliard	Eprap	Clev & Thorn	South Eastern	South Creeks	Upper Tingal	Lower Tingal	Cooch & SMBI	NSI
Deterioration of ecosystem health resulting from high sediment load	H24		E32	H24		H24		H24	H24	
Deterioration of ecosystem health resulting from high nitrogen load	H24	H24	E32	H24	H24	H24		H24	H24	
Deterioration of ecosystem health resulting from high phosphorus load	H24	H24	H24	H24	H24	H24		H24	H24	
Deterioration of ecosystem health resulting from overuse of water resource				H24						
Loss of and/or Deterioration of riparian condition			H24	H24		H24				
Deterioration of ecosystem health from under investment in infrastructure				H24	H24					
Decline in aquatic species diversity and abundance	E32	H24	H24	H24		H24			H24	H24
Impact to reputation as Council is perceived as not managing responsibilities	H24	H24	H24	H24	H24	H24		H24	H24	H24
Public health issues arise from water management (e.g. algal blooms)		H24	H24	H24	H24	H24		H24	H24	
Management measures are not implemented									H24	H24
Impact to public amenity and recreational values			H24							
Maximum Catchment Risk Rating	***E32***	***H24***	***E32***	***H24***	***H24***	***H24***		***H24***	***H24***	***H24***

Note: Orange shading indicates high risk rating, red shading indicates extreme risk rating. Higher numbers reflect greater risk ratings. Refer to Appendix C for further detail.
Refer to Section 3.2 of this report for further information on pressures to environmentally sensitive areas, and Section 2 for greater detail on a particular catchment.



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Maximum Risk Ratings for Impacts to Environmentally Sensitive Waters Risk Category

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Table 4-3 Specific High & Extreme Risk Issues identified for Population Growth

Specific Issue	Catchment Risk Rating									
	Tarra	Hilliard	Eprap	Clev & Thorn	South Eastern	South Creeks	Upper Tingal	Lower Tingal	Cooch & SMBI	NSI
Deterioration of waterway health resulting from high sediment load			H24		H24				H24	H24
Deterioration of waterway health resulting from high nitrogen load		H24	E32		H24				H30	H24
Deterioration of waterway health resulting from high phosphorus load		H24	E32		H24				H24	H24
Loss of and/or Deterioration of riparian condition									H24	H24
Wastewater management unsustainable			H24		H24				E40	E32
Under investment of infrastructure results in poor outcomes and affects Council reputation		H24	H24		H24				H24	H24
Decline in aquatic species biodiversity and abundance		H24	H24		H24				H24	
Impact to Council reputation, as Council is perceived as not managing responsibilities		H24	H24		H24				H24	H24
Public health issues arise from waterway management		H24	H24		H24				H24	
Public health issues arise from supply of drinking water		H20	H20		H20				H20	H20
Public health issues arise from wastewater management		H24	H24		H24				H24	H24
Impacts to groundwater dependant / freshwater ecosystems due to overuse of water resources										H24
Maximum Catchment Risk Rating		H24	E32		H24				E40	E32

Note: Orange shading indicates high risk rating, red shading indicates extreme risk rating. Higher numbers reflect greater risk ratings. Refer to Appendix C for further detail.
Refer to Section 3.3 of this report for further information on population growth pressures, and Section 2 for greater detail on a particular catchment.

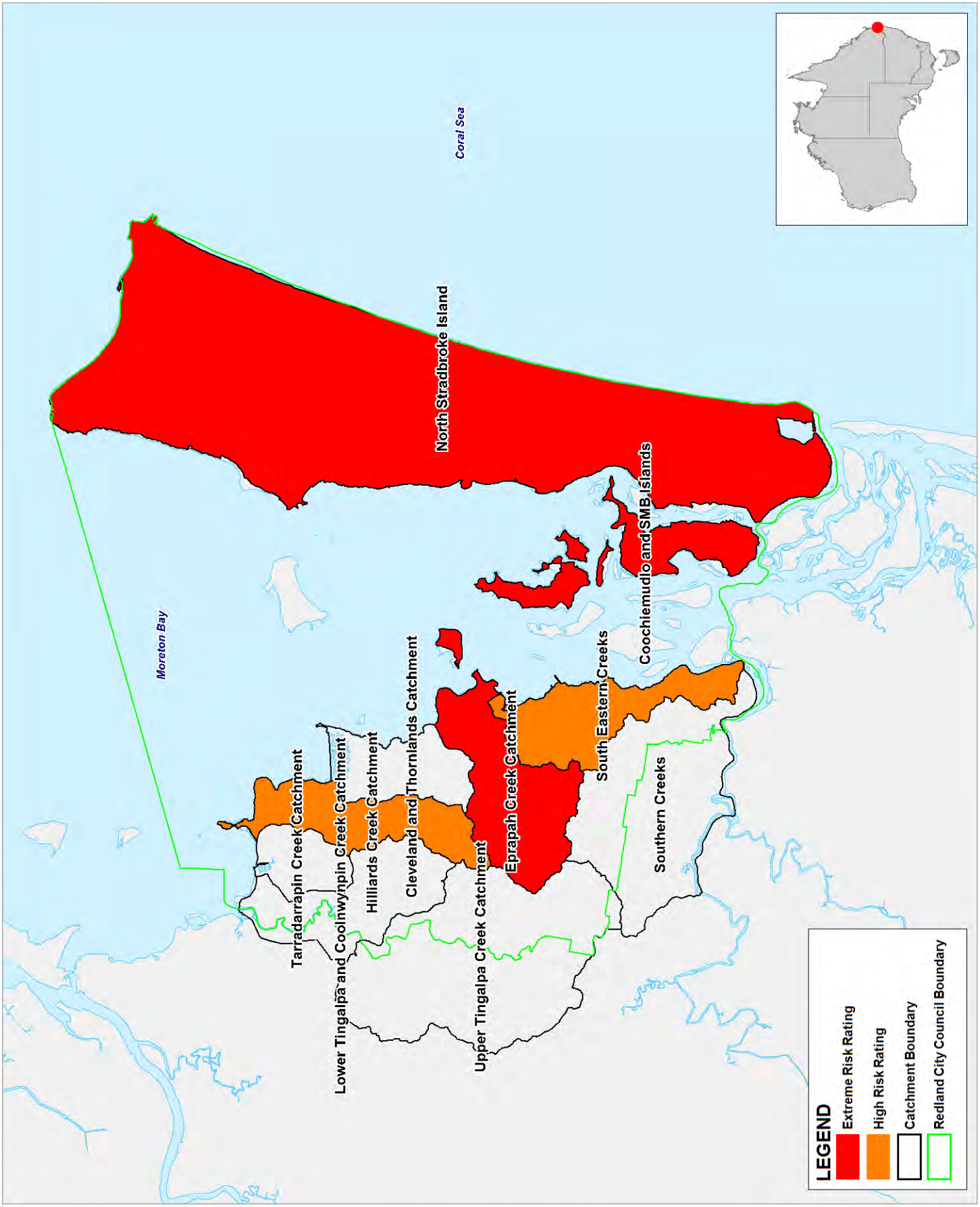

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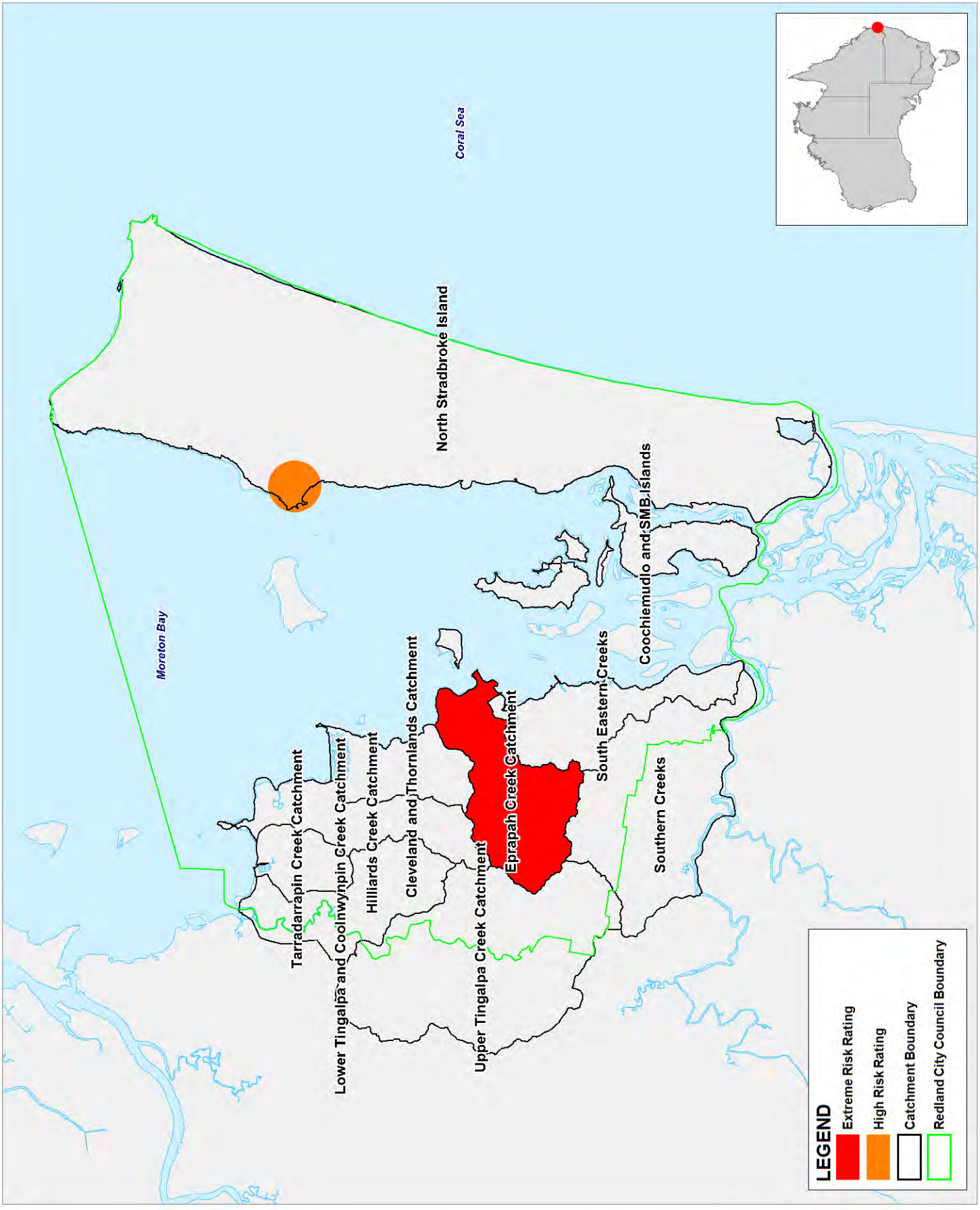
Table 4-4 Specific High & Extreme Risk Issues identified for STP Capacity Constraints

Specific Issue	Catchment Risk Rating									
	Tarra	Hilliard	Eprap	Clev & Thorn	South Eastern	South Creeks	Upper Tingal	Lower Tingal	Cooch & SMBI	NSI
Flows exceed licence conditions, requiring investment in recycled water use (with cost & risk implications)										H24
Nitrogen loads exceed licence conditions, requiring investment in additional treatment /reuse (with cost & risk implications)			E32							H24
Phosphorus loads exceed licence conditions, requiring investment in additional treatment /reuse (with cost & risk implications)										H24
Flows predicted to exceed design capacity			E32							H24
Maximum Catchment Risk Rating			***E32***							***H24***

Note: Orange shading indicates high risk rating, red shading indicates extreme risk rating. Higher numbers reflect greater risk ratings. Refer to Appendix C for further detail.
Refer to Section 3.4 of this report for further information on STP capacity pressures, and Section 2 for greater detail on a particular catchment.



Title:

Maximum Risk Ratings for Sewage Treatment Plant Capacity Constraints Risk Category

Figure: **4-4**

Rev: **A**

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Approx. Scale

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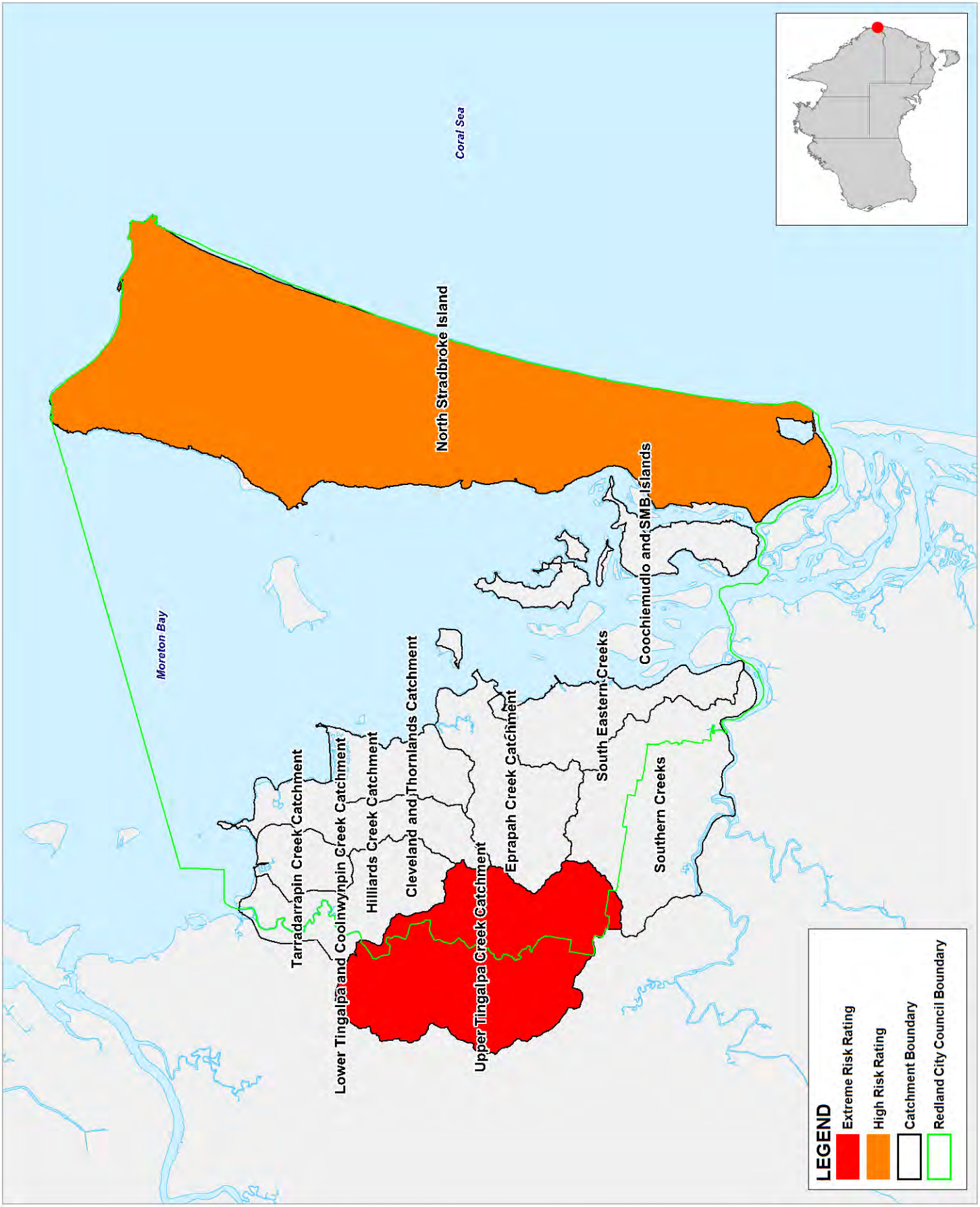
Table 4-5 Specific High & Extreme Risk Issues identified for Water Supply Constraints

Specific Issue	Catchment Risk Rating									
	Tarra	Hilliard	Eprap	Clev & Thorn	South Eastern	South Creeks	Upper Tingal	Lower Tingal	Cooch & SMBI	NSI
Development pressures result in high sediment loads that may affect drinking water quality							H24			
Development pressures result in high nitrogen loads that may affect drinking water quality							H24			
Development pressures result in high phosphorus loads that may affect drinking water quality							H24			
Public health issues arise from supply of drinking water (i.e. trihalomethanes)							E30			
Lower than expected drinking water supply (i.e. due to native title claims, lower sustainable yields than anticipated)										H24[2]
Impacts to groundwater dependant ecosystems due to exceeding sustainable storage yields										H24
Maximum Catchment Risk Rating							***E30***			***H24***

Note: Orange shading indicates high risk rating, red shading indicates extreme risk rating. Higher numbers reflect greater risk ratings. Refer to Appendix C for further detail.
Refer to Section 3.5 of this report for further information on water supply pressures, and Section 2 for greater detail on a particular catchment.

[2] It is noted that discussion with Councillors (9/10/12) suggests that the ILUA is unlikely to affect water supply. This may reduce the risk rating, however requires further investigation to confirm.



Title:

Maximum Risk Ratings for Water Supply Constraints Risk Category

Figure: 4-5

Rev: A

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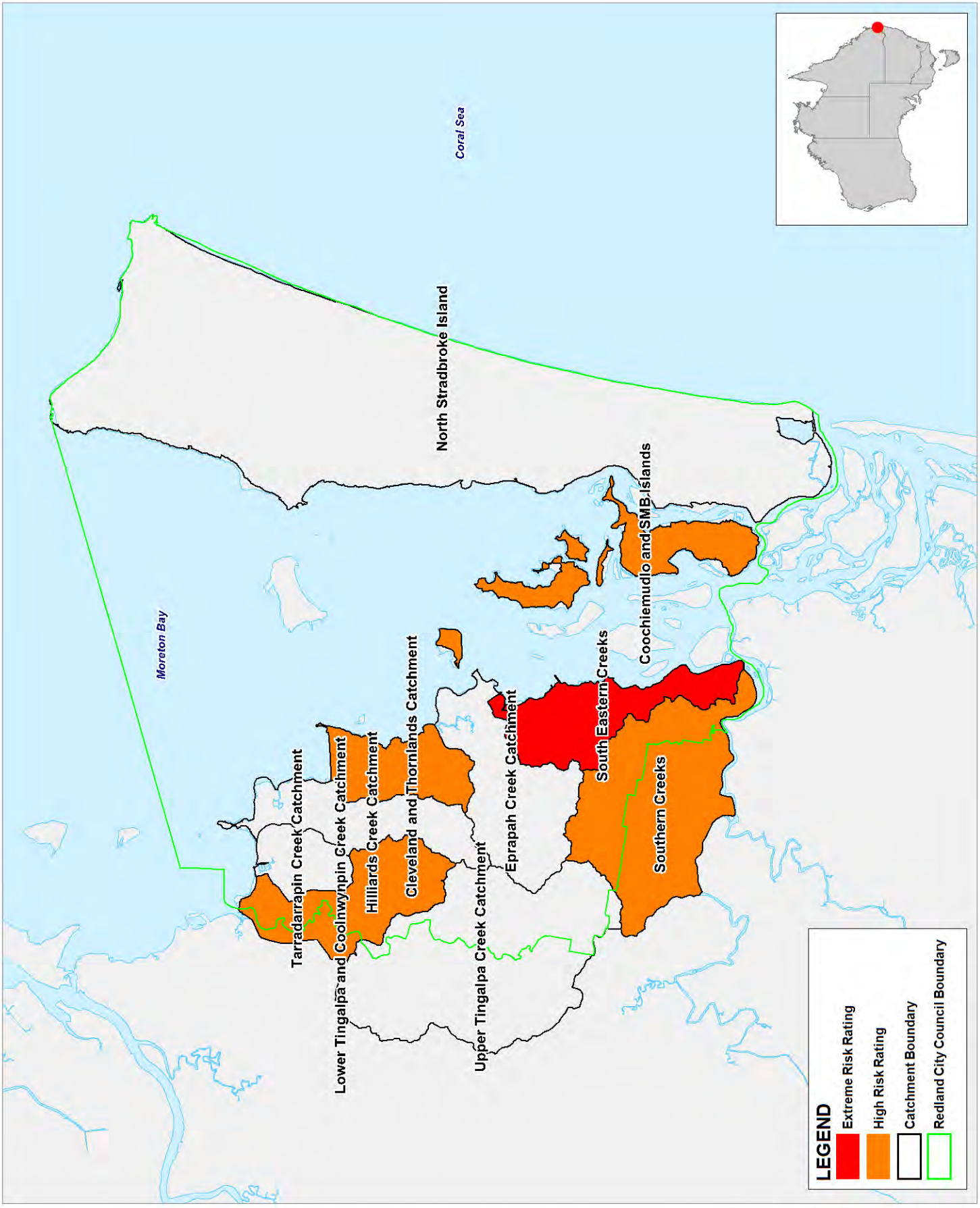
Table 4-6 Specific High & Extreme Risk Issues identified for Flooding

Specific Issue	Catchment Risk Rating									
	Tarra	Hilliard	Eprap	Clev & Thorn	South Eastern	South Creeks	Upper Tingal	Lower Tingal	Cooch & SMBI	NSI
Flows predicted to exceed design capacity					H24					
High cost of damage to properties & infrastructure if not managed (underinvestment of infrastructure)					E32					
Public safety / health issues arise from issue not being managed					H24					
Potential for high cost of land resumption of flood affected properties					H24					
Impact to reputation as Council is perceived as not managing responsibilities				H24	E32	H24		H24	H24	
Maximum Catchment Risk Rating				***H24***	***E32***	***H24***		***H24***	***H24***	

Note: Orange shading indicates high risk rating, red shading indicates extreme risk rating. Higher numbers reflect greater risk ratings. Refer to Appendix C for further detail.
Refer to Section 3.6 of this report for further information on flooding pressures, and Section 2 for greater detail on a particular catchment.



Title:

Maximum Risk Ratings for Flooding Risk Category

Figure: **4-6**

Rev: **A**

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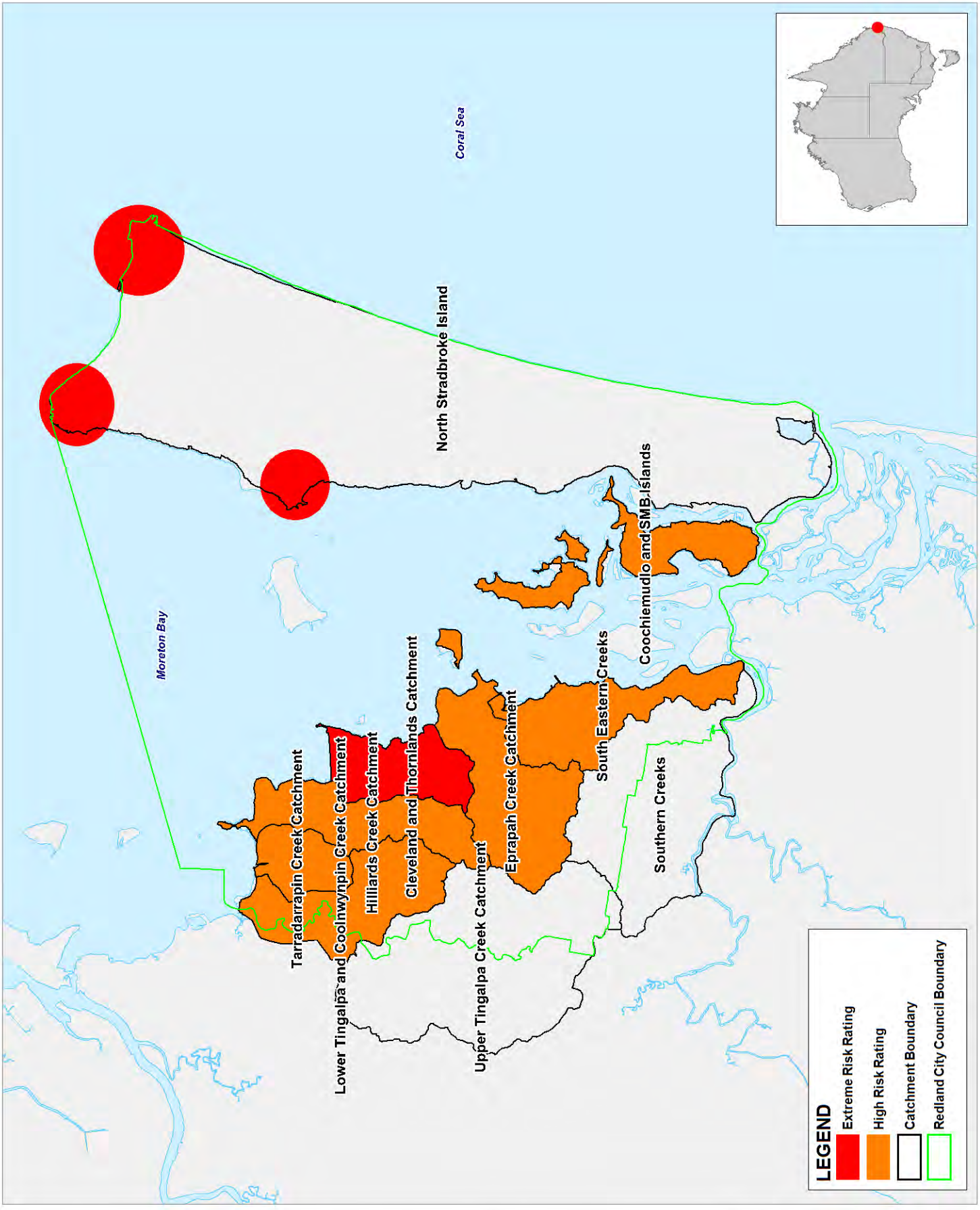
Filepath : I:\B18583_I_GML RCC TWCM Strategy NJR\DRG\WQU_010_121009_MRRFloodingRisk_A4.wor

Table 4-7 Specific High & Extreme Risk Issues identified for Storm Tide Inundation

Specific Issue	Catchment Risk Rating									
	Tarra	Hilliard	Eprap	Clev & Thorn	South Eastern	South Creeks	Upper Tingal	Lower Tingal	Cooch & SMBI	NSI
High cost of damage to properties & infrastructure if not managed (underinvestment of infrastructure)										E50
Public safety / health issues arise from issue not being managed										H24
Potential for high cost of land resumption of flood affected properties				H24				H24		H24
Impact to reputation as Council is perceived as not managing responsibilities	H24			E32				H24	H24	H24
Climate change increases the impacts of storm tide inundation										E32
Impact to water quality / ecosystem health if sewerage infrastructure compromised	H24							H24		
Impact to ecosystem health from saltwater ingress to freshwaters		H24	H24	H24	H24					
Maximum Catchment Risk Rating	***H24***	***H24***	***H24***	***E32***	***H24***			***H24***	***H24***	***E50***

Note: Orange shading indicates high risk rating, red shading indicates extreme risk rating. Higher numbers reflect greater risk ratings. Refer to Appendix C for further detail. Refer to Section 3.7 of this report for further information on storm tide inundation pressures, and Section 2 for greater detail on a particular catchment.



Title:

Maximum Risk Ratings for Storm Tide Risk Category

Figure: **4-7**

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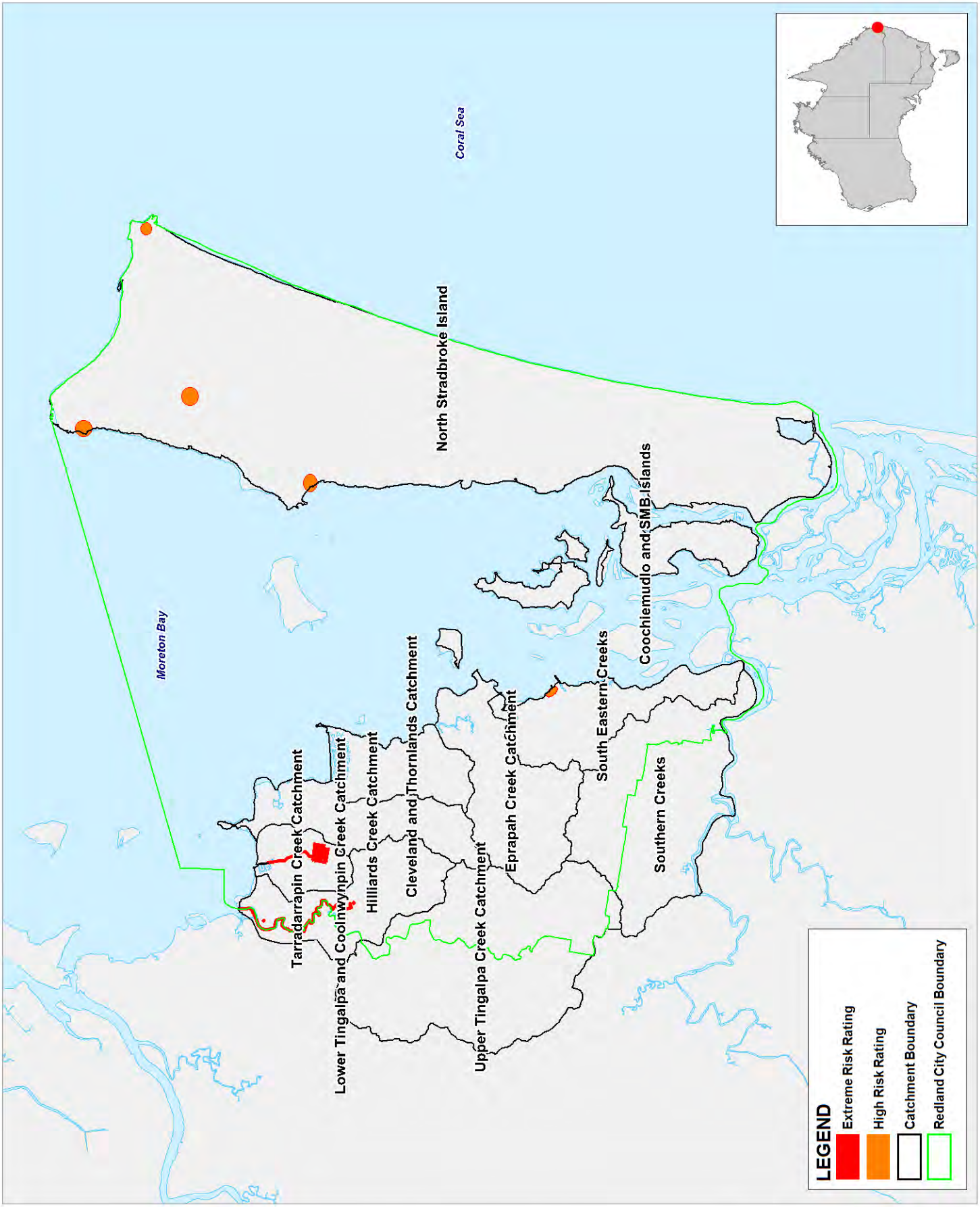
Table 4-8 Specific High & Extreme Risk Issues identified for Landfill Leachate

Specific Issue	Catchment Risk Rating									
	Tarra	Hilliard	Eprap	Clev & Thorn	South Eastern	South Creeks	Upper Tingal	Lower Tingal	Cooch & SMBI	NSI
Increased wet weather flows to PS overloads system, with potential for greater pump station overflows and impacts to waterway health	E40									
Leachate from dry weather flows affects STP treatment ability, and quality of water discharged impacting on waterway health	H24									
Public health issues arise from leachate management										H24
DERM fines for not meeting licence requirements for management of landfill leachate / STP discharge (fines also applicable from Allconnex / Redwater)										H24
Climate change impacts increase potential for leachate generation and associated impacts					H24					
Maximum Catchment Risk Rating	***E40***				***H24***					***H24***

Note: Orange shading indicates high risk rating, red shading indicates extreme risk rating. Higher numbers reflect greater risk ratings. Refer to Appendix C for further detail.
Refer to Section 3.8 of this report for further information on landfill leachate pressures, and Section 2 for greater detail on a particular catchment.



Title:

Maximum Risk Ratings for Landfill Leachate Risk Category

Figure: **4-8**

Rev: **B**

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Approx. Scale

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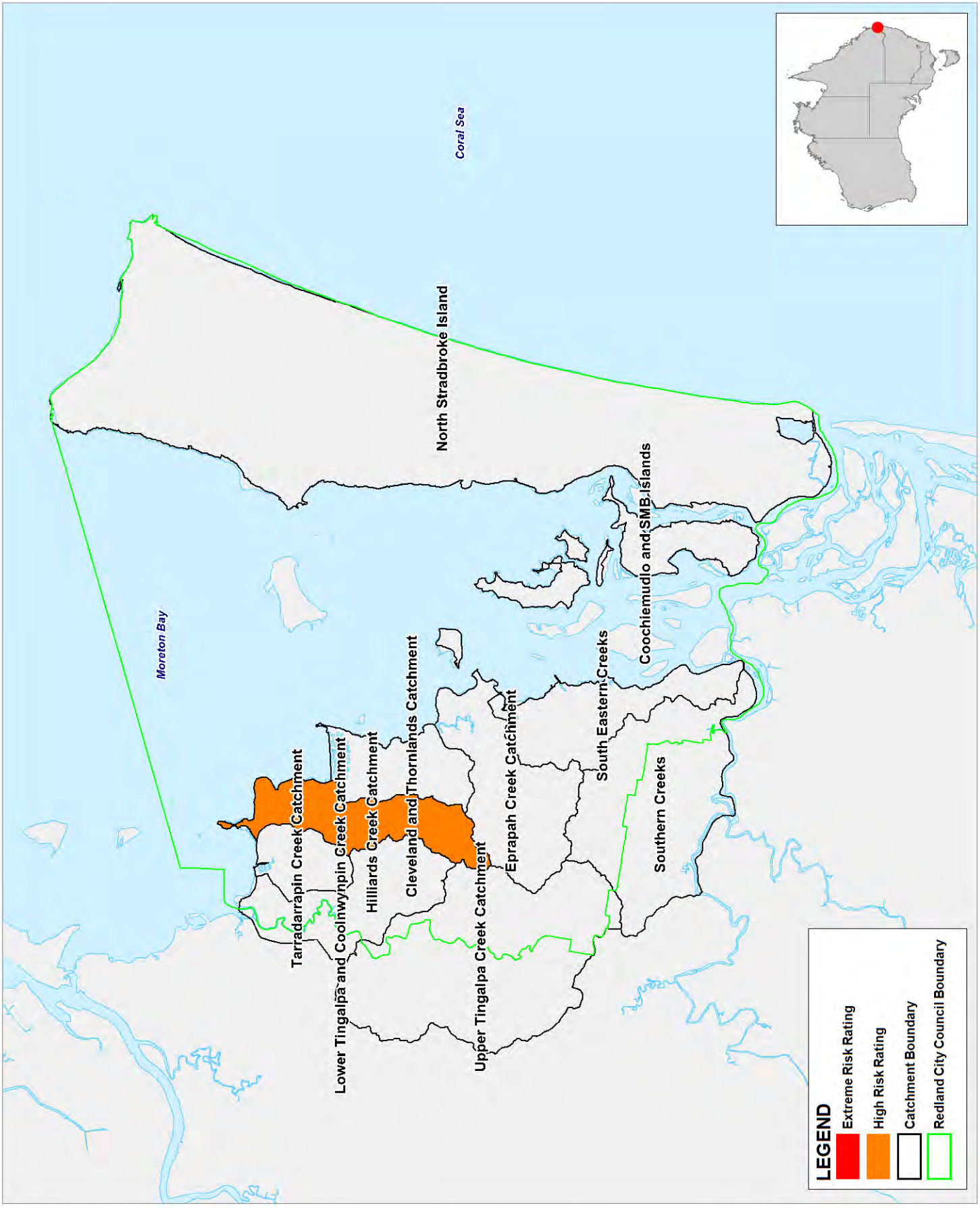
Filepath : I:\B18583_I_GML RCC TWCM Strategy NJR\DRG\WQU_012_121009_MRRLandfillLeachate_A4.wor

Table 4-9 Specific High & Extreme Risk Issues identified for Dry Weather Sewage Overflows

Specific Issue	Catchment Risk Rating									
	Tarra	Hilliard	Eprap	Clev & Thorn	South Eastern	South Creeks	Upper Tingal	Lower Tingal	Cooch & SMBI	NSI
Overflows impact on waterway health		H24								

Note: Orange shading indicates high risk rating, red shading indicates extreme risk rating. Higher numbers reflect greater risk ratings. Refer to Appendix C for further detail.
Refer to Section 3.4 of this report for further information on wastewater infrastructure pressures, and Section 2 for greater detail on a particular catchment.



Title:

Maximum Risk Ratings for Dry Weather Sewage Overflows

Figure: **4-9**

Rev: **A**

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Table 4-10 Specific High & Extreme Risk Issues identified for Wet Weather Sewage Overflows

Specific Issue	Catchment Risk Rating									
	Tarra	Hilliard	Eprap	Clev & Thorn	South Eastern	South Creeks	Upper Tingal	Lower Tingal	Cooch & SMBI	NSI
Overflows impact on waterway health	H20	H20	H20	H20	H20	H20	H20	H20	H20	H20
Overflows impact on human health	H30	H30	H30	H30	H30	H30	H30	H30	H30	H30
Overflows impact on public amenity and recreational values (e.g. swimming, fishing, etc.)	H30	H30	H30	H30	H30	H30	H30	H30	H30	H30
Financial impacts from DERM fines	H20	H20	H20	H20	H20	H20	H20	H20	H20	H20
Impact to reputation as Council is perceived as not managing responsibilities	H20	H20	H20	H20	H20	H20	H20	H20	H20	H20
Overflows have financial impact on commercial fishing/oystering	H20	H20	H20	H20	H20	H20	H20	H20	H20	H20
Overflows have economic impact on tourism	H20	H20	H20	H20	H20	H20	H20	H20	H20	H20
Highest Risk Rating	***H30***	***H30***	***H30***	***H30***	***H30***	***H30***	***H30***	***H30***	***H30***	***H30***

Note: Orange shading indicates high risk rating, red shading indicates extreme risk rating. Higher numbers reflect greater risk ratings. Refer to Appendix C for further detail.
Refer to Section 3.4 of this report for further information on wastewater infrastructure pressures, and Section 2 for greater detail on a particular catchment.

Title:

Maximum Risk Ratings for Wet Weather Sewage Overflows Risk Category

Figure: **4-10**

Rev: **A**

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5.0

Solutions

5 SOLUTIONS

5.1 Guiding TWCM Principles and Objectives

A key component of developing a TWCM strategy is ensuring clear principles and objectives are defined. By setting clear TWCM principles and objectives this will allow for the optimal TWCM solutions to be selected that are consistent with Council's policy directions and regulatory requirements.

Redland City Council has undertaken substantial consultation with the community during the development of the *Redlands 2030 Community Plan*. In recognition of this, the vision outlined in Council's Community Plan has been adopted as the vision for this TWCM Plan, as outlined in Box 1.

Box 1 Redland City Council's TWCM Vision

"In 2030, the Redlands will be a well-designed, vibrant city of mainland and island communities, each with distinctive character, heritage and lifestyles. Our shared values will shape the way we care for each other and how we protect the land, seas and waters where we choose to be."

Strategic documents (including Council's Community and Corporate Plan) were used to identify overarching strategic objectives for the TWCM Plan and develop specific objectives for TWCM. The objectives were developed in consultation with key stakeholders (Council and Allconnex) and included a workshop with Council on Wednesday 20 June 2011.

A high level TWCM role objective was developed as follows:

Redland City Council's (RCC) TWCM Plan will provide an overarching document that draws together water cycle management related objectives from all RCC plans. It is a holistic document that aims to manage all elements of the water cycle in a way that strives to meet the community's aspirations and legislative requirements.

The TWCM Plan will identify water cycle management priorities (through a risk assessment process) and provide direction for addressing these issues in a way that optimises environmental and social benefits within the Redlands region and minimises cost.

The overarching corporate strategic objectives identified to align with the TWCM Plan are included in Appendix D. The specific objectives developed are outlined in Table 5-1.

Table 5-1 Total Water Cycle Management Objectives

Long Term TWCM Strategy	Specific Objective
1. Improve Waterway Health	1.1 Rehabilitation of riparian zones to protect waterway health and improve habitat and amenity.
	1.2 Protect the values of waterways and wetlands through the Redlands Planning Scheme.
	1.3 Retain sediment on-site and reduce sediment moving into waterways.
	1.4 Reduce nutrient and sediment pollution by engaging with local landholders (businesses and private) through the Waterway Extension Program.
	1.5 Identify and eliminate unregulated water quality (or contamination) hotspots in the landscape
	1.6 Better management of trunk urban stormwater.
	1.7 Use and reuse contaminated water.
2. Protect Environmentally Sensitive Areas	2.1 Maintenance of HEV waterways and ecological processes.
3. Plan and facilitate Sustainable Population Growth	3.1 Investigate and future proof water resources in the land through innovation.
	3.2 New development to meet alternative water supply targets set by Queensland Development Code MP 4.2 and 4.3.
	3.3 Plan and articulate our future water supply needs.
4. Manage Wastewater Treatment Systems to protect receiving waters and public health	4.1 Meet and go beyond licence conditions by reducing effluent flows and pollutant loads within the wastewater system.
	4.2 Minimise trade waste.
	4.3 Sustainably manage biosolids, through beneficial reuse (i.e. agriculture).
	4.4 Reduce number of sewage overflows caused by blockages, inflow and infiltration.
	4.5 Encourage waste minimisation and cleaner production, including waste prevention, recycling, and pre-treatment.
	4.6 Safeguard public health and the environment.
	4.7 Equitably recover the cost of services to commerce and industry, including the cost of conveyance, treatment and disposal and, maintenance and repair of damage to the sewerage system.
5. Sustainably Manage Water Resources to protect the environment and provide reliable, least cost supply	5.1 Maximise efficient use of water through demand management measures and water saving devices. (Water conservation measures to target daily consumption of less than 200L/p/day as per SEQ Water Supply Strategy)
	5.2 Use water that's 'fit for purpose' i.e. using a quality of water no better than what is required (e.g. alternative source of water for landscape irrigation, toilet flushing, industry, construction).
	5.3 Investigate opportunities to use alternative water sources such as ground water, recycled water and stormwater (EPP Water s19).
6. Safeguard the community and increase resilience to the impacts of Flooding & Storm Tide	6.1 Manage flood and storm tide risk to the community and property.

5.2 Development of Solutions

Solutions were developed to address the key water cycle management issues identified in each catchment (i.e. those issues identified as having high to extreme risks). In developing the solutions, all possible solutions were identified to address the issues at a conceptual level without regard to practicality or costs to ensure that all possible outcomes were considered. Previous Council planning studies were also reviewed to ensure actions contained in these studies were broadly represented in the solutions developed for addressing the identified water management issues. The solutions developed ranged from centralised to decentralised initiatives and incorporated both conventional and innovative ideas to ensure a variety of solutions were put forward for review in each catchment.

A workshop with key stakeholders was facilitated on 24 July 2012 to review the solutions for each catchment and identify the following:

1. New solutions to be considered.
2. Solutions to be removed, and justification for removal (i.e. high risks or not meeting the TWCM objectives).

The solution workshop did not remove many solutions, however it did allow a greater appreciation of the opportunities for solutions to be implemented in each catchment, and identified a number of additional solutions to be considered in future detailed planning. A description of each solution identified during the workshop is provided in Appendix E.

5.3 Recommended Solution Sets for Detailed Planning

The costs and benefits associated with implementing the solutions nominated for each catchment were broadly evaluated using information from existing Council planning studies and literature values. The information collated was used to make a qualitative performance assessment of the costs and benefits of each solution, which is detailed in the following section. Further information on the documented costs and benefits of solutions in each catchment is included in Appendix F.

Solution sets selected for further detailed planning in each catchment are outlined in the tables in the following sections. It is noted that detailed planning will be required to further evaluate the costs and benefits of the nominated solutions, so that the preferred least cost solutions can be selected to address the key water cycle management issues identified. However, the key solutions from each solution set have been identified and are briefly described. The key solutions have been identified as a result of the following:

- Stakeholder consultation during the solutions workshop
- Solutions that were identified to have a high overall level of performance from the broad assessment of costs and benefits
- Solutions that are required to address key TWCM issues and legislative requirements of the EPP Water.

An outline of the options available to Council for assessing solutions during the detailed planning stage (e.g. Multi Criteria Analysis/Least Cost Planning), and suggested assessment criteria for use is included in Appendix G.

5.3.1 Solutions Applicable to All Catchments

A number of the key solutions identified were noted to be applicable to all catchments. These solutions have been identified in this section to recognise their additional importance in addressing key water cycle management issues on a catchment wide basis, and to avoid repetition in later sections of this report. Table 5-3 to Table 5-1 should be referred to for an outline of the below solution's performance in each catchment.

Key solutions applicable to all catchments to address key TWCM issues are briefly described below. Refer to Appendix E for a more detailed solution description.

- Develop a business case for healthy waterways to support the implementation of solutions
- Monitoring to evaluate effectiveness of management solutions. Currently Council undertakes ambient monitoring of freshwaters as part of its waterway recovery reporting. It is intended that this program be continued and expanded on once solutions are implemented, so that the effectiveness of solutions can be reviewed. This will assist to identify the effectiveness of individual solutions, and also monitor how the implemented actions are progressing towards meeting target WQOs, fulfilling requirements of the EPP Water.
- Integrate WSUD into government capital infrastructure works e.g. road/ park upgrades
- Develop and implement an improved waterway health asset management system (e.g. appropriate management of stormwater treatment devices)
- Investigate sources of hot spot pollution and identify targeted treatment strategies
- Education & /or capacity building and investment in incentive schemes to support other solutions
- Education & Capacity Building Campaigns to Address Flooding and Storm Tide Issues. Three separate educational campaigns were put forward to address flooding and storm tide issues, including:
    - Mapping made available to public
    - Notes on rates
    - Install historical flood marks/signs

  It was noted that the above campaigns would be used as a positive educational experience and should not be alarmist.
- Improved marketing around TWCM initiatives
- Improved connectivity to waterways through education & participation in waterway improvement projects. In particular the workshop identified that the Cleveland catchment would provide a good opportunity to do this, through revitalisation works.
- Increase / re-prioritise the allocation of funding, through a variety of possible measures, to assist in the implementation of TWCM solutions. This was identified to be a politically sensitive issue, however it was noted during the solutions workshop (using previous experience from the outcomes of MBRC's TWCM planning project) that the cost to protect waterway health is not anticipated to be much greater than current costs.
- Investigations to more accurately define population growth for future planning purposes. This solution was identified during workshops as it was raised that population projections have been

greater than actual growth. It was identified as being important to be able to appropriately plan for and address the issue of population growth in the Redlands region. In particular, this solution relates to those catchments with population growth pressures.

- Management of wet weather overflows. A number of solutions were identified as having a good potential to address this issue, including:
    - Improved prevention of illegal stormwater inflow connections to sewer
    - Pump station EMPs / upgrades to reduce likelihood of wet weather overflow
    - Sewerage upgrades to improve storage/conveyance of wet weather flows
    - Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation of existing sewers, and use of smart sewers in greenfield development)
- Inspections and improved management of septic and on site wastewater treatment systems. This solution may assist to improve water quality as there are a number of septic and on site wastewater treatment systems in the Redlands, and appropriate maintenance has been identified as an issue. It was noted at a late stage in this study, that recent investigations have also found properties with septic or on site treatment systems within the Redlands sewerage catchments (i.e. they have access to centralised sewerage infrastructure). These properties should be connected to the sewer, with septic / on site systems decommissioned. It was also noted that this issue extends to all catchments, however the highest risk catchments include SMBIs, North Stradbroke Island, and Upper Tingalpa Catchment (the later both water supply catchments).

Previous detailed planning studies and documents applicable to total water cycle management planning in the Redlands region are also outlined briefly below:

- *Storm Tide Hazard Study* (Cardno, 2011). This study has been undertaken for the Redlands Region, to identify the risk associated with the possibility of extreme storm tides used in long-term town planning and emergency response needs. Results have been mapped, and the potential impacts of climate change have been considered.
- *Catchment Prioritisation and Mapping of Riparian Soils and Landforms for Redland City (Mainland)* (Hydrobiology, 2009). Also referred to as 'creek functional unit mapping' this study investigated and mapped riparian landform and soils for mainland catchments to identify key issues and prioritise catchments for future management and rehabilitation actions. Broad management strategies were recommended in relation to the following 3 categories:
    - Protect, enhance and restore riparian zones
    - Protect, enhance and restore waterway geomorphic and ecological processes
    - Protect, enhance and restore water quality.

Table 5-2 summarises the catchment priority ranking outcomes of the study. It is noted that the study has only been undertaken for mainland catchments, and it is recommended that the study be replicated to include the island catchments.

Table 5-2 Catchment Management Priority Rankings for Redland City (Hydrobiology, 2009)

TWCM Planning Catchment	Creek Functional Mapping Catchment	Priority
South Eastern Creeks	Southern Redland Bay (including Weinam Creek)	High
Cleveland & Thornlands	Cleveland	High
Tarradarrapin	Tarradarrapin	High
Lower Tingalpa	Lower Tingalpa and Coolnwynpin Creek	High
South Eastern Creeks	Moogurrapum	High
Eprapah Creek	Eprapah Creek	High
Hilliards Creek	Hilliards Creek	Medium
Cleveland & Thornlands	Thornlands	Medium
Southern Creeks	Native Dog Creek	Medium
Southern Creeks	California Creek	Low
Southern Creeks	Serpentine Creek	Low
Upper Tingalpa Creek	Upper Tingalpa Creek	Low

- *Trade Waste Policy and Environmental Management Plan (Redland Shire Council, 2004)*. The purpose of this document is to provide guidance on how RCC's liquid waste disposal service for domestic, commercial and industrial waste is provided in accordance with the principles of environmental sustainability and in a manner which safeguards public health and is consistent with Redland Water & Waste's responsibilities and obligations under Queensland legislation. Key objectives outlined in the plan are to be achieved through a combination of policy instruments, including:
    - Sewer admission limits (acceptable concentration limits for sewerable wastes). Effluent improvement programs may also be required for all Category 2 (i.e. high strength and volume) trade waste generators.
    - Conditional trade waste approvals (permits and agreements)
    - "User pays" pricing
- *Water Netserv Plan.* This document is currently being developed by Redland Water, and will address TWCM planning requirements for sewage management (including biosolids and sewerage system overflows) and trade waste management.

5.3.2 Tarradarrapin Creek Catchment

The solutions identified to address TWCM issues in Tarradarrapin Creek catchment are outlined in Table 5-3. Table 5-3 also includes a high level performance assessment of the costs and benefits of implementing each solution, in addition to an overall assessment of the solutions performance (refer to Appendix F for further details on costs and benefits).

The key relevant previous planning studies that have been undertaken for this catchment include:

- *Flood Risk Assessment Study for Tarradarrapin Creek West Branch* (JWP, 2005). This study has identified that "*a significant proportion of the study area is at risk from flooding, including key road crossings and numerous allotments*". It recommended that results be used investigate

potential flood mitigation options in further detail. It is noted, however, that the risk assessment undertaken by RCC did not identify flooding as a high risk issue in this catchment.

- *Catchment Prioritisation and Mapping of Riparian Soils and Landforms for Redland City (Mainland)* (Hydrobiology, 2009). This study identifies Tarradarrapin Creek catchment as a **high priority** catchment for management actions.

Of note, no Integrated Waterway Management Plan (IWMP) has been developed for this catchment. However, its development has been identified as a high priority by Council (RCC Waterway Recovery Policy Action Plan 2012). Currently, Council has a record of a number of GPTs surrounding Sovereign Waters Estate (Wellington Point) that treat runoff prior to entering the lake. It also has a record of a number of GPTs and two bioretention systems in Birkdale, that treat stormwater prior to discharging to the western branch of Tarradarrapin Creek.

Key solutions from the catchment solution set presented in Table 5-3 are briefly described below:

- **Stormwater harvesting for Public Open Space (POS) irrigation at Judy Holt Park.** This solution was identified as a potential 'breakthrough project' for stormwater harvesting in the Redlands, and addresses requirements of the EPP Water to investigate opportunities for stormwater harvesting. The solution would assist to improve waterway health in the catchment, which has been identified as a key management issue, while also meeting other TWCM objectives (e.g. using water that's fit for use). Current water quality (from Council's monitoring program) indicates generally fair water quality, with some hot spots located around and immediately downstream of the proposed stormwater harvesting site. Hence the use of such a scheme may improve water quality in Tarradarrapin Creek.
- **WSUD Retrofit.** As Tarradarrapin Creek catchment is a fully urbanised catchment with limited existing water quality treatment devices, this solution was nominated as a key solution to address waterway health. It is noted that while the solution is likely to be expensive, it also has potential to greatly improve water quality and waterway health. Furthermore, significant capital cost savings could be achieved if WSUD retrofit was undertaken in combination with capital works upgrades (identified as a separate solution in Table 5-3), although the benefits would depend on the extent of capital works undertaken and hence the opportunities to integrate WSUD.
- **Active Extension Programs Idea: Rain gardens in backyards.** This solution may provide a cost effective method of targeting stormwater in existing urban areas to improve waterway health.
- **Improved landfill leachate management & treatment systems.** This solution is required to address the issue of landfill leachate generation and treatment issues in the catchment. Significant cost savings may be achieved through avoided transportation and treatment costs (at facilities external to RCC). It is noted that a Landfill Leachate Management Options and Viability Study has been commissioned to investigate the best options for addressing this issue, and the results of this study should be used to guide further actions.
- **Storm tide mitigation investigations and/or works implemented.** A significant issue identified in this catchment is the potential for sewerage infrastructure to be affected by storm tide inundation, and potential implications on water quality if infrastructure is compromised. This solution entails undertaking detailed planning studies to further investigate the implications of

storm tide on sewerage infrastructure in the catchment, and identify appropriate mitigation measures to be implemented.

- **Constraints on future development**. This solution was identified to ensure future development is not constructed on land subject to flooding / storm tide inundation. As Tarradarrapin catchment is fully urbanised, the solution would be applicable to prevent redevelopment in these areas.

As Tarradarrapin catchment is fully urbanised, and only minor increases to pollutant flows and loads are expected in the future, conditions are not likely to worsen significantly with a business as usual approach. However, considering existing conditions highlight a number of water quality hot spots in the catchment, and the catchment drains to HEV waters (Waterloo Bay) and RAMSAR listed wetlands of international significance (Tarradarrapin Wetland and Moreton Bay Marine Park), solutions are required to work towards improving current conditions to meet WQOs and protect Environmental Values.

Table 5-3 Tarradarrapin Catchment TWCM Solutions

Solution	Water Cycle Management Issue Addressed								High Level Performance Assessment		
	Deterioration of Waterway Health	Potential to Impact to Environmentally Sensitive Waters	Population Growth	Sewage Treatment Plant Capacity Constraints	Water Supply Constraints	Flooding and Storm Tide	Landfill Leachate	Sewage Overflows	Cost Perf.	Benefits	Priority Rating
Waterway Rehabilitation											
Rehabilitation of waterways - Riparian buffer zones (private land)	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - Habitat restoration (Council land)	✓	✓	✓						Medium	Low	Medium
Rehabilitation of waterways - Bank Stability Works	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - In-Stream Improvement works	✓	✓	✓						Medium	Medium	Medium
Increased riparian protection for waterways (buffer/waterway corridor widths)	✓	✓	✓						High	Low	Medium
Identify and prioritise waterway fish barrier locations	✓	✓							Low	Medium	Medium
Monitoring to evaluate effectiveness of management solutions	✓	✓	✓						Medium	High	High
Diffuse Pollution Management											
Increased implementation / enforcement of E&SC management practices	✓	✓	✓						High	Low	Medium
Integrate WSUD into government capital infrastructure works	✓	✓							High	Medium	High
Improved waterway health asset management system	✓	✓	✓						High	High	High
Future development to achieve better than SPP Water requirements (for WSUD)	✓	✓	✓						Low	Low	Low
Water Sensitive Urban Design Retrofit (beyond capital infrastructure works)	✓	✓							Low	High	Medium
Pollutant Hot Spot Management											
Rehabilitation of poorly performing water bodies	✓	✓							Medium	Medium	Medium
Improved landfill leachate management & treatment systems	✓	✓					✓		Medium	High	High
Investigate sources of hot spot pollution & identify targeted treatment strategies	✓	✓							High	Medium	High
Education & Capacity Building	✓	✓									
Education & /or capacity building and investment in incentive schemes	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Active Extension Programs Idea: Rain gardens in backyards	✓	✓	✓						High	Medium	High
Improved marketing around TWCM initiatives	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	✓	✓			✓				Low	High	Medium
Improved connectivity to waterways through education & participation in waterway improvement projects	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Education campaign to address flooding and storm tide issues - Mapping made available to public						✓			High	Medium	High
Education campaign to address flooding and storm tide issues - Include notes on rates						✓			High	Medium	High
Education campaign to address flooding and storm tide issues - Install historical flood marks/signs						✓			High	High	High
Water Supply & Demand Management											
Stormwater harvesting for Public Open Space	✓	✓	✓		✓				Medium	Medium	Medium
Sewerage											
Improve prevention of illegal stormwater inflow connections to sewer	✓	✓	✓					✓	Medium	Medium	Medium
Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	✓	✓						✓	Medium	Medium	Medium
Sewerage upgrades to improve storage/conveyance of wet weather flows	✓	✓						✓	Low	Medium	Medium
Reduction of wet weather infiltration (through rehabilitation/smart sewers)	✓	✓						✓	Low	Medium	Medium
Investigate wastewater infrastructure rates charged on mains water consumption basis	✓	✓						✓	High	Low	Medium
Flooding & Storm Tide											
Flood mitigation investigation/works implemented (western branch Tarradarrapin Creek)						✓			Low	High	Medium
Constraints on future land development to address flooding and storm tide issues			✓			✓			High	High	High
Funding to Implement Solutions											
Develop business case for healthy waterways to support solutions	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Increase / re-prioritise funding to support TWCM solutions	✓	✓	✓	✓	✓	✓	✓	✓	Medium	High	High

Note: TWCM Issues that are not relevant to this catchment are shaded in grey.

5.3.3 Hilliards Creek

The solutions identified to address TWCM issues in Hilliards Creek catchment are outlined in Table 5-4. Table 5-4 also includes a high level performance assessment of the costs and benefits of implementing each solution, in addition to an overall assessment of the solutions performance (refer to Appendix F for further details on costs and benefits).

The key relevant previous planning studies that have been undertaken for this catchment include:

- *Hilliards Creek Catchment Management Plan* (JWP, 2007). This study investigated flooding, water quality and waterway management issues in the catchment. A number of flood mitigation works, including road and culvert upgrades were recommended. It also presented a number of waterway rehabilitation works to be undertaken on both private and public owned land. For water quality, a number of opportunities were identified to retrofit GPTs, wetlands and bioretention basins on Council owned land, however these measures did not achieve water quality objectives (WQOs). Constraints were noted for retrofitting end of pipe solutions in the catchment, however it was acknowledged that further investigations to retrofit streetscape WSUD (providing 'at source' treatment) should be investigated to work towards meeting WQOs.
- *Redland Water Wastewater Treatment Plant Strategy to 2025* (Water Strategies, 2011). The report identified that Cleveland STP is currently performing well. It noted that the current STP licence is provisional and that DERM had requested an investigation of the impacts of effluent discharges on Hilliards Creek. Since this study was undertaken, licence negotiations have indicated that load limits for nutrients are likely to be set at current loads, and therefore reuse may be required to meet these licence requirements. **Key recommendations that should be addressed include:**
    - Undertake further studies to determine the best option for water recycling
    - Investigate the impacts on water quality in Hilliard's Creek for current and increased plant loading
    - Investigate the sustainability of on-site irrigation reuse
    - Investigate the possibility of installing a solar dryer at Cleveland to service all plants, and reduce the generation of biosolids.
- *Reuse at Concrete Plants - Cleveland Industrial Estate Concept Report* (KBR, 2007). This report followed on from earlier investigations identifying potential cost effective opportunities to reuse recycled water. The report concluded that four concrete batching facilities within the Cleveland industrial Estate could generate a demand of up to 102kL/day for recycled water. Five options were examined to supply recycled water to the concrete batching facilities. The cheapest option indicated a levelised cost of supply of approximately $9.35/kL ($2012).
- *Thornlands Total Water Cycle Management* (Redland Water, 2009). This investigation included review of an option to supply recycled water (from either Cleveland or Victoria Point STP) to the following developments via dual reticulation:
    - Kinross Road
    - South East Thornlands
    - Double Jump and Bunker Road residential developments

Another option included using recycled water for irrigating woodlots. This was the preferred option of the study, however the following limitations to the viability of this option have been identified during the current planning study:

- Thornlands Integrated Enterprise Area is no longer going ahead
- There is a land shortage for allocating woodlands

Furthermore, a review by Water Strategies (2011) identified that an upgrade to the Victoria Point STP may in fact be the preferred least cost solution to achieve TN licence conditions (at Victoria Point STP). However it is noted (from the current TWCM Planning study) that recycled water use from Cleveland STP may be required in the future (with Kinross Road and SET development pressures) to meet with new licence conditions that require a no worsening in pollutant loads to maintain the ecological health of Hilliards Creek**. Further detailed planning investigations are recommended to investigate the best option.**

- *Kinross Sewerage Options Study* (RW, 2010). This study identified the preferred sewerage collection system for the Kinross Road Development Area as option 3b, a gravity system with two pump stations. Option 3b gained the highest value for money. Despite having the highest value assessment (based on technical, environmental, economic and social criteria assessment), a dual reticulation reuse option (biolytix System) was not adopted due to the high NPV. As previously identified, it is recommended that further investigation of recycled water options be undertaken.
- *Kinross Road Structure Plan – Stormwater Infrastructure Concept Plan* (EnGenY, 2010). This report identifies flood mitigation requirements (detention basins) and water quality treatment infrastructure for the proposed Kinross Road development. For water quality, it recommends thirteen GPTs and bioretention basins to meet required pollutant load reduction targets. The stormwater quality and quantity requirements shown in the report have been used to inform the Priority Infrastructure Plan (PIP) as regional solutions, and are reflected as a schedule of works for the delivery of trunk infrastructure items.
- *Catchment Prioritisation and Mapping of Riparian Soils and Landforms for Redland City (Mainland)* (Hydrobiology, 2009). The study identified Hilliards Creek catchment as a **medium priority** catchment for management actions.

Currently, Council has no record of any vegetated treatment systems within the catchment. However a number of GPTs are known to exist, primarily in the Suburb of Ormiston, with a couple also located in Wellington Point and Alexandra Hills. A GPT also exists around the Cleveland industrial estate.

Key solutions from the catchment solution set presented in Table 5-4 are briefly described below:

- **WSUD Retrofit.** Existing urban development forms a significant proportion of Hilliards Creek catchment, and apart from GPTs, no water sensitive urban design initiatives are recorded to exist. This solution was nominated as a key solution to address poor waterway health. Hilliards Creek CMP (JWP, 2007) recommends a number of locations for large scale vegetated treatment systems, however greater treatment could be achieved through streetscape retrofit. Furthermore, significant capital cost savings could be achieved if WSUD retrofit was undertaken in combination with capital works upgrades, however the benefits would depend on the extent of capital works undertaken and hence the opportunities to integrate WSUD.

- **Active Extension Programs Idea: Rain gardens in backyards.** This solution may provide a cost effective method of targeting stormwater in existing urban areas to improve waterway health.
- **Recycled Water supplied to greenfield development areas, or for industrial use.** Using recycled water from the Cleveland STP was nominated as a key potential solution during the solution workshop. As discussed above, many studies have been undertaken on the feasibility of recycled water use, however further investigation needs to be undertaken to clarify the costs, benefits and legislative requirements of such schemes. Importantly, additional investigations should consider the implications of new licence conditions for Cleveland STP (likely limiting nutrient discharge to current loads), and improving / maintaining the ecological health of Hilliards Creek. A key gap in knowledge is the sustainable pollutant load that Hilliards Creek can assimilate, and further investigations are recommended to identify this.
- **Stormwater harvesting for dual reticulation (greenfield - Kinross Road).** This solution has potential to provide significant treatment of pollutant loads, particularly TSS, which Council monitoring identifies as a key pollutant of concern in freshwater reaches of Hilliards Creek. Furthermore, a stormwater harvesting scheme may assist to mitigate additional flow generated from the Kinross Road development, where it is anticipated that detention basins will be required. Opportunity also exists to use existing farm dams as storage areas. Stormwater harvesting has not been considered as an alternative source of supply in any of the detailed planning studies undertaken for this catchment, and should be considered to meet requirements of the EPP Water.
- **Rehabilitation of poorly performing water bodies**. A number of small water bodies exist in Hilliards Creek catchment. Poorly functioning water bodies may be contributing to poor water quality in this catchment, and may be a source of hot spot pollution. Council is currently finalising a management strategy that should be adopted for poorly performing water bodies.
- **Nutrient Trading.** Workshop participants identified that rural areas may be a major contributor of pollutant loads in this catchment. As such, nutrient trading was suggested as a possible way to fund solutions that target high pollutant loads in rural areas at low cost (e.g. in comparison to upgrading an STP to achieve similar treatment). This assists to facilitate the adoption of the most cost effective solution for treating pollutants. Prior to implementing, this solution would require more detailed investigation to quantify sustainable pollutant load targets for the catchment, sources of hot spot pollution, and establish the regulatory framework in consultation with key stakeholders.
- **Rural BMP for horticultural land - implementation of filter/buffer strips**. This solution may provide for cost effective removal of significant pollutant loads generated in rural areas. Further investigation to quantify potential pollutant load reduction and costs is required.
- **Increased implementation / enforcement of E&SC management practices.** This solution was identified to be of key value in this catchment due to significant future development pressures (Kinross Road). Furthermore, TSS has been identified as key pollutant of concern in Council's freshwater monitoring program.

EHMP and Council water quality monitoring indicates that EPP WQOs are currently not met in freshwaters or estuarine reaches of Hilliards Creek. Significant population growth is forecast in Hilliards Creek catchment, and if business continues as usual, this may result in a significant

worsening in current conditions. The solutions presented identify options to address existing issues and plan for minimising future impacts of development (e.g. through use of recycled water or stormwater, and improved erosion and sediment control practices). Although further detailed planning is required to confirm the best options to work towards meeting EPP WQOs (including determination of sustainable pollutant loads), it is anticipated that it would be possible to improve upon, or at least achieve a no worsening to existing conditions.

Table 5-4 Hilliards Creek Catchment TWCM Solutions

Solution	Water Cycle Management Issue Addressed								High Level Performance Assessment		
	Deterioration of Waterway Health	Potential to Impact to Environmentally Sensitive Waters	Population Growth	Sewage Treatment Plant Capacity Constraints	Water Supply Constraints	Flooding and Storm Tide	Landfill Leachate	Sewage Overflows	Cost Perf.	Benefits	Priority Rating
Waterway Rehabilitation											
Rehabilitation of waterways - Riparian buffer zones (private land) [1]	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - Habitat restoration (Council land only)[1]	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - Bank Stability Works[1]	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - In-Stream Improvement works[1]	✓	✓	✓						Medium	Medium	Medium
Increased riparian protection for waterways	✓	✓	✓						High	Medium	High
Identify and prioritise waterway fish barrier locations	✓	✓							Low	Medium	Medium
Monitoring to evaluate effectiveness of management solutions	✓	✓	✓						Medium	High	High
Diffuse Pollution Management											
Increased implementation / enforcement of E&SC management practices	✓	✓	✓						High	High	High
Rural BMP for horticultural land - implementation of filter/buffer strips	✓	✓							Medium	High	High
Integrate WSUD into government capital infrastructure works	✓	✓							High	Medium	High
Improved waterway health asset management system	✓	✓	✓						High	High	High
Future development to achieve better than SPP Water requirements (for WSUD)	✓	✓	✓						Medium	High	High
Naturalising land currently degraded by human activities	✓	✓	✓						Low	Medium	Medium
Water Sensitive Urban Design Retrofit (beyond capital infrastructure works)	✓	✓							Low	High	Medium
Pollutant Hot Spot Management											
BMP for poultry farms - EMP review	✓	✓							High	Medium	High
Rehabilitation of poorly performing water bodies	✓	✓							Medium	High	High
Investigate sources of hot spot pollution & identify targeted treatment strategies	✓	✓							High	High	High
Nutrient Trading	✓	✓	✓	✓					High	Medium	High
Education & Capacity Building											
Education & /or capacity building and investment in incentive schemes	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Active Extension Programs Idea: Rain gardens in backyards	✓	✓	✓						High	Medium	High
Improved marketing around TWCM initiatives	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	✓	✓			✓				Low	High	Medium
Improved connectivity to waterways through education & participation in waterway improvement projects	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Water Supply & Demand Management											
Stormwater harvesting for POS	✓	✓	✓		✓				Medium	Medium	Medium
Stormwater harvesting for dual reticulation (greenfield - Kinross Road)	✓	✓	✓		✓				Medium	High	High
Rainwater harvesting communal tanks (greenfield)	✓	✓	✓		✓				Low	Medium	Medium
Recycled water supplied to large industrial users (KBR, 2007)									Low	Medium	Medium
Recycled water irrigated to woodlots (Redland Water, 2009)	✓	✓	✓	✓	✓				Low	High	Medium
Recycled water supplied to urban users using Cleveland STP (dual reticulation) (Redland Water, 2009)									Low	High	Medium
Sewerage											
Provide sewerage infrastructure for unsewered areas	✓	✓	✓						Low	Medium	Medium
Inspections and improved management of septic and on site wastewater treatment systems	✓	✓	✓						High	Medium	High
Improve prevention of illegal stormwater inflow connections to sewer	✓	✓	✓					✓	Medium	Medium	Medium
Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	✓	✓						✓	Medium	Medium	Medium
Sewerage upgrades to improve storage/conveyance of wet weather flows	✓	✓						✓	Low	Medium	Medium
Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	✓	✓						✓	Low	Medium	Medium
Investigate wastewater infrastructure rates charged on mains water consumption basis	✓	✓						✓	High	Low	Medium
Development Control											
Cap on population growth	✓	✓	✓	✓	✓				Medium	High	High
Increased restrictions on development extent and intensity for proposed development areas	✓	✓	✓						Medium	High	High
Investigations to more accurately define population growth for future planning purposes	✓		✓	✓	✓				High	High	High
Funding to Implement Solutions											
Develop business case for healthy waterways to support solutions	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Increase / re-prioritise funding to support TWCM solutions	✓	✓	✓	✓	✓	✓	✓	✓	Medium	High	High

[1] Refer to solutions recommended in Hilliards Creek Rehabilitation Plan (JWP, 2007)

Note: TWCM Issues that are not relevant to this catchment are shaded in grey.

5.3.4 Cleveland and Thornlands

The solutions identified to address TWCM issues in the Cleveland and Thornlands catchment are outlined in Table 5-5. Table 5-5 also includes a high level performance assessment of the costs and benefits of implementing each solution, in addition to an overall assessment of the solutions performance (refer to Appendix F for further details on costs and benefits).

The key relevant previous planning studies that have been undertaken for this catchment include:

- *Thornlands flood and WQ assessment (*EnGenY 2011). This study has identified approximately 385 flood affected freehold properties within the Thornlands catchment during a 100 year ARI event, however it identified additional survey was required to determine whether floor level inundation of these houses occurred. Furthermore, although it was noted that a number of locations along both Redland Bay Road and Boundary Road were overtopped during the 100 year ARI event, modelling results suggested most major crossings complied with QUDM requirements for the 100 year ARI event. Only one crossing was identified not to be adequately sized (Lotus Close), and it was noted that upgrades were planned for this section of road. The water quality assessment identified only one location for a bioretention basin and significant constraints to implementing end of pipe water quality treatment devices in this catchment, and thus achieving water quality objectives. However it is noted that the study did not investigate the potential to retrofit streetscape design options treating stormwater 'at source', which would likely provide significant additional treatment opportunities. The study only investigated the Thornlands Catchment, and did not include the Cleveland catchment.
- *Catchment Prioritisation and Mapping of Riparian Soils and Landforms for Redland City (Mainland)* (Hydrobiology, 2009). This study identified the Cleveland sub catchment as a **high priority** catchment for management actions, however the Thornlands sub catchment was identified as a **medium priority**.

Of note, no Integrated Waterway Management Plan (IWMP) has been developed for the Cleveland sub catchment, however its development has been identified as a high priority by Council (RCC Waterway Recovery Policy Action Plan 2012). Currently, Council has a record of three GPTs in Cleveland subcatchment, with one vegetated swale and constructed wetland in the upper reaches of Ross Creek. Within the Thornlands subcatchment, a number of GPTs (Ecosol units) are installed around the upper catchment (downstream of intensive agriculture and park residential properties). It also has a record of three constructed wetlands and a couple of swales within the Thornlands subcatchment.

Key solutions from the catchment solution set presented in Table 5-5 are briefly described below:

- **Stormwater harvesting for Public Open Space (POS) irrigation - Redland Showgrounds and Pinklands Sporting Fields.** These sites were identified as potential 'breakthrough projects' for stormwater harvesting in the Redlands. Further detailed studies regarding their feasibility would address requirements of the EPP Water to investigate opportunities for stormwater harvesting. The solution is anticipated to improve waterway health in the catchment, which has been identified as a key management issue, while also meeting other TWCM objectives (e.g. using water that's fit for use). Current water quality (from Council's monitoring program) indicates TN as the key parameter of concern, with a hot spot located in Ross Creek downstream of the proposed showground stormwater harvesting site. Hence the use of such a

scheme has potential to significantly improve water quality in Ross Creek, as well as the water quality discharging to Moreton Bay.

- **WSUD Retrofit.** As the catchment is largely urbanised, with limited existing water quality treatment devices, this solution was nominated as a key solution to address waterway health, particularly in the Cleveland sub catchment (Ross Creek). The catchment was identified as a classic fast response urban catchment, which needs WSUD to concentrate on promoting retention and slowing flows. It was nominated that streetscape WSUD (such as bioretention systems/ rain gardens) would work best, and that opportunity exists to undertake retrofit works during the CBD revitalisation works. This, in combination with other works undertaken during capital works upgrades, would make retrofit much more cost effective. The benefits, however, would depend on the extent of capital works undertaken and hence the opportunities to integrate WSUD.
- **Active Extension Programs Idea: Rain gardens in backyards.** This solution may provide a cost effective method to achieve WSUD retrofit in the catchment and target stormwater quality in existing urban areas to improve waterway health. It also promotes community education, land stewardship and connectivity to local waterways.
- **Waterway Rehabilitation.** It was noted that some of the waterways within this catchment (on both private property and Council land) nominated to be in poor or very poor condition are also located on alluvial soils with high nutrient export potential (Hydrobiology, 2009). Therefore this solution was recognised as potentially achieving significant water quality benefits through stabilising these high nutrient soils.
- **Increased implementation / enforcement of E&SC management practices.** This solution was identified to be of key value in this catchment due to significant future development pressures (South East Thornlands). Furthermore, TSS has been identified as key pollutant of concern in Council's freshwater monitoring program.

As Cleveland and Thornlands catchment is largely urbanised, only small increases to stormwater flows and pollutant loads are expected in the future, and conditions are not likely to worsen significantly with a business as usual approach. However, considering current monitoring indicates poor TN and water quality hot spots within the catchment, and the catchment drains to Moreton Bay, solutions are required to work towards improving current conditions to meet WQOs and protect Environmental Values. The proposed solutions have the potential to significantly improve upon current water quality, and work towards achieving WQOs.

Table 5-5 Cleveland and Thornlands Catchment TWCM Solutions

Solution	Water Cycle Management Issue Addressed								High Level Performance Assessment		
	Deterioration of Waterway Health	Potential to Impact to Environmentally Sensitive Waters	Population Growth	Sewage Treatment Plant Capacity Constraints	Water Supply Constraints	Flooding and Storm Tide	Landfill Leachate	Sewage Overflows	Cost Perf.	Benefits	Priority Rating
Waterway Rehabilitation											
Rehabilitation of waterways - Riparian buffer zones (private land)	✓	✓	✓						Medium	High	High
Rehabilitation of waterways - Habitat restoration (Council land)	✓	✓	✓						Medium	High	High
Rehabilitation of waterways - Bank Stability Works	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - In-Stream Improvement works	✓	✓	✓						Medium	Medium	Medium
Increased riparian protection for waterways (buffer/waterway corridor widths)	✓	✓	✓						High	Medium	High
Identify and prioritise waterway fish barrier locations	✓	✓							Medium	Low	Medium
Monitoring to evaluate effectiveness of management solutions	✓	✓	✓						Medium	High	High
Diffuse Pollution Management											
Increased implementation / enforcement of E&SC management practices	✓	✓	✓						High	High	High
Rural BMP for grazing land - fencing off stock & revegetation around 1st & 2nd order streams	✓	✓				✓			Medium	Medium	Medium
Rural BMP for horticultural land - implementation of filter/buffer strips	✓	✓							Medium	Medium	Medium
Integrate WSUD into government capital infrastructure works e.g. road/ park upgrades	✓	✓							High	Medium	High
Improved waterway health asset management system	✓	✓	✓						High	High	High
Future development to achieve better than SPP Water requirements (for WSUD)	✓	✓	✓						Low	Medium	Medium
Naturalising land currently degraded by human activities	✓	✓	✓						Low	Medium	Medium
Water Sensitive Urban Design Retrofit (beyond capital infrastructure works)	✓	✓							Low	High	Medium
Pollutant Hot Spot Management											
BMP for poultry farms - EMP review	✓	✓							High	Low	Medium
Rehabilitation of poorly performing water bodies	✓	✓							Medium	Medium	Medium
Investigate sources of hot spot pollution & identify targeted treatment strategies	✓	✓							High	High	High
Education & Capacity Building											
Education & /or capacity building and investment in incentive schemes	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Active Extension Programs Idea: Rain gardens in backyards	✓	✓	✓						High	Medium	High
Improved marketing around TWCM initiatives	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	✓	✓			✓				Low	High	Medium
Improved connectivity to waterways through education & participation in waterway improvement projects	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Education campaign to address flooding and storm tide issues - Mapping made available to public						✓			High	Medium	High
Education campaign to address flooding and storm tide issues - Include notes on rates						✓			High	Medium	High
Education campaign to address flooding and storm tide issues - Install historical flood marks/signs						✓			High	High	High
Water Supply & Demand Management											
Stormwater harvesting for POS	✓	✓	✓		✓				Medium	High	High
Sewerage											
Inspections and improved management of septic and on site wastewater treatment systems	✓	✓	✓						High	Medium	High
Improve prevention of illegal stormwater inflow connections to sewer	✓	✓	✓					✓	Medium	Medium	Medium
Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	✓	✓						✓	Medium	Medium	Medium
Sewerage upgrades to improve storage/conveyance of wet weather flows	✓	✓						✓	Low	Medium	Medium
Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	✓	✓						✓	Low	Medium	Medium
Investigate wastewater infrastructure rates charged on mains water consumption basis	✓	✓						✓	High	Low	Medium
Flooding & Storm tide											
Flood mitigation investigation/works implemented						✓			Low	High	Medium
Funding to Implement Solutions											
Develop business case for healthy waterways to support solutions	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Increase / re-prioritise funding to support TWCM solutions	✓	✓	✓	✓	✓	✓	✓	✓	Medium	High	High

Note: TWCM Issues that are not relevant to this catchment are shaded in grey.

5.3.5 Eprapah Creek

The solutions identified to address TWCM issues in Eprapah Creek catchment are outlined in Table 5-6. Table 5-6 also includes a high level performance assessment of the costs and benefits of implementing each solution, in addition to an overall assessment of the solutions performance (refer to Appendix F for further details on costs and benefits).

The key relevant previous planning studies that have been undertaken for this catchment include:

- *Eprapah Creek Waterway Management Plan* (City Design, 2004). This study investigated waterway health of Eprapah creek and its two key tributaries, Sandy Creek and Little Eprapah Creek. Flooding was not investigated in any detail, however it was noted that flooding was identified as a relatively low priority in the Eprapah Creek Catchment. The study recommended appropriate waterway buffer widths, and presented an action plan based around seven broad waterway management strategies. Approximately 90% of the recommended actions have been commenced or completed, working towards improving creek health (RCC, 2010).
- *Redland Water Wastewater Treatment Plant Strategy to 2025* (Water Strategies, 2011). The report identified that Victoria Point STP is currently performing well and that the plant may be expected to reach its licenced effluent load limit for total nitrogen of 13.5 kg/d between 2015 and 2022. The report suggests that the preferred strategy for meeting this licence requirement would be an upgrade of the STP, which was costed by GHD to be approximately $5.2 million, with only marginal increases to operating costs and energy use. It was identified that this alternative would be better than the recommended option to irrigate woodlands that was presented in the study by Redland Water (2009) (refer below). Further investigation is required to determine the best option for meeting licence requirements and protecting receiving water quality. The report also recommended a number of STP improvement works that should be undertaken, and that Redland Water have planned for in capital works upgrades.
- *Thornlands Total Water Cycle Management* (Redland Water, 2009). This investigation included review of an option to supply recycled water (from either Cleveland or Victoria Point STP) to the following developments via dual reticulation:
    - Kinross Road
    - South East Thornlands
    - Double Jump and Bunker Road residential developments

  Another option included using recycled water for irrigating woodlots. This was the preferred option of the study, however the following limitations to the viability of this option have been identified during the current planning study:
    - Thornlands Integrated Enterprise Area is no longer planned to proceed
    - There is a land shortage for allocating woodlands

  Furthermore, a review by Water Strategies (2011) identified that an upgrade to the Victoria Point STP may in fact be the preferred least cost solution to achieve TN licence conditions (at Victoria Point STP). **Further detailed planning investigations are recommended to investigate the best option.**

- *Southeast Thornlands Structure Plan – Stormwater Infrastructure Concept Plan* (EnGenY, 2010). The report identifies stormwater quantity and quality trunk infrastructure requirements, associated costs and infrastructure charges for the proposed South East Thornlands development area. The stormwater quality treatment train proposed to meet load based WQOs includes five GPT'S, six bioretention systems and two wetlands. The stormwater quality and quantity requirements shown in the report have been used to inform the PIP as regional solutions, and are reflected as a schedule of works for the delivery of trunk infrastructure items.
- *Fish Barrier Assessment Guidelines: a case study in Eprapah and Hilliards Creeks* (Hoolihan, 2010). This study identifies the location of significant fish barriers in Eprapah Creek, and recommends remediation strategies to address them.
- *Catchment Prioritisation and Mapping of Riparian Soils and Landforms for Redland City (Mainland)* (Hydrobiology, 2009). The study identified Eprapah Creek catchment as a high priority catchment for management actions

Currently, Council has no record of any vegetated treatment systems within the catchment. However ten GPTs are known to exist, primarily around Victoria Point, with one also located in Thornlands.

Key solutions from the catchment solution set presented in Table 5-6 are briefly described below:

- **Increased implementation / enforcement of E&SC management practices.** This solution was identified to be of key value in this catchment due to significant future development pressures (South East Thornlands, Bunker Road and Double Jump Road development areas). Furthermore, TSS has been identified as key pollutant of concern in Council's freshwater monitoring program.
- **Active Extension Programs Idea: Rain gardens in backyards.** This solution may provide a cost effective method of targeting stormwater in existing urban areas to improve waterway health.
- **Recycled Water.** Using recycled water from the Victoria STP was nominated as a key potential solution during the solution workshop. As discussed above, many studies have been undertaken on the feasibility of recycled water use, however further investigation needs to be undertaken to clarify the costs, benefits and legislative requirements of such schemes.
- **Improved Nutrient Treatment at Victoria Point STP.** Rather than using recycled water, previous studies have suggested that an upgrade to Victoria Point STP may be the most cost effective method of meeting TN load licence conditions (Water Strategies, 2011). Additional dosing of chlorine may also provide a cost effective means of reducing TP loads, which constitutes a major proportion of total phosphorus loads in the catchment.
- **Stormwater harvesting for dual reticulation (greenfield – South East Thornlands, Bunker and Double Jump Road developments).** This solution has potential to provide significant treatment of pollutant loads, assisting to protect waterway health from future development pressures in the catchment. Stormwater harvesting has not been considered as an alternative source of supply in any of the detailed planning studies undertaken for this catchment, and should be considered to meet requirements of the EPP Water. Proposed treatment measures (i.e. bioretention basins and wetlands in the SET Structure Plan) could be used as part of the treatment strategy, and there is opportunity to use existing farm dams/ water bodies as storage areas (which may also assist in their rehabilitation strategy). The solution also provides other

significant benefits in terms of water supply and potential for community education and capacity building.

- **Investigate sources of hot spot pollution & identify targeted treatment strategies.** This solution was identified during the workshop to be important for addressing waterway health issues in the catchment. A number of hot spots have been recorded in this catchment, which require further investigation to identify and address the source. Monitoring indicates that rural areas may be contributing a significant source of pollutants, and in particular it was noted that water bodies (e.g. farm dams) and poultry farms may be the source of these hot spots. Therefore the following related solutions were also identified as having potentially high benefits:
    - BMPs for poultry farms – reviewing current farm practices and EMPs for improvement
    - Rehabilitation of poorly performing water bodies
- **Nutrient Trading.** Workshop participants identified that rural areas may be a major contributor of pollutant loads in this catchment, with water quality hotspots identified upstream of urban areas. As such, nutrient trading was suggested as a possible way to fund solutions that target high pollutant loads in rural areas at low cost (e.g. in comparison to upgrading an STP to achieve similar treatment).
- **Waterway Rehabilitation.** It was noted that some of the waterways within this catchment (on both private property and Council land) nominated to be in poor or very poor condition are also located on alluvial soils with high nutrient export potential (Hydrobiology, 2009). Therefore this solution was recognised as potentially achieving significant water quality benefits through stabilising these high nutrient soils. Additionally, a large proportion of waterways in poor and very poor condition are located on agricultural lands. As rural lands have been identified as a source of pollution in the catchment, rural best management practices to fence off waterways (from stock access) and rehabilitate riparian zones were rated highly in this catchment.
- **Cap on Population Growth.** This solution would reduce the current pressures on waterway health from planned future development in the catchment (SET, Bunker Road and Double Jump Road). However it is a politically sensitive option that may also have economic impacts on the region.

EHMP and Council water quality monitoring indicates that EPP WQOs are currently not met in freshwaters or estuarine reaches of Eprapah Creek, with Victoria Point STP having considerable influence to high nutrient loading in the estuary. Significant population growth is forecast in Eprapah Creek catchment, and if business continues as usual, this may result in a significant worsening in current conditions. The solutions presented identify options to address existing issues and plan for minimising future impacts of development (e.g. through improved erosion and sediment control practices and use of stormwater or recycled). Although further detailed planning is required to confirm the best options to work towards meeting EPP WQOs, it is anticipated that it would be possible to improve upon existing conditions. It is further noted that the EPP Water stipulates that water quality must be improved upon to work towards achieving the scheduled WQOs set for HEV receiving waters in the Western Bay (HEVa1284). Therefore management measures must be implemented to improve upon, rather than just maintain, current water quality from this catchment.

Table 5-6 Eprapah Creek Catchment TWCM Solutions

Solution	Water Cycle Management Issue Addressed								High Level Performance Assessment		
	Deterioration of Waterway Health	Potential to Impact to Environmentally Sensitive Waters	Population Growth	Sewage Treatment Plant Capacity Constraints	Water Supply Constraints	Flooding and Storm Tide	Landfill Leachate	Sewage Overflows	Cost Perf.	Benefits	Priority Rating
Waterway Rehabilitation											
Rehabilitation of waterways - Riparian buffer zones (private land)	✓	✓	✓						Medium	High	High
Rehabilitation of waterways - Habitat restoration (Council land)	✓	✓	✓						Medium	High	High
Rehabilitation of waterways - Bank Stability Works	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - In-Stream Improvement works	✓	✓	✓						Medium	Medium	Medium
Increased riparian protection for waterways (buffer/waterway corridor widths)	✓	✓	✓						High	Medium	High
Monitoring to evaluate effectiveness of management solutions	✓	✓	✓						Medium	High	High
Diffuse Pollution Management											
Increased implementation / enforcement of E&SC management practices	✓	✓	✓						High	High	High
Rural BMP for grazing land - fencing off stock & revegetation around 1st & 2nd order streams	✓	✓				✓			Medium	High	High
Rural BMP for horticultural land - implementation of filter/buffer strips	✓	✓							Medium	Medium	Medium
Integrate WSUD into government capital infrastructure works	✓	✓							High	Medium	High
Improved waterway health asset management system	✓	✓	✓						High	High	High
Future development to achieve better than SPP Water requirements (for WSUD)	✓	✓	✓						Low	High	Medium
Naturalising land currently degraded by human activities (e.g. tree planting in rural areas void of vegetation)	✓	✓	✓						Low	Medium	Medium
Pollutant Hot Spot Management											
BMP for poultry farms - EMP review	✓	✓							High	High	High
Rehabilitation of poorly performing water bodies	✓	✓							Medium	High	High
Investigate sources of hot spot pollution & identify targeted treatment strategies	✓	✓							High	High	High
Nutrient Trading	✓	✓	✓	✓					High	Medium	High
Education & Capacity Building											
Education & /or capacity building and investment in incentive schemes	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Active Extension Programs Idea: Rain gardens in backyards	✓	✓	✓						High	Medium	High
Improved marketing around TWCM initiatives	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	✓	✓			✓				Low	High	Medium
Improved connectivity to waterways through education & participation in waterway improvement projects	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Water Supply & Demand Management											
Stormwater harvesting for POS	✓	✓	✓		✓				Medium	Medium	Medium
Stormwater harvesting for dual reticulation (greenfield)	✓	✓	✓		✓				Low	High	Medium
Rainwater harvesting communal tanks (greenfield)	✓	✓	✓		✓				Low	Medium	Medium
Recycled water supplied to large agricultural/ industrial users.	✓	✓	✓	✓	✓				Medium	Low	Medium
Recycled water supplied to urban users (public open space)	✓	✓	✓	✓	✓				Low	Low	Low
Recycled water irrigated to woodlots	✓	✓	✓	✓	✓				Low	High	Medium
Recycled water supplied to urban users using Victoria Point STP (dual reticulation)	✓	✓	✓	✓	✓				Low	Medium	Medium
Sewerage											
Provide sewerage infrastructure for unsewered areas	✓	✓	✓						Low	High	Medium
Inspections and improved management of septic and on site wastewater treatment systems	✓	✓	✓						High	Medium	High
Improved nutrient treatment processes at Victoria Point STP	✓	✓		✓					Low	High	Medium
Improve prevention of illegal stormwater inflow connections to sewer	✓	✓	✓					✓	Medium	Medium	Medium
Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	✓	✓						✓	Medium	Medium	Medium
Sewerage upgrades to improve storage/conveyance of wet weather flows	✓	✓						✓	Low	Medium	Medium
Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	✓	✓						✓	Low	Medium	Medium
Investigate wastewater infrastructure rates charged on mains water consumption basis	✓	✓						✓	High	Low	Medium
Development Control											
Cap on population growth	✓	✓	✓	✓	✓				Medium	High	High
Increased restrictions on development extent and intensity for proposed development areas	✓	✓	✓						Medium	Medium	Medium
Investigations to more accurately define population growth for future planning purposes	✓		✓	✓	✓				High	High	High
Funding to Implement Solutions											
Develop business case for healthy waterways to support solutions	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Increase / re-prioritise funding to support TWCM solutions	✓	✓	✓	✓	✓	✓	✓	✓	Medium	High	High

Note: TWCM Issues that are not relevant to this catchment are shaded in grey.

5.3.6 South Eastern Creeks

The solutions identified to address TWCM issues in South Eastern Creeks catchment are outlined in Table 5-7. Table 5-7 also includes a high level performance assessment of the costs and benefits of implementing each solution, in addition to an overall assessment of the solutions performance (refer to Appendix F for further details on costs and benefits).

The key relevant previous planning studies that have been undertaken for this catchment include:

- *Native Dog Creek and Torquay Creek Integrated Waterways Planning Report* (EnGenY, 2010). This study investigated flooding, water quality and waterway health management issues in the Torquay Creek sub catchment, which forms part of the South Eastern Creeks catchment. Road upgrade works at Oakland Avenue and Serpentine Creek Road were recommended to provide adequate flood immunity. Recommended waterway buffer widths are identified to maintain ecosystem function, and management actions are proposed to achieve target waterway conditions. To achieve pollutant load based reduction targets for the ultimate development scenario, a treatment strategy incorporating riparian buffer zone rehabilitation, rainwater tanks, swales on rural roads, and bioretention devices (sized to be 1.5% of the catchment) was recommended. It is noted that this strategy includes retrofitting bioretention systems and encouraging the adoption of rainwater tanks in existing urban areas.
- *Moogurrapum Creek Catchment Management Plan* (JWP, 2007). This study investigated local flooding issues within the catchment and recommended a number of flood mitigation options be implemented. The study also developed a waterway rehabilitation plan including actions for weed removal, revegetation, pipe outlet protection and remediation of scouring and erosion. A water quality assessment recommended locations for six wetlands, three bioretention basins, two swales and two GPTs to improve water quality, however it was noted that load based reduction targets were not met, due to land constraints for locating large end of pipe devices.
- *Weinam Creek Catchment Conceptual Stormwater Management Plan* (GHD, 2006). This study investigated flooding within the Weinam Creek catchment, and identified a number of mitigation measures to resolve key problem areas identified. Locations for a number of GPTs, bioretention basins and wetlands were proposed to meet load based WQOs in the catchment. The plan also identified reaches of Weinam creek for rehabilitation and erosion control, and recommended a weed management plan be developed.
- *Catchment Prioritisation and Mapping of Riparian Soils and Landforms for Redland City (Mainland)* (Hydrobiology, 2009). The study identified South Eastern Creeks catchment as a **high priority** catchment for management actions.

Currently, Council has a record of a number of vegetated treatment systems within the catchment, including swales, wetlands and bioretention systems. These are located toward the north of the catchment in the subcatchments of Moogurrapum and Weinam Creeks. A number of GPTs are also noted to exist throughout the catchment. A few of the vegetated systems may have been implemented as a result of the recommendations from catchment management plans (GHD, 2006; JWP, 2007).

Key solutions from the catchment solution set presented in Table 5-7 are briefly described below:

- **Increased implementation / enforcement of E&SC management practices.** This solution was identified to be of key value in this catchment due to significant future development pressures around Weinam Creek and Double Jump Road. Furthermore, TSS has been identified as key pollutant of concern in Council's freshwater monitoring program.
- **Active Extension Programs Idea: Rain gardens in backyards.** This solution may provide a cost effective method of targeting stormwater in existing urban areas to improve waterway health.
- **Stormwater harvesting for dual reticulation (greenfield development around Double Jump Road and Weinam Creek).** This solution has potential to provide significant treatment of pollutant loads, assisting to protect waterway health from future development pressures in the catchment. Stormwater harvesting has not been considered as an alternative source of supply in any of the detailed planning studies undertaken for this catchment, and should be considered to meet requirements of the EPP Water.
- **Nutrient Trading.** Workshop participants identified that rural areas may be a major contributor of pollutant loads in this catchment, and that nutrient trading may be effective.
- **Waterway Rehabilitation.** It was noted that some of the waterways within this catchment (on both private property and Council land) nominated to be in poor or very poor condition are also located on alluvial soils with high nutrient export potential (Hydrobiology, 2009). Therefore this solution was recognised as potentially achieving significant water quality benefits through stabilising these high nutrient soils. Additionally, a large proportion of waterways in poor and very poor condition are located on agricultural lands with alluvial soils, therefore rural best management practices to fence off waterways (from stock access) and rehabilitate riparian zones were also rated highly in this catchment.
- **Rural BMPs horticultural land - implementation of filter/buffer strips.** A large area of intensive agricultural / horticultural land was identified in this catchment, and this solution was identified as potentially providing a cost effective means of improving water quality from these sites.
- **Constraints on future development.** This solution was identified to ensure future development is not constructed on land subject to flooding / storm tide inundation.
- **Increased riparian protection for waterways (buffer/waterway corridor widths)**. This solution was proposed to be beneficial due to future development pressures in the catchment, particularly around Weinam Creek. It is noted that riparian zones were identified in the Weinam Creek CMP (GHD, 2006) to be consistent with RCC's Planning Scheme, and were 60 m (40 m core riparian zone and 20 m outer riparian zone). At minimum these buffer zones should be adhered to.
- **Solutions for Pollutant Hot Spot Management.** Effective solutions to assist in addressing the likely cause of pollutant hot spots in the catchment were identified during the solutions workshop and costs and benefits assessment as follows:
    - BMPs for poultry farms – reviewing current farm practices and EMPs for improvement
    - Rehabilitation of poorly performing water bodies
    - Improved landfill capping /leachate management & treatment systems

- **Cap on Population Growth.** This solution would reduce the current pressures on waterway health from planned future development in the catchment around Double Jump Road and Weinam Creek. However it is a politically sensitive option that may also have economic impacts on the region.

  Council water quality monitoring indicates elevated concentrations of TSS and nutrients in freshwater reaches of the catchment, in addition to a number of identified pollutant hot spot locations. Significant population growth is forecast in South Eastern Creeks catchment, and if business continues as usual, this may result in a significant worsening in current conditions. The solutions presented identify options to address existing issues and plan for minimising future impacts of development. Although further detailed planning is required to confirm the best options to work towards meeting EPP WQOs, it is anticipated that it would be possible to improve upon, or at minimum maintain existing conditions.

Table 5-7 South Eastern Creeks Catchment TWCM Solutions

Solution	Water Cycle Management Issue Addressed								High Level Performance Assessment		
	Deterioration of Waterway Health	Potential to Impact to Environmentally Sensitive Waters	Population Growth	Sewage Treatment Plant Capacity Constraints	Water Supply Constraints	Flooding and Storm Tide	Landfill Leachate	Sewage Overflows	Cost Perf.	Benefits	Priority Rating
Waterway Rehabilitation											
Rehabilitation of waterways - Riparian buffer zones (private land)	✓	✓	✓						Medium	High	High
Rehabilitation of waterways - Habitat restoration (Council land)	✓	✓	✓						Medium	High	High
Rehabilitation of waterways - Bank Stability Works	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - In-Stream Improvement works	✓	✓	✓						Medium	Medium	Medium
Increased riparian protection for waterways (buffer/w'way corridor widths)	✓	✓	✓						High	Medium	High
Identify and prioritise waterway fish barrier locations	✓	✓							Low	Low	Low
Monitoring to evaluate effectiveness of management solutions	✓	✓	✓						Medium	High	High
Diffuse Pollution Management											
Increased implementation / enforcement of E&SC management practices	✓	✓	✓						High	High	High
Rural BMP for grazing land - fencing off stock & revegetation around 1st & 2nd order streams	✓	✓				✓			Medium	High	High
Rural BMP for horticultural land - implementation of filter/buffer strips	✓	✓							High	Medium	High
Integrate WSUD into government capital infrastructure works	✓	✓							High	Medium	High
Improved waterway health asset management system	✓	✓	✓						High	High	High
Future development to achieve better than SPP Water requirements (for WSUD)	✓	✓	✓						Low	High	Medium
Naturalising land currently degraded by human activities	✓	✓	✓						Low	Medium	Medium
Water Sensitive Urban Design Retrofit (beyond capital infrastructure works)	✓	✓							Low	Medium	Medium
Pollutant Hot Spot Management											
BMP for poultry farms - EMP review	✓	✓							High	High	High
Rehabilitation of poorly performing water bodies	✓	✓							Medium	High	High
Improved landfill leachate management & treatment systems	✓	✓					✓		Medium	High	High
Investigate sources of hot spot pollution & identify targeted treatment strategies	✓	✓							High	High	High
Nutrient Trading	✓	✓	✓	✓					High	Medium	High
Improved management of unsealed roads	✓	✓							Low	High	Medium
Education & Capacity Building											
Education & /or capacity building and investment in incentive schemes	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Active Extension Programs Idea: Rain gardens in backyards	✓	✓	✓						High	Medium	High
Improved marketing around TWCM initiatives	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	✓	✓			✓				Low	High	Medium
Improved connectivity to waterways through education & participation in waterway improvement projects	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Education campaign to address flooding and storm tide issues - Mapping made available to public						✓			High	Medium	High
Education campaign to address flooding and storm tide issues - Include notes on rates						✓			High	Medium	High
Education campaign to address flooding and storm tide issues - Install historical flood marks/signs						✓			High	High	High
Water Supply & Demand Management											
Stormwater harvesting for POS	✓	✓	✓		✓				Medium	Medium	Medium
Stormwater harvesting for dual reticulation (greenfield development around Weinam Creek)	✓	✓	✓		✓				Low	High	Medium
Rainwater harvesting communal tanks (greenfield development around Weinam Creek)	✓	✓	✓		✓				Low	Medium	Medium
Sewerage											
Provide sewerage infrastructure for unsewered areas	✓	✓	✓						Low	Medium	Medium
Inspections and improved management of septic and on site wastewater treatment systems	✓	✓	✓						High	Low	Medium
Improve prevention of illegal stormwater inflow connections to sewer	✓	✓	✓					✓	Medium	Medium	Medium
Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	✓	✓						✓	Medium	Medium	Medium
Sewerage upgrades to improve storage/conveyance of wet weather flows	✓	✓						✓	Low	Medium	Medium
Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	✓	✓						✓	Low	Medium	Medium
Investigate wastewater infrastructure rates charged on mains water consumption basis	✓	✓						✓	Medium	Low	Medium
Flooding & Storm tide											
Flood mitigation investigation/works implemented						✓			Low	High	Medium
Constraints on future development to address flooding & storm tide issues			✓			✓			High	High	High
Development Control											
Cap on population growth	✓	✓	✓	✓	✓				Medium	High	High
Increased restrictions on development extent and intensity for proposed development areas	✓	✓	✓						Medium	Medium	Medium
Investigations to more accurately define population growth for future planning purposes	✓		✓	✓	✓				High	High	High
Funding to Implement Solutions											
Develop business case for healthy waterways to support solutions	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Increase / re-prioritise funding to support TWCM solutions	✓	✓	✓	✓	✓	✓	✓	✓	Medium	High	High

Note: TWCM Issues that are not relevant to this catchment are shaded in grey.

5.3.7 Southern Creeks

The solutions identified to address TWCM issues in Southern Creeks catchment are outlined in Table 5-8. Table 5-8 also includes a high level performance assessment of the costs and benefits of implementing each solution, in addition to an overall assessment of the solutions performance (refer to Appendix F for further details on costs and benefits).

The key relevant previous planning studies that have been undertaken for this catchment include:

- *Native Dog Creek and Torquay Creek Integrated Waterways Planning Report* (EnGenY, 2010). This study investigated flooding, water quality and waterway health management issues in the Native Dog Creek sub catchment. The urban footprint in Southern Creeks catchment is contained within this sub catchment. The study investigated flooding, waterway health and water quality. It recommended a number of culvert and road upgrade works on Mount Cotton Road (owned by Department of Main Roads) and Heinemann Road to provide adequate flood immunity. The study also identified recommended waterway buffer widths to maintain ecosystem function, and proposes management actions to achieve target waterway conditions. To achieve pollutant load based reduction targets for the ultimate development scenario, a treatment strategy incorporating riparian buffer zone rehabilitation, rainwater tanks, swales on rural roads, and bioretention devices (sized to be 1.5% of the catchment) was recommended. It is noted that this strategy includes retrofitting bioretention systems and encouraging the adoption of rainwater tanks in existing urban areas.
- *Redland Water Wastewater Treatment Plant Strategy to 2025* (Water Strategies, 2011). The report identified that Mount Cotton STP is currently performing well. Minor operational improvement works were recommended. It identified that effluent is currently discharged to a holding pond at the Carbrook Golf Club, however there is little information available on how the effluent is managed on the golf course and what quantity is reused for irrigation. A key recommendation was that further investigation be carried out in regard to the current effluent disposal arrangements for the Mt Cotton STP.
- *Catchment Prioritisation and Mapping of Riparian Soils and Landforms for Redland City (Mainland)* (Hydrobiology, 2009). The study identified South Eastern Creeks catchment as a **low to medium priority** catchment for management actions. Native Dog Creek sub catchment was identified as the medium priority.

Currently, Council has a record of a number of vegetated treatment systems within the catchment, including swales and bioretention systems. These are located in urbanised areas of Mount Cotton, within the Native Dog Creek sub catchment. Two GPTs are also recorded in this area.

Key solutions from the catchment solution set presented in Table 5-8 are briefly described below:

- **Rural BMP for Grazing Land - Fencing off Stock and Revegetating 1st & 2nd Order Streams.** It was noted that a large proportion of waterways in poor or very poor condition (Hydrobiology, 2009) were located on grazing lands within this catchment. Additionally, waterways within Serpentine Creek Catchment (adjacent to the Logan River) were also identified to be on alluvial soils with high nutrient export potential (Hydrobiology, 2009). Therefore this solution was recognised as potentially achieving significant water quality benefits through stabilising these high nutrient soils.

- **Solutions for Pollutant Hot Spot Management.** Effective solutions to assist in addressing the likely cause of pollutant hot spots in the catchment were identified during the solutions workshop and costs and benefits assessment as follows:
    - BMPs for poultry farms – reviewing current farm practices and EMPs for improvement
    - Rehabilitation of poorly performing water bodies
    - Improved management of unsealed roads (as per EnGenY, 2010)
    - Restricting unauthorised 4WD access to waterways (e.g. through barriers/policing)

In addition to the above, the following solutions were identified for further investigation in order to meet requirements of the EPP Water:

- **Recycled Water (for POS or Agriculture).** This solution has potential to treat pollutant loads in addition to providing an alternative water supply source in accordance with fit for use principles. Currently some recycling may be undertaken for the Mount Cotton Golf course; however the details are unknown. Further investigations should be undertaken to investigate potential uses of recycled water from Mount Cotton STP.
- **Stormwater Harvesting.** Further investigation of stormwater harvesting opportunities should be undertaken within the Native Dog Creek catchment, particularly for POS irrigation. This would assist to provide treatment of stormwater in addition to providing a fit for use alternative water supply source.

There is some predicted future development within the Native Dog Creek sub catchment, therefore water quality can be expected to worsen slightly with a business as usual approach. Although further detailed planning is required to confirm the best options to work towards meeting EPP WQOs, it is anticipated that through implementing some of the suggested solutions, it would be possible to improve upon, or at minimum maintain existing conditions and Environmental Values. Furthermore, it was noted during the solutions workshop that additional studies should be undertaken to develop suitable WQOs appropriate for protecting environmental values in this catchment.

Table 5-8 Southern Creeks Catchment TWCM Solutions

Solution	Water Cycle Management Issue Addressed								High Level Performance Assessment		
	Deterioration of Waterway Health	Potential to Impact to Environmentally Sensitive Waters	Population Growth	Sewage Treatment Plant Capacity Constraints	Water Supply Constraints	Flooding and Storm Tide	Landfill Leachate	Sewage Overflows	Cost Perf.	Benefits	Priority Rating
Waterway Rehabilitation											
Rehabilitation of waterways - Implement recommendations from Native Dog Creek IWMP (EnGenY 2011)	✓	✓	✓						Medium	Medium	Medium
Increased riparian protection for waterways	✓	✓	✓						High	Low	Medium
Identify and prioritise waterway fish barrier locations	✓	✓							Low	Low	Low
Restrict unauthorised 4WD Access e.g. fencing/barriers	✓	✓							Medium	Medium	Medium
Policing unauthorised 4WD Access e.g. Cameras for access identification/ fines	✓	✓							Low	Low	Low
Develop localised WQOs for Native Dog and Serpentine Creeks	✓	✓							Medium	Medium	Medium
Investigations/monitoring to better define waterway health	✓	✓	✓						Medium	High	High
Monitoring to evaluate effectiveness of management solutions	✓	✓	✓						Medium	High	High
Diffuse Pollution Management											
Increased implementation / enforcement of E&SC management practices	✓	✓	✓						High	Low	Medium
Rural BMP for grazing land - fencing off stock & revegetation around 1st & 2nd order streams	✓	✓				✓			Medium	High	High
Rural BMP for horticultural land - implementation of filter/buffer strips	✓	✓							Medium	Low	Medium
Integrate WSUD into government capital infrastructure works e.g. road/ park upgrades	✓	✓							High	Medium	High
Improved waterway health asset management system	✓	✓	✓						High	Medium	High
Future development to achieve better than SPP Water requirements (for WSUD)	✓	✓	✓						Low	Low	Low
Naturalising land currently degraded by human activities	✓	✓	✓						Low	Medium	Medium
Implement Water Sensitive Urban Design Retrofit	✓	✓							Low	Medium	Medium
Pollutant Hot Spot Management											
BMP for poultry farms - EMP review	✓	✓							High	Medium	High
Rehabilitation of poorly performing water bodies	✓	✓							Medium	High	High
Investigate sources of hot spot pollution & identify targeted treatment strategies	✓	✓							High	High	High
Nutrient Trading	✓	✓	✓	✓					High	Low	Medium
Improved management of unsealed roads	✓	✓							Medium	High	High
Education & Capacity Building											
Education & /or capacity building and investment in incentive schemes	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Active Extension Programs Idea: Rain gardens in backyards	✓	✓	✓						High	Low	Medium
Improved marketing around TWCM initiatives	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	✓	✓			✓				Low	Medium	Medium
Improved connectivity to waterways through education & participation in waterway improvement projects	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Education campaign to address flooding and storm tide issues - Mapping made available to public						✓			High	Medium	High
Education campaign to address flooding and storm tide issues - Include notes on rates						✓			High	Medium	High
Education campaign to address flooding and storm tide issues - Install historical flood marks/signs						✓			High	High	High
Water Supply & Demand Management											
Stormwater harvesting for POS	✓	✓	✓		✓				Medium	Low	Medium
Recycled water supplied to large agricultural/ industrial users	✓	✓	✓	✓	✓				Medium	Medium	Medium
Recycled water supplied to urban users (public open space)	✓	✓	✓	✓	✓				Low	Medium	Medium
Recycled water disposed to land or irrigated to woodlots	✓	✓	✓	✓	✓				Medium	Medium	Medium
Sewerage											
Inspections and improved management of septic and on site wastewater treatment systems	✓	✓	✓						High	low	Medium
Improved nutrient treatment processes of STPs (Mt Cotton STP)	✓	✓		✓					Low	High	Medium
Improve prevention of illegal stormwater inflow connections to sewer	✓	✓	✓					✓	Medium	Medium	Medium
Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	✓	✓						✓	Medium	Medium	Medium
Sewerage upgrades to improve storage/conveyance of wet weather flows	✓	✓						✓	Low	Medium	Medium
Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	✓	✓						✓	Low	Medium	Medium
Investigate wastewater infrastructure rates charged on mains water consumption basis	✓	✓						✓	High	Low	Medium
Flooding & Storm tide											
Flood mitigation works implemented						✓			Low	High	Medium
Development Control											
Cap on population growth	✓	✓	✓	✓	✓				Medium	Medium	Medium
Funding to Implement Solutions											
Develop business case for healthy waterways to support solutions	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Increase / re-prioritise funding to support TWCM solutions	✓	✓	✓	✓	✓	✓	✓	✓	Medium	High	High

Note: TWCM Issues that are not relevant to this catchment are shaded in grey.

5.3.8 Upper Tingalpa

The solutions identified to address TWCM issues in the Upper Tingalpa Creek catchment are outlined in Table 5-9. Table 5-9 also includes a high level performance assessment of the costs and benefits of implementing each solution, in addition to an overall assessment of the solutions performance (refer to Appendix F for further details on costs and benefits).

The key relevant previous planning studies that have been undertaken for this catchment include:

- *Tingalpa Creek Waterway Management Plan* (City Design, 2003). This study was undertaken for the whole of Tingalpa Creek catchment, including the Lower Tingalpa Creek catchment. Flooding was not investigated in any detail, however it was noted that flooding and drainage problems are relatively minor throughout the catchment because urban development is limited. The study recommended appropriate waterway buffer widths, and recommended a number of actions and strategies to improve waterway health. Approximately 75% of the recommended actions have been commenced or completed, working towards improving creek health (RCC, 2010).
- *Natural Asset Management Plan for Leslie Harrison Dam* (KBR, 2011). This plan identifies management actions based on the recognition of threats and opportunities to Seqwater's objectives (primarily water quality). The plan includes a schedule of priority actions that will assist with the management of natural assets. Examples of key priority actions include implementing event based water quality monitoring, improving weed management, encouraging landholders to assess, service and / or replace ageing on site wastewater systems and develop and implement a riparian restoration plan.
- *Catchment Prioritisation and Mapping of Riparian Soils and Landforms for Redland City (Mainland)* (Hydrobiology, 2009). The study identified South Eastern Creeks catchment as a **low priority** catchment for protection and management actions, due to low future land use pressures and existing protection under the Redlands Planning Scheme

Currently, Council has no record of vegetated treatment systems or GPTs within the catchment, likely due to its rural nature.

Key solutions from the catchment solution set presented in Table 5-9 are briefly described below:

- **Rural BMP for Grazing Land - Fencing off Stock and Revegetating 1st & 2nd Order Streams.** This solution was recognised as effective due to the large proportion of waterways in poor and very poor condition (Hydrobiology, 2009) located on grazing lands within this catchment.
- **Upgrade WTP process at Capalaba Treatment Plant.** This solution has been identified as necessary to protect the quality of drinking water.
- **Waterway Rehabilitation.** During the workshop, the following waterway rehabilitation solutions were identified as effective management measures in this catchment. It is, however, noted that no poor or very poor condition waterways were identified on RCC owned land:
    - Riparian buffer zones
    - Habitat restoration (Council land only)

- In stream improvement works

- **Naturalising land currently degraded human activities**. This was discussed in the workshop as being an effective solution currently being undertaken by the State in upper reaches of this catchment. Karreman quarry offset rehabilitation works was also identified as an excellent example of best practice quarry management.
- **Rehabilitation of poorly performing water bodies.** This solution was identified due to the large number of water bodies located in this catchment.

There is no future development planned within RCC's local government area, however it was recognised that there may be development pressures from other Council areas in the larger Tingalpa Creek catchment. Therefore water quality could be expected to worsen slightly with a business as usual approach. Current Council water quality monitoring indicates elevated levels of TSS and nitrogen. Although further detailed planning is required to confirm the best options to work towards meeting EPP WQOs, it is anticipated that through implementing some of the suggested solutions, it would be possible to improve upon, or at minimum maintain existing conditions and Environmental Values. As the catchment is a drinking water catchment, management actions are essential to protect drinking water quality.

Table 5-9 Upper Tingalpa Creek Catchment TWCM Solutions

Solution	Water Cycle Management Issue Addressed								High Level Performance Assessment		
	Deterioration of Waterway Health	Potential to Impact to Environmentally Sensitive Waters	Population Growth	Sewage Treatment Plant Capacity Constraints	Water Supply Constraints	Flooding and Storm Tide	Landfill Leachate	Sewage Overflows	Cost Perf.	Benefits	Priority Rating
Waterway Rehabilitation											
Rehabilitation of waterways - Riparian buffer zones (private land)	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - Habitat restoration (Council land)	✓	✓	✓						Low	Low	Low
Rehabilitation of waterways - Bank Stability Works	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - In-Stream Improvement works	✓	✓	✓						Medium	Medium	Medium
Increased riparian protection for waterways	✓	✓	✓						High	Medium	High
Identify and prioritise waterway fish barrier locations	✓	✓							Low	Low	Low
Monitoring to evaluate effectiveness of management solutions	✓	✓	✓						Medium	High	High
Diffuse Pollution Management											
Rural BMP for grazing land - fencing off stock & revegetation around 1st & 2nd order streams	✓	✓				✓			Medium	High	High
Rural BMP for horticultural land - implementation of filter/buffer strips	✓	✓							Medium	Low	Medium
Integrate WSUD into government capital infrastructure works e.g. road/ park upgrades	✓	✓							High	Low	Medium
Improved waterway health asset management system	✓	✓	✓						High	Low	Medium
Naturalising land currently degraded by human activities	✓	✓	✓						Low	Medium	Medium
Pollutant Hot Spot Management											
Rehabilitation of poorly performing water bodies	✓	✓							Medium	High	High
Investigate sources of hot spot pollution & identify targeted treatment strategies	✓	✓							High	Medium	High
Nutrient Trading	✓	✓	✓	✓					High	Low	Medium
Education & Capacity Building											
Education & /or capacity building and investment in incentive schemes	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Active Extension Programs Idea: Rain gardens in backyards	✓	✓	✓						High	Low	Medium
Improved marketing around TWCM initiatives	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	✓	✓			✓				Low	Medium	Medium
Improved connectivity to waterways through education & participation in waterway improvement projects	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Water Supply & Demand Management											
Stormwater harvesting for POS	✓	✓	✓		✓				Medium	Medium	Medium
Upgrade WTP process at Capalaba Treatment Plant					✓				Medium	Medium	Medium
Sewerage											
Inspections and improved management of septic and on site wastewater treatment systems	✓	✓	✓						High	High	High
Improve prevention of illegal stormwater inflow connections to sewer	✓	✓	✓					✓	Medium	Medium	Medium
Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	✓	✓						✓	Medium	Medium	Medium
Sewerage upgrades to improve storage/conveyance of wet weather flows	✓	✓						✓	Low	Medium	Medium
Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	✓	✓						✓	Low	Medium	Medium
Investigate wastewater infrastructure rates charged on mains water consumption basis	✓	✓						✓	High	Low	Medium
Funding to Implement Solutions											
Develop business case for healthy waterways to support solutions	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Increase / re-prioritise funding to support TWCM solutions	✓	✓	✓	✓	✓	✓	✓	✓	Medium	High	High

Note: TWCM Issues that are not relevant to this catchment are shaded in grey.

5.3.9 Lower Tingalpa

The solutions identified to address TWCM issues in Lower Tingalpa Creek catchment are outlined in Table 5-10. Table 5-10 also includes a high level performance assessment of the costs and benefits of implementing each solution, in addition to an overall assessment of the solutions performance (refer to Appendix F for further details on costs and benefits).

The key relevant previous planning studies that have been undertaken for this catchment include:

- *Tingalpa Creek Waterway Management Plan* (City Design, 2003). This study was undertaken for the whole of Tingalpa Creek catchment, including the Upper Tingalpa Creek catchment. Flooding was not investigated in any detail. The study recommended appropriate waterway buffer widths, and recommended a number of actions and strategies to improve waterway health. Approximately 75% of the recommended actions have been commenced or completed, working towards improving creek health (RCC, 2010).
- *Coolnwynpin Creek Catchment Flood Study* (Worsley Parsons, 2010). This study investigated flooding issues within a subcatchment of the Lower Tingalpa Creek catchment (Coolnwynpin Creek). It identifies mitigation measures to address roadway overtopping and property inundation issues. It also recommends further localised analysis of flood behaviour for some areas.
- *Redland Water Wastewater Treatment Plant Strategy to 2025* (Water Strategies, 2011). The report identified that the Thorneside and Capalaba STPs are currently performing well, despite the Capalaba STP being overloaded. Discussions with Redland Water have indicated that capacity issues at Capalaba STP have since been resolved through scheduled upgrade works. A number of improvement works were recommended that should, and may already have been implemented.
- *Redland Recycled Water Project (*KBR, 2006). This study investigated a number of potential recycled water users, mainly for POS irrigation with some commercial users. The report identified few industrial users in the Redland Shire area that have shown up as large water consumers. The two main water consuming industries were identified to be food processing and cement batching plants. The food processing industries were eliminated due to the high potential for adverse publicity. The cement batching plants were considered as a separate project (for the Cleveland STP). Two schemes were short listed for Capalaba and Victoria Point STPs, however the levelised cost of providing water for these schemes was not cost effective due to low demands (>$10/kL). It recommended that dual reticulation schemes be further investigated for more cost effective supply.
- *Redland Recycled Water Project, Addendum Report (*KBR, 2007). This report further investigated the feasibility of dual reticulation schemes in the Redlands. It did not identify any cost effective schemes for the Capalaba STP. The most cost effective supply included a dual reticulation scheme to service new future developments at Kinross Road and South East Thornlands. Later detailed planning studies, however, have indicated that dual reticulation schemes do not present the preferred option due to high costs (Redland Water, 2009).
- *Catchment Prioritisation and Mapping of Riparian Soils and Landforms for Redland City (Mainland)* (Hydrobiology, 2009). This study identifies Lower Tingalpa catchment as a **high priority** catchment for management actions.

Of note, no Integrated Waterway Management Plan (IWMP) has been developed for this catchment, however its development has been identified as a high priority by Council (RCC Waterway Recovery Policy Action Plan 2012). Currently, Council has a record of a number of GPTs around Capalaba, however there is no record of any vegetated treatment systems.

Key solutions from the catchment solution set presented in Table 5-10 are briefly described below:

- **WSUD Retrofit.** As Lower Tingalpa Creek catchment is a largely urbanised catchment with limited existing water quality treatment devices, this solution was nominated as a key solution to address waterway health. It is noted that while the solution is likely to be expensive, it also has potential to greatly improve water quality and waterway health. Furthermore, significant capital cost savings could be achieved if WSUD retrofit was undertaken in combination with capital works upgrades, however the benefits would depend on the extent of capital works undertaken and hence the opportunities to integrate WSUD. It was noted that WSUD retrofit solutions should be focused at the streetscape scale in this catchment.
- **Active Extension Programs Idea: Rain gardens in backyards.** This solution may provide a cost effective method to achieve WSUD retrofit in the catchment and target stormwater quality in existing urban areas to improve waterway health. It also promotes community education, land stewardship and connectivity to local waterways.
- **Improved landfill capping /leachate management & treatment systems.** This solution is required to address the issue of landfill leachate generation and treatment issues in the catchment. Significant cost savings may be achieved through avoided transportation and treatment costs (at facilities external to RCC). It is noted that a Landfill Leachate Management Options and Viability Study has been commissioned to investigate the best options for addressing this issue, and the results of this study should be used to guide further actions.
- **Storm tide and flood mitigation investigations and/or works implemented.** A significant issue identified in this catchment is the potential for sewerage infrastructure to be affected by storm tide inundation, and potential implications on water quality if infrastructure is compromised. This solution entails undertaking detailed planning studies to further investigate the implications of storm tide on sewerage infrastructure in the catchment, and identify appropriate mitigation measures to be implemented. It is further noted that flooding issues have been identified in the catchment, and mitigation measures /further studies should be undertaken in accordance with recommendations by Worley Parsons (2010).
- **Recycled Water supplied for POS or industrial users.** This solution was nominated to have significant potential during the solutions workshop, particularly as Capalaba STP has recently been upgraded to provide 240 kL/day of Class A+ recycled water (currently not used). In particular, opportunities were flagged to use recycled water within the adjacent Capalaba Industrial Estate, and such opportunities could be included in the Capalaba Redevelopment Master Plan. Another opportunity identified was the use of recycled water to irrigate the Howeston Golf Course, in Birkdale. It is noted that previous investigations have identified low demand and high cost for recycled water use in the region, however these studies are dated and the availability of recycled water at Capalaba may improve the feasibility of such schemes. As such, further investigation is recommended.

Although the Lower Tingalpa catchment is largely urbanised, future growth pressures on the STPs discharging to Tingalpa Creek (Thorneside and Capalaba) predict potentially significant increases to

pollutant flows and loads in the future, particularly with a business as usual approach. Combined with the current poor water quality in the catchment, it is clear that additional management measures are required to work towards improving current conditions to meet WQOs and protect Environmental Values. Although further detailed planning studies are required to confirm the best options to work towards meeting EPP WQOs, it is anticipated that it would be possible to improve upon, or at minimum maintain existing conditions through the implementation of preferred solutions.

Table 5-10 Lower Tingalpa Creek Catchment TWCM Solutions

Solution	Water Cycle Management Issue Addressed								High Level Performance Assessment		
	Deterioration of Waterway Health	Potential to Impact to Environmentally Sensitive Waters	Population Growth	Sewage Treatment Plant Capacity Constraints	Water Supply Constraints	Flooding and Storm Tide	Landfill Leachate	Sewage Overflows	Cost Perf.	Benefits	Priority Rating
Waterway Rehabilitation											
Rehabilitation of waterways - Riparian buffer zones (private land)	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - Habitat restoration (Council land)	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - Bank Stability Works	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - In-Stream Improvement works	✓	✓	✓						Medium	Medium	Medium
Increased riparian protection for waterways	✓	✓	✓						High	Low	Medium
Identify and prioritise waterway fish barrier locations	✓	✓							Low	Low	Low
Monitoring to evaluate effectiveness of management solutions	✓	✓	✓						Medium	High	High
Diffuse Pollution Management											
Increased implementation / enforcement of E&SC management practices	✓	✓	✓						High	Low	Medium
Rural BMP for grazing land - fencing off stock & revegetation around 1st & 2nd order streams	✓	✓				✓			Low	Low	Low
Rural BMP for horticultural land - implementation of filter/buffer strips	✓	✓							Medium	Low	Medium
Integrate WSUD into government capital infrastructure works	✓	✓							High	Medium	High
Improved waterway health asset management system	✓	✓	✓						High	High	High
Future development to achieve better than SPP Water requirements (for WSUD)	✓	✓	✓						Low	Low	Low
Naturalising land currently degraded by human activities	✓	✓	✓						Low	Medium	Medium
Water Sensitive Urban Design Retrofit (beyond capital infrastructure works)	✓	✓							Low	High	Medium
Pollutant Hot Spot Management											
BMP for poultry farms - EMP review	✓	✓							High	Low	Medium
Rehabilitation of poorly performing water bodies (e.g. toxic dams/lakes)	✓	✓							Medium	Medium	Medium
Improved landfill leachate management & treatment systems	✓	✓					✓		Medium	High	High
Investigate sources of hot spot pollution & identify targeted treatment strategies	✓	✓							High	High	High
Education & Capacity Building											
Education & /or capacity building and investment in incentive schemes	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Active Extension Programs Idea: Rain gardens in backyards	✓	✓	✓						High	High	High
Improved marketing around TWCM initiatives	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	✓	✓			✓				Low	High	Medium
Improved connectivity to waterways through education & participation in waterway improvement projects	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Education campaign to address flooding and storm tide issues - Mapping made available to public						✓			High	Medium	High
Education campaign to address flooding and storm tide issues - Include notes on rates						✓			High	Medium	High
Education campaign to address flooding and storm tide issues - Install historical flood marks/signs						✓			High	High	High
Water Supply & Demand Management											
Stormwater harvesting for POS	✓	✓	✓		✓				Medium	Medium	Medium
Recycled water supplied to large industrial/commercial users	✓	✓	✓	✓	✓				Medium	Low	Medium
Recycled water supplied to urban users (public open space)	✓	✓	✓	✓	✓				Medium	Medium	Medium
Recycled water disposed to land or irrigated to woodlots	✓	✓	✓	✓	✓				Medium	Low	Medium
Sewerage											
Inspections and improved management of septic and on site wastewater treatment systems	✓	✓	✓						High	Low	Medium
Improved nutrient treatment processes of Capalaba and Thorneside STP	✓	✓		✓					Low	Low	Low
Improve prevention of illegal stormwater inflow connections to sewer	✓	✓	✓					✓	Medium	Medium	Medium
Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	✓	✓						✓	Medium	Medium	Medium
Sewerage upgrades to improve storage/conveyance of wet weather flows	✓	✓						✓	Low	Medium	Medium
Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	✓	✓						✓	Low	Medium	Medium
Investigate wastewater infrastructure rates charged on mains water consumption basis	✓	✓						✓	High	Low	Medium
Flooding & Storm tide											
Flood mitigation investigation/works implemented						✓			Medium	High	High
Development Control											
Cap on population growth	✓	✓	✓	✓	✓				Medium	High	High
Funding to Implement Solutions											
Develop business case for healthy waterways to support solutions	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Increase / re-prioritise funding to support TWCM solutions	✓	✓	✓	✓	✓	✓	✓	✓	Medium	High	High

Note: TWCM Issues that are not relevant to this catchment are shaded in grey.

5.3.10 Coochiemudlo and SMBIs

The solutions identified to address TWCM issues within the Coochiemudlo and SMBI catchment are outlined in Table 5-11. Table 5-11 also includes a high level performance assessment of the costs and benefits of implementing each solution, in addition to an overall assessment of the solutions performance (refer to Appendix F for further details on costs and benefits).

The key relevant previous planning studies that have been undertaken for this catchment include:

- *Southern Moreton Bay Islands Concept Drainage Design* (GHD, 2007). This study recommends two standard stormwater treatment designs dependent on whether kerb and channel drainage exists. Where swales exist, the recommended strategy is swales and buffer strips, and where kerb and channel exist, the recommended strategy includes GPTS prior to bioretention basins. Land acquisitions were also identified and costed in areas affected by tidal inundation or overland flow as well as where strategic easements were required.
- *Sustainability Study Into the On-Site Wastewater Systems on SMBIs* (RCC, 2011). The study recognises that management of wastewater on the SMBIs is critical to the long term sustainability of the islands. It identifies that a centralised sewerage reticulation network is required as the long-term solution, however recommends a temporary local planning instrument to enforce improved treatment of on-site treatment facilities, particularly when the sustainable primary treatment dwelling density of 4 dwellings per hectare is reached. This planning policy requires advanced secondary treatment measures on new houses as an interim measure (prior to a sewerage network) to protect public health and the environment. The study identified current development pressures on Macleay Island as being of greatest concern, followed by Lamb and Karragarra Islands.

Currently, Council has no record of any GPTs or vegetated treatment systems within the catchment. No IWMP has been undertaken for the catchment, no creek functional mapping has been undertaken and limited information exists in terms of waterway and water body mapping. It is recommended that further investigations be undertaken to fill these gaps.

Key solutions from the catchment solution set presented in Table 5-11 are briefly described below:

- **Provide sewerage infrastructure for unsewered areas.** Despite being expensive, this was identified as a priority solution applicable to the SMBIs to ensure long term sustainability, particularly considering the significant future development pressures.
- **Increased restrictions on development extent and intensity for proposed development areas.** During the workshop, this solution was identified as an effective means for protecting waterway health in the Bay, as it was recognised that existing planning schemes may not be appropriate.
- **Acquisition of land inundated by flooding/storm tide.** This solution was identified in the workshop, and it was recognised that Council currently has an ongoing buyback / land swap program for flood constrained land. Another cost effective solution to address flooding and storm tide issues was to review constraints on future land development as it was recognised that existing planning schemes may not be appropriate.

- **Flood mitigation investigation / works implemented.** During the workshop it was identified that further investigations and mitigation works are required to ensure coastal infrastructure (ferry terminals, parking etc.) has immunity from storm tide/flooding.
- **Increased riparian protection/buffer zones for waterways & bay.** This solution was identified as a cost effective means to reduce the impact to waterway health from future development pressures.
- **Increased implementation / enforcement of E&SC management practices.** This solution was identified to be of key value in this catchment due to significant future development pressures.
- **Improved Management of Unsealed Roads.** This solution was identified during the workshop to be an effective solution for the islands, particularly on Macleay.
- **Active Extension Programs Idea: Rain gardens in backyards.** This solution may provide a cost effective method of targeting stormwater in existing urban areas to improve waterway health.
- **Cap on Population Growth.** This solution would reduce the current pressures on waterway health from planned future development in the catchment. However it is a politically sensitive option that may also have economic impacts on the region.

It is noted that a Biolytix/BioWater scheme was set up on Macleay Island in 2004 as a wastewater treatment, collection and re-use system as part of a trial under the Queensland Advanced Wastewater Treatment Technology program. The trial was undertaken with the objective of identifying if the BioWater scheme could provide an economically and environmentally sustainable wastewater solution for SMBI. Recent correspondence with Council has indicated that the system has maintenance and operational issues, with not all residents appropriately maintaining the systems. Additionally, it was noted that the golf course that the system irrigates to generally doesn't use the water due to high rainfall in the region. Thus tanks need to be emptied to prevent overflowing. Further investigation is required to address these issues and investigate whether the solution can provide a sustainable wastewater treatment option for the SMBIs.

Council water quality monitoring indicates elevated concentrations of pollutants and pollutant hot spots within this catchment. Significant population growth is forecast within the Coochiemudlo and SMBIs catchment, and if business continues as usual, this may result in a significant worsening in current conditions. The solutions presented identify options to address existing issues and plan for minimising future impacts of development. Although further detailed planning is required to confirm the best options to work towards meeting EPP WQOs, it is anticipated that it would be possible to improve upon, or at minimum maintain existing conditions through implementing preferred solutions.

Table 5-11 Coochiemudlo & SMBIs Catchment TWCM Solutions

Solution	Water Cycle Management Issue Addressed								High Level Performance Assessment		
	Deterioration of Waterway Health	Potential to Impact to Environmentally Sensitive Waters	Population Growth	Sewage Treatment Plant Capacity Constraints	Water Supply Constraints	Flooding and Storm Tide	Landfill Leachate	Sewage Overflows	Cost Perf.	Benefits	Priority Rating
Waterway Rehabilitation											
Rehabilitation of waterways - Riparian buffer zones	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - Habitat restoration (Council land)	✓	✓	✓						Medium	Low	Medium
Rehabilitation of waterways - Bank Stability Works	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - In-Stream Improvement works	✓	✓	✓						Medium	Medium	Medium
Increased riparian protection/buffer zones for waterways & bay	✓	✓	✓						High	High	High
Identify and prioritise waterway fish barrier locations	✓	✓							Medium	Low	Medium
Investigations/monitoring to better define waterway health	✓	✓	✓						Medium	High	High
Monitoring to evaluate effectiveness of management solutions	✓	✓	✓						Medium	High	High
Diffuse Pollution Management											
Increased implementation / enforcement of E&SC management practices	✓	✓	✓						High	High	High
Integrate WSUD into government capital infrastructure works	✓	✓							High	Medium	High
Improved waterway health asset management system	✓	✓	✓						High	High	High
Future development to achieve better than SPP Water requirements (for WSUD)	✓	✓	✓						Low	High	Medium
Naturalising land currently degraded by human activities	✓	✓	✓						Low	Medium	Medium
Pollutant Hot Spot Management											
Rehabilitation of poorly performing water bodies	✓	✓							Medium	Medium	Medium
Investigate sources of hot spot pollution & identify targeted treatment strategies	✓	✓							High	High	High
Improved management of unsealed roads	✓	✓							Medium	High	High
Education & Capacity Building											
Education & /or capacity building and investment in incentive schemes	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Active Extension Programs Idea: Rain gardens in backyards	✓	✓	✓						High	Medium	High
Improved marketing around TWCM initiatives	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	✓	✓			ü				Low	High	Medium
Improved connectivity to waterways through education & participation in waterway improvement projects	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Education campaign to address flooding and storm tide issues - Mapping made available to public						✓			High	Medium	High
Education campaign to address flooding and storm tide issues - Include notes on rates						✓			High	Medium	High
Education campaign to address flooding and storm tide issues - Install historical flood marks/signs						✓			High	High	High
Water Supply & Demand Management											
Stormwater harvesting for POS	✓	✓	✓		✓				Medium	Medium	Medium
Stormwater harvesting for dual reticulation (greenfield)	✓	✓	✓		✓				Low	Medium	Medium
Rainwater harvesting communal tanks (greenfield)	✓	✓	✓		✓				Low	Medium	Medium
Recycled water supplied to large industrial users	✓	✓	✓	✓	✓				Low	Low	Low
Recycled water supplied to urban users (public open space)	✓	✓	✓	✓	✓				Low	Low	Low
Recycled water supplied to urban users (dual reticulation)	✓	✓	✓	✓	✓				Low	Medium	Medium
Sewerage											
Provide sewerage infrastructure for unsewered areas	✓	✓	✓						Low	High	Medium
Inspections and improved management of septic and on site wastewater treatment systems	✓	✓	✓						High	High	High
Improve prevention of illegal stormwater inflow connections to sewer	✓	✓	✓					✓	Medium	Medium	Medium
Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	✓	✓						✓	Medium	Medium	Medium
Sewerage upgrades to improve storage/conveyance of wet weather flows	✓	✓						✓	Low	Medium	Medium
Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	✓	✓						✓	Low	Medium	Medium
Investigate wastewater infrastructure rates charged on mains water consumption basis	✓	✓						✓	High	Low	Medium
Flooding & Storm tide											
Flood mitigation investigation/works implemented						✓			Low	High	Medium
Constraints on future land development to address flooding and storm tide issues			✓			✓			High	High	High
Acquisition of land inundated by flooding/storm tide						✓			Medium	Medium	Medium
Development Control											
Cap on population growth	✓	✓	✓	✓	✓				Medium	High	High
Increased restrictions on development extent and intensity for proposed development areas	✓	✓	✓						Medium	High	High
Investigations to more accurately define population growth for future planning purposes	✓		✓	✓	✓				High	High	High
Funding to Implement Solutions											
Develop business case for healthy waterways to support solutions	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Increase / re-prioritise funding to support TWCM solutions	✓	✓	✓	✓	✓	✓	✓	✓	Medium	High	High

Note: TWCM Issues that are not relevant to this catchment are shaded in grey.

5.3.11 North Stradbroke Island

The solutions identified to address TWCM issues within the NSI catchment are outlined in Table 5-1. Table 5-1 also includes a high level performance assessment of the costs and benefits of implementing each solution, in addition to an overall assessment of the solutions performance (refer to Appendix F for further details on costs and benefits).

The key relevant planning study that has been undertaken for this catchment includes:

- *Redland Water Wastewater Treatment Plant Strategy to 2025* (Water Strategies, 2011). The report identified that the Point Lookout STP is overloaded in peak holiday periods and urgently needs augmentation. The report also identified that the Dunwich STP will require upgrading in the next few years to meet peak holiday loading. It noted that studies were being undertaken to investigate the cause of elevated TN in groundwater background concentrations at the Dunwich STP. Correspondence with Redland Water (undertaken during the TWCM Planning project) indicates that the intention is for plant upgrades to Point Lookout to commence as soon as possible to address capacity issues. It also identified that study recommendations for improved operation and maintenance of the irrigation area and improved irrigation efficiency have been implemented to address the issue of elevated TN. It is not known if these measures have been successful.

Council has no record of any GPTs or vegetated treatment systems within the catchment. No IWMP has been undertaken for the catchment, no creek functional mapping has been undertaken and limited information exists in terms of waterway and water body mapping. It is recommended that further investigations be undertaken to fill these gaps.

Key solutions from the catchment solution set presented in Table 5-1 are briefly described below:

- **Further investigate sustainable wastewater treatment options for new development.** This solution was identified during the workshop as being necessary to address potential development pressures between Amity and Dunwich.
- **Improved Management of Unsealed Roads.** This solution was identified during the workshop to be an effective solution on unleased mining and recreational roads to protect water quality, particularly for HEV receiving waters such as Brown Lake.
- **Investigations to better define sustainable groundwater yields.** This was identified during the workshop in order to ensure water extracted for potable use is sustainable for the community and the environment.
- **Storm tide mitigation investigation / works implemented.** During the workshop it was identified that further investigations and mitigation works are required to ensure appropriate coastal management on the Island. Amity was noted as a particular issue, with several lots already lost due to flooding/storm tide inundation and shoreline erosion.
- **Increased restrictions on development extent and intensity for proposed development areas.** This solution was identified as a cost effective means of protecting waterway health in the Bay from the pressures of population growth.

- **Constraints on future land development to address flooding and storm tide issues.** This was identified as a cost effective means of reducing development on land subject to flooding/storm tide.
- **Increased riparian protection/buffer zones for waterways & bay.** This solution was identified as a cost effective means to reduce the impact to waterway health from future development pressures.
- **Increased implementation / enforcement of E&SC management practices.** This solution was identified to be of key value in this catchment due to significant future development pressures.
- **Improved landfill capping /leachate management & treatment systems.** This solution is required to address the issue of landfill leachate generation and treatment issues in the catchment. It is noted that a Landfill Leachate Management Options and Viability Study has been commissioned to investigate the best options for addressing this issue, and the results of this study should be used to guide further actions.
- **Investigate and reduce leakage 'losses' from potable water infrastructure**. This solution was identified to address potential water supply issues in the catchment (from uncertainty of supply), and also addresses demand management requirements of the EPP Water.
- **Cap on Population Growth.** This solution would reduce the current pressures on waterway health from planned future development in the catchment. However it is a politically sensitive option that may also have economic impacts on the region.
- **Recycled Water.** It is noted that no recycled water investigations have been undertaken for NSI, and investigations of potential reuse opportunities should be undertaken to address requirements of the EPP Water.

A snapshot assessment of ecological health indicated poor to moderate condition of waterways surveyed on NSI (FRC, 2011). Significant population growth is forecast on NSI, and if business continues as usual, this may result in a significant worsening in current conditions. The solutions presented identify options to address existing issues and plan for minimising future impacts of development. Although further detailed planning is required to confirm the best options to work towards meeting EPP WQOs, it is anticipated that it would be possible to improve upon, or at minimum maintain existing conditions through implementing preferred solutions.

Table 5-1 North Stradbroke Islands Catchment TWCM Solutions

Solution	Water Cycle Management Issue Addressed								High Level Performance Assessment		
	Deterioration of Waterway Health	Potential to Impact to Environmentally Sensitive Waters	Population Growth	Sewage Treatment Plant Capacity Constraints	Water Supply Constraints	Flooding and Storm Tide	Landfill Leachate	Sewage Overflows	Cost Perf.	Benefits	Priority Rating
Waterway Rehabilitation											
Rehabilitation of waterways - Riparian buffer zones	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - Habitat restoration (Council land)	✓	✓	✓						Medium	Low	Medium
Rehabilitation of waterways - Bank Stability Works	✓	✓	✓						Medium	Medium	Medium
Rehabilitation of waterways - In-Stream Improvement works	✓	✓	✓						Medium	Medium	Medium
Increased riparian protection for waterways	✓	✓	✓						High	Medium	High
Identify and prioritise waterway fish barrier locations	✓	✓							Low	Low	Low
Investigations to better define sustainable groundwater yields	✓	✓	✓		✓				Medium	High	High
Investigations/monitoring to better define waterway health	✓	✓	✓						Medium	High	High
Monitoring to evaluate effectiveness of management solutions	✓	✓	✓						Medium	High	High
Diffuse Pollution Management											
Increased implementation / enforcement of E&SC management practices and capacity building through education	✓	✓	✓						High	High	High
Integrate WSUD into government capital infrastructure works e.g. road/ park upgrades	✓	✓							High	Low	Medium
Improved waterway health asset management system	✓	✓	✓						High	Medium	High
Future development to achieve better than SPP Water requirements (for WSUD)	✓	✓	✓						Low	Medium	Medium
Pollutant Hot Spot Management											
Rehabilitation of poorly performing water bodies (e.g. toxic dams/lakes)	✓	✓							Medium	Medium	Medium
Improved landfill leachate management & treatment systems	✓	✓					✓		Medium	High	High
Investigate sources of hot spot pollution & identify targeted treatment strategies	✓	✓							High	High	High
Improved management of unsealed roads	✓	✓							Medium	High	High
Education & Capacity Building											
Education & /or capacity building and investment in incentive schemes	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Active Extension Programs Idea: Rain gardens in backyards	✓	✓	✓						Medium	Medium	Medium
Improved marketing around TWCM initiatives	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	✓	✓			✓				Low	Medium	Medium
Improved connectivity to waterways through education & participation in waterway improvement projects	✓	✓	✓	✓	✓	✓	✓	✓	High	Medium	High
Education campaign to address flooding and storm tide issues - Mapping made available to public						✓			High	Medium	High
Education campaign to address flooding and storm tide issues - Include notes on rates						✓			High	Medium	High
Education campaign to address flooding and storm tide issues - Install historical flood marks/signs						✓			High	High	High
Water Supply & Demand Management											
Stormwater harvesting for POS	✓	✓	✓		✓				Medium	Medium	Medium
Stormwater harvesting for dual reticulation (greenfield)	✓	✓	✓		✓				Low	Medium	Medium
Rainwater harvesting communal tanks (greenfield)	✓	✓	✓		✓				Low	Medium	Medium
Recycled water supplied to large agricultural/ industrial users	✓	✓	✓	✓	✓				Medium	Low	Medium
Recycled water supplied to urban users (public open space)	✓	✓	✓	✓	✓				Low	Medium	Medium
Recycled water disposed to land or irrigated to woodlots (note limited feasible due to koala habitat & land shortage)	✓	✓	✓	✓	✓				Medium	Low	Medium
Recycled water supplied to urban users (dual reticulation)	✓	✓	✓	✓	✓				Low	Medium	Medium
Investigate and reduce leakage 'losses' from potable water infrastructure					✓				Medium	High	High
Desalination plant for water supply					✓				Low	High	Medium
New/ upgraded water supply infrastructure (e.g. dams, weirs, pipeline, bores)					✓				Low	High	Medium
Sewerage											
Inspections and improved management of septic and on site wastewater treatment systems	✓	✓	✓						High	High	High
Improved nutrient treatment processes of STPs (Dunwich and Point Lookout)	✓	✓		✓					Low	High	Medium
Improve prevention of illegal stormwater inflow connections to sewer	✓	✓	✓					✓	Medium	Medium	Medium
Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	✓	✓						✓	Medium	Medium	Medium
Sewerage upgrades to improve storage/conveyance of wet weather flows	✓	✓						✓	Low	Medium	Medium
Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	✓	✓						✓	Low	Medium	Medium
Investigate wastewater infrastructure rates charged on mains water consumption basis	✓	✓						✓	High	Low	Medium
Further investigate sustainable wastewater treatment options for new development	✓	✓	✓						Low	High	Medium
Flooding & Storm tide											
Storm Tide mitigation investigation/works implemented						✓			Low	High	Medium
Constraints on future land development to address flooding and storm tide issues			✓			✓			High	High	High
Acquisition of land inundated by flooding/storm tide						✓			Low	High	Medium
Development Control											
Cap on population growth	✓	✓	✓	✓	✓				Medium	High	High
Increased restrictions on development extent and intensity for proposed development areas	✓	✓	✓						Medium	Medium	Medium
Investigations to more accurately define population growth for future planning purposes	✓		✓	✓	✓				High	High	High
Funding to Implement Solutions											
Develop business case for healthy waterways to support solutions	✓	✓	✓	✓	✓	✓	✓	✓	High	High	High
Increase / re-prioritise funding to support TWCM solutions	✓	✓	✓	✓	✓	✓	✓	✓	Medium	High	High

6.0

Photo of Old Cleveland Jetty, by Jack Hardy

Implementation Plan

6 IMPLEMENTATION PLAN

The implementation plan presented in Table 6-1 below identifies the actions required to achieve TWCM objectives and work towards achieving the overall long term strategic outcomes. The responsible group for implementing each action has been identified, along with other stakeholders who should be involved and / or consulted during the implementation process. A timeframe for the action to be completed and a high level cost estimate for undertaking the action has also been included.

It is noted that in most instances, further detailed planning will be required to identify the likely costs of implementing solutions, and the optimal solutions to progress with (i.e. those that meet the objectives at least cost to the community and the environment). Where available, indicative unit costs to implement a solution are also presented.

Those actions shaded in red indicate high priority actions. High priority actions include those actions required to meet legislative requirements, actions to progress with detailed planning studies for high performance solutions to address water cycle management issues (as identified in Section 5), and those actions required to fill key information gaps.

Table 6-1 TWCM Implementation Plan

Long Term TWCM Strategy	Specific TWCM Objective	Actions (5 yrs)	Supporting Waterway Recovery Policy Actions[1]	Supports Redland Corporate Plan Outcome								Responsible Group	Stakeholders	Timing	High Level Cost Estimate[2]
				Healthy Natural Environment	Green Living	Embracing the Bay	Quandamooka Country	Wise Planning & Design	Strong & Connected	Supportive & Vibrant Economy	Inclusive & Ethical Governance				
1. Improve Waterway Health	1.1 Rehabilitation of riparian zones to protect waterway health and improve habitat and amenity	1.1.1 Rehabilitate waterways on Council and privately owned land where recommended in catchment IWMP's and WMP's (Hilliards, Torquay and Native Dog Creek Catchments)	1.1.4 1.1.6 2.3.3 8.2.2	✓	✓	✓		✓	✓		✓	CSG	CIG, CEU, EEU, MCG, Community groups, schools, SEQ catchments	2013-2018	$500,000/ annum rehabilitation $150,000/ study
		1.1.2 Undertake further detailed planning investigations for opportunities to rehabilitate poor or very poor condition waterways on Council owned land. High priority catchments: Cleveland and Thornlands, Eprapah, South Eastern Creeks Medium Priority: Tarradarrapin, Lower Tingalpa	1.1.4 1.2.1 3.1.5 8.2.2	✓	✓	✓		✓	✓		✓	CEU (plans) CSG (implements)	CIG, CSG, EEU, MCG, Community groups, schools, SEQ catchments	2013-2018	Detailed Planning Study Cost[3] Capex @ $10-20/m^2 rehabilitation
		1.1.3 Continue to support and investigate further opportunities to rehabilitate poor or very poor condition waterways on privately owned land. High priority catchments: Cleveland and Thornlands, Eprapah, South Eastern Creeks, Upper Tingalpa Medium Priority: Tarradarrapin, Lower Tingalpa	1.1.4 1.1.6 1.2.1 2.3.3 3.1.5 8.2.2	✓	✓	✓		✓	✓		✓	CSG	Private landowners, EEU, MCG, SEQ catchments	2013-2018	Detailed Planning Study Cost[3] Capex @ $20/m^2 rehabilitation
		1.1.4 Undertake mapping for waterways and waterway condition on NSI and SMBIs so that rehabilitation requirements may be identified (could be undertaken through waterway functional mapping project for islands)	1.1.4 1.3.2 5.1.2	✓	✓	✓		✓				CEU	Private landowners	2013	$70,000
	1.2 Protect the values of waterways and wetlands through the Redlands Planning Scheme	1.2.1 Investigate options to increase riparian protection for waterways (buffer/waterway corridor widths) e.g. through Redland Planning Scheme review, Voluntary Conservation Agreements (ALL catchments). High Priority for South Eastern Creeks, Coochiemudlo & SMBIs, NSI.	1.4.4 1.4.5 3.2.5 5.1.1	✓	✓	✓		✓	✓		✓	CEU	CPU, Private landowners	2013-2018	Internal cost only
		1.2.2 Continue with load modelling to determine impacts of population growth on the further deterioration of waterway health. High priority.	1.3.1	✓	✓	✓		✓				CEU	Redland Water, CPU	2012-2013	$20,000 (catchment model update)

Long Term TWCM Strategy	Specific TWCM Objective	Actions (5 yrs)	Supporting Waterway Recovery Policy Actions[1]	Supports Redland Corporate Plan Outcome								Responsible Group	Stakeholders	Timing	High Level Cost Estimate[2]
				Healthy Natural Environment	Green Living	Embracing the Bay	Quandamooka Country	Wise Planning & Design	Strong & Connected	Supportive & Vibrant Economy	Inclusive & Ethical Governance				
		1.2.3 Use findings of updated catchment modelling to assess the benefits of implementing the solutions restricting population growth in key development areas. (High priority for Hilliards, Eprapah, South Eastern Creeks, Coochiemudlo & SMBIs, NSI. Low priority for Southern Creeks, Lower Tingalpa.)	1.3.1	✓	✓	✓		✓				CEU	Redland Water, CPU	2013-2014	Detailed Planning Study Cost[3]
		1.2.4 Ensure the Priority Infrastructure Plan takes into consideration the preferred solution set(s) for each catchment identified in the Total Water Cycle Management Plan		✓	✓	✓		✓				CIG	CEU, SAG, CSG, RDMG,	2012-2021	Internal only
	1.3 Retain sediment on-site and prevent sediment moving into waterways and causing environmental harm	1.3.1 Continue to support implementation and enforcement of Erosion & Sediment Control (E&SC) management practices on private land and capacity building through appropriate compliance resources and education (ALL catchments excluding Upper Tingalpa). High Priority catchments: Hilliards, Cleveland and Thornlands, Eprapah, South Eastern Creeks, Coochiemudlo & SMBIs, NSI.	5.2.1 5.2.2 5.2.4 5.2.5	✓	✓	✓		✓				CSG, PDG, SAG		2013-2018	$100,000 /yr (Opex)
		1.3.2 Undertake detailed planning to investigate restricting unauthorised 4WD access to waterways e.g. fencing/signs/ barriers to waterways (Southern Creeks Catchment) and potential for cameras for access identification / fines	2.1.1	✓	✓	✓		✓				CIG	RDMG, CEU	2013-2016	Detailed Planning Study Cost[3] Capex $15,000 / km fencing
	1.4 Reduce nutrient and sediment pollution by engaging with local landholders (businesses and private) through the Waterway Extension Program	1.4.1 Continue to support hot spot program and implementing rural best management practices through the extension program (Eprapah, Upper Tingalpa, South Eastern Creeks, Southern Creeks). High Priority.	1.1.4 2.1.3 2.1.4 3.1.5 8.2.2	✓	✓	✓		✓	✓		✓	CEU	Private Landowners, EEU, MCG, SEQ catchments, community groups	2013-2017	$150,000/ annum (Opex)
		1.4.2 Undertake detailed planning studies to investigate implementing rural Best Management Practices (BMPs) for grazing land – e.g. fencing off stock & revegetating 1st & 2nd order streams. High Priority Catchments: Eprapah, South Eastern Creeks, Southern Creeks, Upper Tingalpa	1.1.4 2.1.3 2.1.4 3.1.5 8.2.2	✓	✓	✓		✓	✓	✓	✓	CEU	Private Landowners, EEU, MCG, SEQ catchments, community groups	2013-2017	Detailed Planning Study Cost[3] Capex. $230,000 /km Opex. $340/yr

Long Term TWCM Strategy	Specific TWCM Objective	Actions (5 yrs)	Supporting Waterway Recovery Policy Actions[1]	Supports Redland Corporate Plan Outcome								Responsible Group	Stakeholders	Timing	High Level Cost Estimate[2]
				Healthy Natural Environment	Green Living	Embracing the Bay	Quandamooka Country	Wise Planning & Design	Strong & Connected	Supportive & Vibrant Economy	Inclusive & Ethical Governance				
		1.4.3 Undertake detailed planning studies to investigate implementing rural BMPs on land used for horticulture/ intensive agriculture - use of filters / buffer strips (ALL mainland catchments). High Priority Catchments: Hilliards, South Eastern Creeks.	2.1.3 2.1.4 8.2.2	✓	✓	✓		✓	✓		✓	CEU	Private Landowners, SEQ catchments	2013-2017	Detailed Planning Study Cost[3] Capex. $1,600/ha Opex. $390/ha
		1.4.4 Continue support for naturalising land currently degraded by human activities (e.g. tree planting in rural areas void of vegetation) through the Rural Support and Waterway Extension Programs High Priority: Upper Tingalpa Medium Priority: Hilliards, Cleveland and Thornlands, Eprapah, South Eastern Creeks, Southern Creeks, Lower Tingalpa, Coochiemudlo and SMBIs	3.1.4	✓	✓	✓		✓	✓		✓	CSG	EEU, MCG, Private Landowners, Community Groups,	2013-2017	Revegetation cost $20/m^2 Existing Opex budget
		1.4.5 Use the existing programs to support the implementation of recommended solutions through education and capacity building: • Waterways Extension • Land For Wildlife • Voluntary Conservation Agreement • Rural Support (ALL catchments) High Priority	8.1.4 8.2.3	✓	✓	✓		✓	✓		✓	CSG	EEU, MCG, private landowners, Community Groups, Schools	2013-2017	$320,000/yr
	1.5 Identify and eliminate unregulated water quality (or contamination) hotspots in the landscape	1.5.1 Undertake a trial to investigate costs and benefits of developing an incentive program for residents to construct rain gardens e.g. in Your Backyard or Waterway Extension program. Note Melbourne Water has a similar program. (ALL catchments). High priority catchments: Tarradarrapin, Hilliards, Cleveland and Thornlands, Eprapah, South Eastern Creeks, Lower Tingalpa, Coochiemudlo & SMBIs.	8.1.4 8.2.2 8.2.3	✓	✓	✓		✓	✓		✓	CEU	EEU, MCG, Private landowners, Community Groups, Schools	2013-2017	Detailed Planning Study Cost[3] $20,000 (Capex for program development only, does not include incentives)
		1.5.2 Continue ambient monitoring, including additional monitoring to better define waterway health within Southern Creeks, Coochiemudlo & SMBIs and NSI catchments. (ALL catchments)	1.1.2 9.1.1 9.3.1	✓	✓	✓		✓			✓	CEU		2013-2017	$30,000 /yr ($1,000 / site)

Long Term TWCM Strategy	Specific TWCM Objective	Actions (5 yrs)	Supporting Waterway Recovery Policy Actions[1]	Supports Redland Corporate Plan Outcome								Responsible Group	Stakeholders	Timing	High Level Cost Estimate[2]
				Healthy Natural Environment	Green Living	Embracing the Bay	Quandamooka Country	Wise Planning & Design	Strong & Connected	Supportive & Vibrant Economy	Inclusive & Ethical Governance				
		1.5.3 Continue Council's hot spot monitoring program, incorporating additional sites. (ALL catchments). High Priority.	1.3.2 2.1.1	✓	✓	✓		✓			✓	CEU		2013-2017	$55,000 /yr (60 sites)
		1.5.4 Undertake detailed planning studies to investigate sources of hot spot pollution & identify targeted treatment strategies. (ALL catchments). High Priority.	1.3.2 2.1.1 2.1.2	✓	✓	✓		✓				CEU		2013-2017	$50,000/yr
		1.5.5 Implement monitoring to evaluate the effectiveness of management solutions. (ALL catchments) High Priority.	1.1.2 9.1.1 9.2.1	✓	✓	✓		✓			✓	CEU		2013-2017	$1,000 / site
		1.5.6 Finalise management framework and identify priority artificial water bodies for management. (ALL catchments). High Priority.	2.1.2 2.1.4 4.1.3	✓	✓	✓		✓						2013-2014	$65,000
		1.5.7 Continue to investigate rehabilitation and maintenance of poorly performing artificial water bodies (ALL catchments). High Priority.	2.1.4 4.1.1 4.1.3	✓	✓	✓		✓				CEU	CSG, private landowners	2014-2017	$50,000/an planning $150,000/an implementation
		1.5.8 Undertake detailed planning study to investigate BMPs for poultry farms, such as EMP reviews. High Priority catchments: Eprapah, South Eastern Creeks, Southern Creeks Medium Priority: Hilliards, Cleveland and Thornlands , Lower Tingalpa	2.1.2 2.1.4 8.2.3	✓	✓	✓		✓				CEU	PCS, poultry farm owners	2013-2014	Detailed Planning Study Cost[3] Approx $3000/farm (Capex)
		1.5.9 Continue with Landfill Options and Viability Study to assess potential solutions for landfill leachate management in Redlands. High Priority.		✓	✓	✓		✓				Redwaste	Redland Water	2012-2013	$110,000
		1.5.10 Implement recommendations / undertake further detailed planning investigations pending outcomes of the Options and Viability assessment (Task 1.5.9). High Priority.		✓	✓	✓		✓				Redwaste	Redland Water	2013-2014	$2-5 Million
		1.5.11 Implement recommended WSUD retrofit works as recommended in IWMP and CMPs (Hilliards, Native Dog Creek, Torquay). Includes management of unsealed roads (Torquay and Native Dog Creek)	1.1.6 2.3.3	✓	✓	✓		✓			✓	CIG	CEU, IPG, EEU, MCG, Community Groups, Schools	2013-2017	$15.8 Million (Capex)

Long Term TWCM Strategy	Specific TWCM Objective	Actions (5 yrs)	Supporting Waterway Recovery Policy Actions[1]	Supports Redland Corporate Plan Outcome								Responsible Group	Stakeholders	Timing	High Level Cost Estimate[2]
				Healthy Natural Environment	Green Living	Embracing the Bay	Quandamooka Country	Wise Planning & Design	Strong & Connected	Supportive & Vibrant Economy	Inclusive & Ethical Governance				
		1.5.12 Undertake further detailed planning to investigate other WSUD retrofit opportunities. High priority for Hilliards (at source), Tarradarrapin, Cleveland and Thornlands, Lower Tingalpa. Medium Priority for Eprapah, South Eastern Creeks, Coochiemudlo and SMBIs, NSI.	1.2.1 2.3.1	✓	✓	✓		✓	✓		✓	CIG	CEU, IPG EEU, MCG, Community Groups, Schools	2013-2017	Detailed Planning Study Cost[3] $342/m2 (Capex) $3.40/m2 (Opex)
		1.5.13 Undertake detailed planning to investigate improved management of unsealed roads. High Priority catchments: Southern Creeks, NSI, Coochiemudlo and SMBIs Medium Priority catchments: South Eastern Creeks	2.1.2	✓	✓	✓		✓				CIG	RDMG, CEU	2013-2017	Detailed Planning Study Cost[3] $21/m2 (Capex) $2.50/m2 (Opex)
	1.6 Improved management of trunk urban stormwater	1.6.1 Undertake detailed planning for the completion of Catchment Management Plans for: • Cleveland & Thornlands 12/13 • Tarradarrapin & Lower Tingalpa 13/14 • SMBI 14/15 • Upper Tingalpa 15/16		✓	✓	✓		✓	✓			CIG	CEU	2013-2016	Detailed Planning Study Cost[3]
		1.6.2 Integrate Water Sensitive Urban Design (WSUD) into government capital infrastructure works e.g. road/ park upgrades through revised policy provisions and creation of standard WSUD drawings for use. (ALL catchments). High Priority.	2.3.1 5.1.1	✓	✓	✓		✓	✓		✓	CIG	RDMG, CEU, CPU, EEU, MCG, Community Groups, Schools	2013-2014	$20,000 (provision of standard drawings only)
		1.6.3 Develop an improved waterway health asset management system for assets on public land (e.g. appropriate management of stormwater treatment devices) (ALL catchments). High Priority.	6.1.3 6.1.4 6.1.9	✓	✓			✓				CIG – water quality devices (public) CEU – waterway health	RDMG, CSG,	2013 - 2014	$100,000 (Capex)
		1.6.4 Develop an improved waterway health asset management system to ensure compliance of devices on private land (e.g. appropriate management of stormwater treatment devices) (ALL catchments). High Priority.	6.1.3 6.1.4 6.1.9	✓	✓			✓				SAG - water quality (private) CEU – waterway health-	CIG RDMG, CSG, CSG	2013 - 2014	$20,000/ yr

Long Term TWCM Strategy	Specific TWCM Objective	Actions (5 yrs)	Supporting Waterway Recovery Policy Actions[1]	Supports Redland Corporate Plan Outcome								Responsible Group	Stakeholders	Timing	High Level Cost Estimate[2]
				Healthy Natural Environment	Green Living	Embracing the Bay	Quandamooka Country	Wise Planning & Design	Strong & Connected	Supportive & Vibrant Economy	Inclusive & Ethical Governance				
	1.7 Use and reuse contaminated water	1.7.1 Undertake detailed planning investigations for use of recycled water and stormwater (refer to below actions 5.3.1, 5.3.2 and 5.3.3 for sustainably managing water resources)		✓	✓			✓						2013-2014	Refer to Actions 5.3.1, 5.3.2, 5.3.3
2 Protect Environmentally Sensitive Areas	2.1 Maintenance of HEV waterways and ecological processes	2.1.1 Undertake detailed planning investigations to estimate sustainable load targets for receiving waterways. High Priority.		✓	✓	✓		✓				CEU	CIG	2013-2014	$150,000
		2.1.2 Develop localised WQOs for Native Dog and Serpentine Creeks (to inform EPP Water)	1.3.2 9.1.1	✓	✓	✓		✓			✓	CEU	EEU, MCG, Community Groups	2013-2014	$80,000
		2.1.3 Develop guidelines for managing natural wetlands of high conservation value. (ALL catchments)	1.3.3 1.4.4	✓	✓	✓		✓				CEU		2012-2013	$50,000
		2.1.4 Implement recommendations for managing natural wetlands of high conservation value. (ALL catchments)		✓	✓	✓		✓	✓		✓	CEU	EEU, MCG, Community groups, schools	2013-2017	$25,000/yr
		2.1.5 Investigations to better define sustainable groundwater yields (North Stradbroke Island). High priority.	1.3.2	✓	✓			✓				Redland Water	CEU	2013-2014	$80,000
		2.1.6 Develop a business case for healthy waterways to support funding for recommended solutions. Review previous business case put forward and identify improvements (ALL catchments). High Priority.		✓	✓	✓	✓	✓	✓	✓		CIU	CEU, MCG	2013-2014	$80,000
		2.1.7 Investigate the increase /re-prioritisation of available funding to program and support the implementation of recommended TWCM solutions (ALL catchments) High Priority.		✓	✓	✓		✓				CEU	CIU, MCG	2013-2014	Detailed Planning Study Cost[3]
3. Plan and facilitate Sustainable Population Growth	3.1 Investigate and future proof water resources in the land through innovation	3.1.1 Undertake detailed planning studies to investigate nutrient trading within catchments. Undertake in consultation with the Department of Environment and Heritage Protection. High Priority for Hilliards, Eprapah, South Eastern Creeks. Medium priority for Southern Creeks, Upper Tingalpa.	2.1.5 2.1.1 2.1.2	✓	✓	✓		✓				CEU	Redland Water, DEHP		Detailed Planning Study Cost[3]

Long Term TWCM Strategy	Specific TWCM Objective	Actions (5 yrs)	Supporting Waterway Recovery Policy Actions[1]	Supports Redland Corporate Plan Outcome								Responsible Group	Stakeholders	Timing	High Level Cost Estimate[2]
				Healthy Natural Environment	Green Living	Embracing the Bay	Quandamooka Country	Wise Planning & Design	Strong & Connected	Supportive & Vibrant Economy	Inclusive & Ethical Governance				
		3.1.2 Undertake detailed planning studies to investigate future development achieving better than the SPP Healthy Waters requirements (for WSUD). (ALL catchments excluding Upper Tingalpa)	5.1.1	✓	✓	✓		✓				CIG	CEU, CPU		Detailed Planning Study Cost[3]
		3.1.3 Investigate implementing a marketing campaign in support of TWCM initiatives (ALL catchments) High Priority.	2.3.2 8.1.2	✓	✓	✓					✓	MCG	CIG, CEU		$5,000 - $60,000
		3.1.4 Investigate opportunities to improve connectivity to waterways through education & participation in waterway improvement projects (e.g. waterway rehabilitation, WSUD retrofit) (ALL catchments). High Priority.	8.1.4 8.2.2	✓	✓	✓		✓	✓			CEU	CSG, EEU	2013-2014	$10,000
	3.2 New development to meet alternative water supply targets set by Queensland Development Code MP 4.2 and 4.3	3.2.1 Ensure water saving target requirements are included in Redland Planning Scheme. High Priority.			✓			✓				CPU	CEU,	2013-2014	$5,000
		3.2.2. Investigate alternative sources of water for new developments, as per actions 5.3.1, 5.3.2 and 5.3.3 for sustainably managing water resource.		✓	✓	✓		✓				Redland Water	CEU, CIU	2013-2014	Refer to Actions 5.3.1, 5.3.2, 5.3.3
	3.3 Plan and articulate our future water supply needs	3.3.1 Investigate upgrade to WTP process at Capalaba Treatment Plant (e.g. to minimise trihalomethanes concentrations) to ensure safe and secure supply (Upper Tingalpa). High Priority.						✓				SEQ Water	Redland Water	2013-2014	$4-10 Million
		3.3.2 Clarify implications of Indigenous Land Use Agreement on NSI water supply. Pending results, undertake detailed planning studies to investigate desalination and other new water supply infrastructure (e.g. dams, weirs, pipeline, bores, stormwater, sewer mining) to ensure secure supply (NSI). High Priority.[1]						✓				SEQ Water, Linkwater, Grid Manager, Traditional Land Owners	Redland Water	2013-2014	$2.00 - $3.50/kL (for Desal) Dependent on source
		3.3.3 Undertake detailed planning studies to more accurately define and/ or routinely monitor and track population growth for future planning purposes (Hilliards, Eprapah, South Eastern Creeks, Coochiemudlo and SMBIs, NSI) as part of local growth management, development assessment and planning scheme review.						✓				CPU	Redland Water, CIG	2013-2014	$100,000 (population model) Internal cost only for monitoring

[1] Note discussion with Councillors (9/10/12) indicates that the ILUA is unlikely to affect water supply, however this should be confirmed. If confirmed, this action would no longer be required.

Long Term TWCM Strategy	Specific TWCM Objective	Actions (5 yrs)	Supporting Waterway Recovery Policy Actions[1]	Supports Redland Corporate Plan Outcome								Responsible Group	Stakeholders	Timing	High Level Cost Estimate[2]
				Healthy Natural Environment	Green Living	Embracing the Bay	Quandamooka Country	Wise Planning & Design	Strong & Connected	Supportive & Vibrant Economy	Inclusive & Ethical Governance				
4. Manage Wastewater Treatment Systems to protect receiving waters and public health	4.1 Meet and go beyond licence conditions by reducing effluent flows and pollutant loads within the wastewater system	4.1.1 Review the work that has been done to investigate the potential for recycled water use (refer to below action 5.3.3 for sustainably managing water resources). Undertake further studies as required.		✓	✓			✓						2013-2014	Refer Action 5.3.3
		4.1.2 Undertake further detailed planning studies to investigate improved nutrient treatment processes at Victoria Point STP (TN capital upgrades, alum dosing for TP) (Eprapah Creek). High Priority.		✓	✓	✓		✓				Redland Water		2013-2014	Detailed Planning Study Cost[3] $5.5 Million (Capex) $40,000/yr (Opex)
		4.1.3 Undertake further detailed planning studies to investigate improved treatment processes at other STPs (Mt Cotton, Capalaba, Thorneside, Dunwich, Point Lookout)		✓	✓	✓		✓				Redland Water		2013-2014	Detailed Planning Study Cost[3]
		4.1.4 Undertake detailed planning studies to investigate implementing a cap on population growth to avoid further deterioration of waterway health (refer action 1.2.2)		✓	✓	✓		✓				CEU	Redland Water, CPU	2013-2014	Refer to Action 1.2.2
	4.2 Minimise trade waste	4.2.1 Continue to implement RCC Trade waste Policy and Environmental Management Plan		✓	✓	✓		✓				Redland Water	RedWaste, CEU	2013-2017	
		4.2.2 Revise the Category 1 classification in the RCC Trade Waste Policy to be consistent with the Model Trade Waste EMP published by DNRM & EPA in 2004.		✓	✓	✓		✓				Redland Water		2013-2014	$5,000
		4.2.3 Implement recommended actions in Netserv Plan to minimise and manage trade waste		✓	✓	✓		✓				Redland Water		2013-2014	
	4.3 Sustainably manage biosolids, through beneficial reuse (ie agriculture)	4.3.1 Continue beneficial reuse of biosolids (currently 100% reuse)		✓	✓			✓				Redland Water		2013-2017	$1.1 Million/yr ($70/tonne, 40 t/day)
		4.3.2 Undertake further detailed planning investigations to assess the viability of a centralized solar drying facility at Cleveland to reduce biosolid generation and associated transport and disposal costs.			✓			✓				Redland Water		2013-2014	Detailed planning cost Works cost $8-14 Million (Capex)
		4.3.3 Implement recommended actions in Netserv Plan to minimise and manage biosolids generation			✓			✓				Redland Water		2013-2014	

Long Term TWCM Strategy	Specific TWCM Objective	Actions (5 yrs)	Supporting Waterway Recovery Policy Actions[1]	Supports Redland Corporate Plan Outcome								Responsible Group	Stakeholders	Timing	High Level Cost Estimate[2]
				Healthy Natural Environment	Green Living	Embracing the Bay	Quandamooka Country	Wise Planning & Design	Strong & Connected	Supportive & Vibrant Economy	Inclusive & Ethical Governance				
	4.4 Reduce number of overflows caused by blockages, inflow and infiltration	4.4.1 Improve prevention of illegal stormwater inflow connections to sewer through increased compliance inspections and education campaigns (ALL catchments). High Priority.		✓	✓	✓		✓	✓			Redland Water	SAG, EEU, MCG, Community Groups, residents	2013-2017	Redland Water Input Required
		4.4.2 Develop pump station EMPs and undertake pump station upgrades to reduce the likelihood of wet weather overflows (ALL catchments) for compliance with the ERA63 code. High Priority.		✓	✓	✓		✓				Redland Water		2013-2017	$20,000 (Opex)
		4.4.3 Undertake detailed planning to investigate sewerage upgrades to improve storage/conveyance of wet weather flows. High Priority.		✓	✓	✓		✓				Redland Water		2013-2017	$50,000 (Opex)
		4.4.4 Undertake detailed planning to investigate reducing wet weather infiltration to sewerage infrastructure through sewer rehabilitation / or installation of smart sewers in greenfield areas (ALL catchments). High Priority.		✓	✓	✓		✓				Redland Water		2013-2017	$50,000 (Opex)
	4.5 To encourage waste minimisation and cleaner production, including waste prevention, recycling, and pre-treatment.	4.5.1 Undertake detailed planning study to review and further investigate the potential for recycled water use (refer to action 5.3.3 for sustainably managing water resources)	2.2.1	✓	✓	✓		✓							Refer to Action 5.3.3
		4.5.2 Undertake Landfill Options and Viability Study to assess potential solutions for landfill leachate management in Redlands, including upgrades to increase the treatment capacity of STPs. Implement recommendations / undertake further detailed planning investigations pending outcomes of the Options and Viability assessment. High Priority for Tarradarrapin, Lower Tingalpa, South Eastern Creeks, NSI.		✓	✓	✓		✓				Redwaste	Redland Water	2012-2013	$2-$5Million (Capex) $110,000 (Opex)
	4.6 To safeguard public health and the environment	4.6.1 Undertake further detailed planning studies investigating the provision of sewerage infrastructure for unsewered areas. High Priority catchments: SMBIs Medium Priority: Hilliards, Eprapah, South East Creeks Develop policy and standards with regard to low pressure sewer systems, for example, connecting missing links in Ormiston		✓	✓	✓		✓				Redland Water	CEU	2013-2017	Redland Water to cost planning study Implement. Cost approx. $34 Million (Capex) $1.1 Million/yr (Opex)

Long Term TWCM Strategy	Specific TWCM Objective	Actions (5 yrs)	Supporting Waterway Recovery Policy Actions[1]	Supports Redland Corporate Plan Outcome								Responsible Group	Stakeholders	Timing	High Level Cost Estimate[2]
				Healthy Natural Environment	Green Living	Embracing the Bay	Quandamooka Country	Wise Planning & Design	Strong & Connected	Supportive & Vibrant Economy	Inclusive & Ethical Governance				
		4.6.2 Undertake detailed planning studies to investigate undertaking inspections and education to improve management of on site wastewater systems. (ALL catchments excluding Tarradarrapin). High priority catchments: Cleveland and Thornlands, Eprapah, Upper Tingalpa, SMBIs, NSI.		✓	✓	✓		✓				SAG	CEU Redland Water Residents	2013-2017	Detailed Planning Study Cost[3]
		4.6.3 Undertake detailed planning studies to further investigate sustainable wastewater treatment options for potential new development on NSI. High Priority.		✓	✓	✓		✓				Redland Water		2015	Detailed Planning Study $150,000 Cost to implement to be determined
		4.6.4 Investigate the sustainability of on-site irrigation at Cleveland STP, as recommended by Water Strategies (2011). High Priority.		✓		✓		✓				Redland Water		2013	$30,000
	4.7 To equitably recover the cost of services to commerce and industry including the cost of conveyance, treatment and disposal and, maintenance and repair of damage to the sewerage system.	4.7.1 Investigate policy initiative for wastewater infrastructure rates to be charged on the basis of mains water consumption. (ALL catchments)			✓			✓				Redland Water	MCG	2013-2014	Internal cost only
5. Sustainably Manage Water Resources to protect the environment and provide reliable, least cost supply	5.1 Maximise efficient use of water through demand management measures and water saving devices	5.1.1 Prepare a Water Demand Management Strategy as part of the Netserv Plan, consistent with the requirements of the Water Supply (Safety and Reliability) Act 2008 and the findings of the Total Water Cycle Management Plan			✓			✓				Redland Water	CIG	July 2013	Internal cost only
		5.1.2 Ensure all new developments continue to install water saving devices and meet water saving targets as required under the Queensland Development Code (MP4.1, 4.2 & 4.3)			✓			✓				SAG	CEU	2013-2017	Low

Long Term TWCM Strategy	Specific TWCM Objective	Actions (5 yrs)	Supporting Waterway Recovery Policy Actions[1]	Supports Redland Corporate Plan Outcome								Responsible Group	Stakeholders	Timing	High Level Cost Estimate[2]
				Healthy Natural Environment	Green Living	Embracing the Bay	Quandamooka Country	Wise Planning & Design	Strong & Connected	Supportive & Vibrant Economy	Inclusive & Ethical Governance				
	(Water conservation measures to target daily consumption of less than 200L/p/day as per SEQ Water Supply Strategy)	5.1.3 Continue funding flow and pressure monitoring and use to investigate and reduce leakage 'losses' from potable water infrastructure (all catchments, North Stradbroke Island high priority to address key issue)			✓			✓				Redland Water		2013-2017	$130,000/yr (flow and pressure monitoring) $200/km to leak sweep
		5.1.4 Continue to endorse and promote permanent water restrictions (developed by Queensland Water Commission)			✓			✓				MCG	Redland Water	2013-2017	Negligible
		5.1.5 Continue to educate the community about the need to be waterwise and how they can reduce water use (e.g. through website, on Council rates etc).			✓			✓				MCG	Redland Water	2013-2017	Negligible
	5.2 Use water that's 'fit for purpose' i.e. using a quality of water no better than what is required (e.g. alternative source of water for landscape irrigation, toilet flushing, industry, construction)	5.2.1 Encourage/support the retrofitting of rainwater tanks in existing developed areas that are internally plumbed for non-potable uses. Future detailed planning investigations may be undertaken to investigate costs and benefits (e.g. of incentive schemes).	2.3.1	✓	✓	✓		✓				SAG		2013-2014	Potential Detailed Planning Study Cost[3] $3,500/ET (Capex) $20/yr (Opex)
	5.3 Investigate opportunities to use alternative water sources such as ground water, recycled water and stormwater (EPP Water s 19)	5.3.1 Undertake detailed planning study to assess stormwater harvesting opportunities, particularly for identified high priority 'breakthrough' projects: • Kinross Road future development (Hilliards Creek) • Showgrounds- Norman Price Park (Cleveland) • Judy Holt Park (Tarradarrapin) • Pinklands sporting fields (Thornlands) (ALL catchments). In addition to the above, the following catchments are high priority: • Eprapah Creek (SET, Bunker Rd, Double Jump Rd) • South Eastern Creeks (Double Jump Rd, Weinam Creek)	2.1.1 2.1.2 2.3.1	✓	✓	✓		✓	✓			CIG CEU	CSG, EEU, MCG	2013-2014	Detailed Planning Study $100,000 To be determined following detailed studies

Long Term TWCM Strategy	Specific TWCM Objective	Actions (5 yrs)	Supporting Waterway Recovery Policy Actions[1]	Supports Redland Corporate Plan Outcome								Responsible Group	Stakeholders	Timing	High Level Cost Estimate[2]
				Healthy Natural Environment	Green Living	Embracing the Bay	Quandamooka Country	Wise Planning & Design	Strong & Connected	Supportive & Vibrant Economy	Inclusive & Ethical Governance				
		5.3.2 Undertake detailed planning study to assess communal rainwater tank opportunities in greenfield developments		✓	✓	✓		✓				CEU		2013-2014	$10/kL (capex) $3.30/kL (opex)
		5.3.3 Review and further investigate the potential for recycled water use (treated STP effluent). High priority for Lower Tingalpa, Hilliards Creek, Eprapah Creek, Southern Creeks, NSI.	2.2.1	✓	✓	✓		✓				Redland Water	CIG	2013-2014	Internal cost only
6. Safeguard the community and increase resilience to the impacts of Flooding & Storm Tide	6.1 Manage flood and storm tide risk to the community and property	6.1.1 Investigate implementing an education campaign to address flooding and storm tide issues, including making mapping made available to the public, including notes on rates, and installing historical flood markers and signs (Tarradarrapin, Cleveland and Thornlands, South Eastern Creeks, Southern Creeks, Lower Tingalpa, Coochiemudlo & SMBIs, NSI) High Priority.				✓		✓	✓		✓	MCG, EEU	CIG ,RDMG	2013-2014	$20,000
		6.1.2 Implement flood mitigation works recommended in detailed planning studies (Lower Tingalpa, South Eastern Creeks, Southern Creeks). High Priority						✓				CIG	RDMG	2013-2015	Lower Tingalpa: $900,000 South Eastern Creeks: $5.7 Million Southern Creeks: $1.4 Million
		6.1.3 Undertake detailed planning study to further investigate flooding /storm tide mitigation options (Tarradarrapin, Cleveland, NSI, Coochiemudlo and SMBIs). High Priority.				✓		✓				CEU	CIG, RDMG	2013-2014	$160,000 (planning studies)
		6.1.4 Investigate implementing constraints on future land development to address flooding and storm tide issues (through planning scheme) (Tarradarrapin, South Eastern Creeks, NSI, Coochiemudlo and SMBIs). High Priority				✓		✓				CPU		2013-2014	$5,000?
		6.1.5 Review current acquisition of land inundated by flooding/storm tide on SMBIs through land exchange program and consider extending program (Coochiemudlo and SMBIs)				✓		✓			✓	CPU	MCG	2012-2013	$1.1 Million (current program)

Long Term TWCM Strategy	Specific TWCM Objective	Actions (5 yrs)	Supporting Waterway Recovery Policy Actions[1]	Supports Redland Corporate Plan Outcome								Responsible Group	Stakeholders	Timing	High Level Cost Estimate[2]
				Healthy Natural Environment	Green Living	Embracing the Bay	Quandamooka Country	Wise Planning & Design	Strong & Connected	Supportive & Vibrant Economy	Inclusive & Ethical Governance				
		6.1.6 Undertake detailed planning study to further investigate implementing land acquisition and exchange program on NSI.				✓		✓			✓	CPU	MCG	2013-2014	$1 Million

[1] Cross references Action in *Draft Waterway Recovery Policy and Action Plan (RCC 2012)*
[2] Cost estimate is indicative only
[3] Assumes cost of approximately $500,000 to undertake detailed planning studies.

Abbreviations for Council Departments:

CEU = City Environment Unit

CSG = City Spaces Group

CIG = City Infrastructure Group

EEU = Environmental Education Unit

SAG = Sustainable Assessment Group

RDMG = Roads, Drainage and Marine Group

MCG = Marketing and Communications Group

CPU = City Planning Unit

PDG = Project Delivery Group

Acronyms:

NSI – North Stradbroke Island

SMBI – Southern Moreton Bay Islands

WEP – Waterway Extension Program

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Appendix A

Existing Water Account Methodology

APPENDIX A: EXISTING WATER ACCOUNT METHODOLOGY

This section presents the methodology used to develop the current water accounts (i.e. 2012).

WATER ACCOUNTING METHODOLOGY

For each of the 10 catchments, existing water cycle accounting was undertaken by quantifying each of the following elements:

- **Rainfall** – accounts for all rainfall on the catchment, based on catchment area and average annual rainfall;
- **Evapotranspiration** – volume of water evaporating from the ground and surface waters, along with transpiration losses from vegetation;
- **Groundwater drainage loss** – volume of water lost out of the system in the form of groundwater infiltration. This water does not flow back into surface waters;
- **Rural extractions** – volume of water extracted from both surface water and groundwater for irrigation and stock watering purposes;
- **Reticulated water yield** – volume of potable water available in each catchment from surface water and groundwater storages, and also from the SEQ Water Grid;
- **Reticulated water demand** – residential and non-residential reticulated water demand within reticulated water network catchments.
- **Exported reticulated water** – volume of reticulated water exported out of the catchment in trunk water infrastructure (i.e. SEQ Grid);
- **Imported reticulated water** – volume of reticulated water imported into the catchment;
- **Reticulated network leakage** (non-revenue water) – volume of water lost from reticulated network infrastructure due to leakage;
- **Stormwater discharges** – surface runoff and groundwater (baseflow) entering receiving waters;
- **Wastewater discharges** – volume of wastewater discharged from STPs into receiving waters; and
- **Recycled water** – wastewater treated at STPs and recycled back into the water network (e.g. through third pipe systems) as a substitute for potable water in some uses.
- **Population** – residential population for each planning catchment, assumed to be connected to the water grid

The methodology for calculating each of the above elements is included in the following sections.

Rainfall

Rainfall volume was calculated for each catchment using catchment area multiplied by the average annual rainfall for the Redlands region. Average rainfall for the mainland catchments was estimated to be 1255 mm/yr. This was determined using long term rainfall from the following BOM rainfall stations within the Redlands mainland region: Redlands HRS 040265, Mount Cotton Farm 40460,

Redland Bay Golf Club 40853, Shailer Park Oregon Drive 40715, Mount Cotton West 40141, and Capalaba Water Treat 40458. Average annual rainfall for Coochiemudlo and SMBIs was estimated to be 1471 mm using Russel Island BOM rainfall station (40185). Average annual rainfall for North Stradbroke Island was estimated to be 1559 mm using Dunwich BOM rainfall station (40537).

Assumptions:

- That each catchment on the mainland experiences approximately the same average annual rainfall per year.

Evapotranspiration

To calculate the volume of water lost out of each catchment through evapotranspiration, potential evapotranspiration (PET) data was sourced from the Climatic Atlas of Australia.

However, for Lower Tingalpa and Coolnwynpin Creek an estimate of actual evapotranspiration was made, to appropriately balance the water cycle, as water outputs were initially calculated to be greater than water inputs.

To estimate actual evapotranspiration in the Lower Tingalpa and Coolnwynpin Creek catchment, the input into each catchment from rainfall was balanced with the following outputs:

- Stormwater runoff;
- Groundwater drainage loss. This was assumed to be 1.5% of annual rainfall, based on modelling studies undertaken in Australia which modelled deep drainage of groundwater (National Water Commission 2010);
- Water demand from Tingalpa Reservoir;
- Water demand from rainwater tanks; and
- Rural surface water demands.

Groundwater Drainage Loss

Water lost out of each catchment through groundwater infiltration and drainage loss was estimated using our water balance in all catchments apart from Lower Tingalpa and Coolnwynpin Creek catchment, where groundwater loss was calculated as being equivalent to 1.5% of annual rainfall. This figure was based on modelling studies undertaken in Australia which modelled deep drainage of groundwater (i.e. water moving to below the root zone). The studies concluded that groundwater deep drainage coefficients (i.e. modelled average annual deep drainage as a percentage of average annual rainfall) generally range between 1.5% and 1.8% (National Water Commission, 2010). The lower figure of 1.5% was utilised for water accounting purposes in the Lower Tingalpa and Coolnwynpin Creek catchment, with an estimate of actual evapotranspiration (rather than PET) used to balance this water account.

Groundwater drainage loss for other catchments was calculated by balancing the input into each catchment from rainfall with the following outputs:

- Stormwater runoff;
- Potential Evapotranspiration;

- Catchment surface water demand (from rainwater tanks and rural surface water use).

This method indicated groundwater drainage loss was higher than may have been predicted using the general findings from NWC modelling studies (i.e. 1.5 - 1.8% of Annual Rainfall). This was particularly the case with North Stradbroke Island, where greater groundwater infiltration is to be expected.

Assumptions:

- It is assumed that the groundwater drainage loss includes the component of groundwater infiltration that drains into aquifers as groundwater recharge, and is effectively lost to the system. Groundwater that eventually flows into surface waters is included in the stormwater discharges component of the water cycle account; and
- The groundwater drainage loss estimate derived from the water balance assumes all other losses to the system have been accounted for, with the remaining loss attributed to groundwater drainage. In reality, other unaccounted for losses (i.e. from unlicensed rural extractions) and the accuracy of available data will affect the accuracy of this estimate.

Rural Extractions

To determine approximate volumes of water extracted from groundwater and surface water sources for rural applications in each catchment, water licence data was sourced from the Department of Environment and Resource Management (DERM).

The water licence data contains details regarding the location of rural water extraction points and the irrigation area in hectares. Based on data from recent surveys of water use on Queensland farms (ABS, 2010), an average irrigation application rate of 4.0 ML/ha was used to calculate the approximate volume of water extracted for rural applications in each catchment, where water use quantities were not nominated.

Using this methodology, the volume of surface water currently extracted and used in rural applications is presented in Table A-1. North Stradbroke Island has the largest surface water extraction, all of which is used for mining purposes. It is noted that no licences currently exist for rural groundwater extraction on the mainland.

Table A-1 Rural Surface Water Extraction per Catchment

Catchment	Total Rural Surface Water Extraction (ML/yr)	Rural Surface Water Extraction Outside of RCC (ML/yr)
Tarradarrapin Creek	16	
Hilliards Creek	172	
Eprapah Creek	160	
Cleveland and Thornlands	156	
South Eastern Creeks	60	
Southern Creeks	32	28
Upper Tingalpa Creek	81	28
Lower Tingalpa and Coolnwynpin Creek	2	
Coochiemudlo & SMBI	0	
North Stradbroke Island	31,500	
Total	**32,179**	**56**

Groundwater licence extraction data within the Redlands region indicated groundwater is currently only sourced from Quaternary Dune Deposits within the North Stradbroke Island Basin. The major use of groundwater from the North Stradbroke Island Basin is nominated to be for urban water supply and mining. Groundwater extraction from North Stradbroke Island Basin (excluding urban water supply) is estimated to be approximately 57,806 ML/yr (assuming nominal licence use).

Assumptions:

- Rural water extraction has only been accounted for where licences exist.
- Rural water extraction has been assumed to equal nominal quantities on licences.
- Where irrigation areas have been stipulated on licences (rather than nominal qualities), the application rate of 4.0 ML/ha (ABS, 2010) has been used to estimate water extracted for rural irrigation purposes.

Reticulated Water Yield

The reticulated water yield was calculated for each catchment, which includes in-catchment raw water yield from surface water storages, groundwater storages, recycled water from STPs, and rainwater tanks, along with imported reticulated water from adjoining catchments. While rainwater tanks are not part of the reticulated water network, they supplement water from the reticulated water network so were factored into the calculations.

To calculate raw water yield from surface water and groundwater storages, production data for water treatment plants (WTPs) in the Redlands region was provided by Allconnex. This comprised annual production data for 2011.

Bulk water is typically exported out of Redlands via the Eastern Pipeline Interconnector (EPI), which is part of the SEQ Water Grid and supplies water from North Stradbroke Island to Redlands and Brisbane. Exported water data was provided by Allconnex for the Heinemann Road reservoir, which is where water exported via the EPI is metered. This exported water data was used to balance the water cycle accounts.

Rainwater tank yields were estimated by first determining the number of people in each catchment using a GIS water demand model. This model, developed by Allconnex, contains the population in equivalent persons (EP) allocated to each lot in the Redlands region from existing through to ultimate development, which is assumed to be 2031.

To determine the volume of water used in rainwater tanks, a number of general assumptions were used in the calculations as follows:

- The uptake of rainwater tanks currently in the Redlands region is assumed to be approximately 10% (based on rainwater tank rebate data received from Queensland Water Commission (QWC) 16/01/2012)
- 5% of these tanks are plumbed internally, the remainder are used for outdoor gardening only (based on rainwater tank rebate data indicating proportion of internally plumbed tanks, received from QWC 16/01/12).
- An average of 2.8 EP per household.

- Indoor reticulated water savings for internally plumbed tanks is 76 L/day (based on Water by Design, 2009).
- Outdoor reticulated water savings is 95 L/day (based on Water by Design, 2009).

Table A - 2 presents a summary of the catchment raw water yield, imported water, and overall reticulated water yield for each catchment.

Table A - 2 Reticulated Water Yield per Catchment

Catchment	Reticulated Water Yield (GL/yr)				
	Catchment Raw Water Yield				*Imported Water*
	Surface Water	Ground-water	Rainwater Tanks	Recycled Water	
Eprapah Creek Catchment	0	0	0.02	0.25	1.1
Lower Tingalpa and Coolnwynpin Creek Catchment	0	0	0.04	0	2.0
Tarradarrapin Creek Catchment	0	0	0.03	0	1.6
Upper Tingalpa Creek Catchment	6.5	0	0.002	0	0
Hilliards Creek Catchment	0	0	0.02	0.007	1.6
Cleveland and Thornlands Catchment	0	0	0.03	0	2.0
South Eastern Creeks	0	0	0.02	0	1.1
Southern Creeks	0	0	0.01	0	0.9
Coochiemudlo and SMB Islands	0	0	0.02	0	0.5
North Stradbroke Island	0	9.8	0.01	0	0

Assumptions:

- All WTPs are assumed to be operational and producing water at a constant volume based on 2011 production figures.

Reticulated Water Demand

Existing reticulated water demand in each catchment was determined using recorded water meter readings supplied by Allconnex. This data was provided as a GIS database, with an average water use in kL/day for 2010 assigned to each lot. These recorded water use values per lot were used to provide a total reticulated water use per catchment in the Redlands.

Assumptions:

- Water meter data is accurate and reflects actual volume of reticulated water used.
- Reticulated water recorded in 2010 is representative of existing conditions (i.e. 2012).

Exported Reticulated Water

With reticulated water trunk infrastructure (including the SEQ Water Grid infrastructure) forming a network across the catchments, potable water is allowed to flow between catchments depending on where the water demand is.

This flow of water was quantified by examining where the water is supplied from, combined with where the water demand is across all catchments with a reticulated water network. Water supply data and water demand figures, as discussed previously, were used in this process.

The volume of reticulated water exported out of each catchment was determined in catchments where the reticulated water yield was greater than the reticulated water demand (e.g. Upper Tingalpa Creek - comprising Leslie Harrison Dam, and North Stradbroke Island – comprising the large groundwater resource).

Assumptions:

- The water balance of reticulated water throughout the Redlands assumes that water exported to Brisbane via the EPI remains constant. In reality, the volume of exported water would fluctuate depending on daily water demand.

Imported Potable Water

The volume of reticulated water imported into each catchment was calculated using water demand figures (from GIS demand model) and water production data. Where there was a deficit in water supply in a catchment after all in-catchment sources (i.e. surface and groundwater storages, rainwater tanks, and recycled water) were accounted for, this deficit was balanced out with imported water from adjacent catchments.

Most catchments in the Redlands region import reticulated water from North Stradbroke Island or Leslie Harrison Dam in the Upper Tingalpa catchment. To determine where water is imported from in catchments with reticulated water supply deficits, reticulated water trunk infrastructure mapping was examined. This provided an indication of the extent of the reticulated water network, and water flow pathways.

Once these reticulated water network linkages had been examined, the volume of bulk water produced from Leslie Harrison Dam and North Stradbroke Island was distributed throughout the catchments with a reticulated water deficit. Based on current production data, this resulted in an approximate volume of 11.5 GL/yr being distributed, with an additional 1.2 GL/yr of water being exported to Brisbane via the EPI.

Reticulated Network Leakage

Reticulated network leakage, or non-revenue water, refers to water which leaks out of reticulated water infrastructure. It is sometimes referred to as non-revenue water as the water does not reach the consumer and therefore the consumer cannot be charged for its use.

In the water accounts, this water is assumed to be lost out of the system. Based on Redland Water systems monitoring data in 2009 and 2010, the average non-revenue water loss (system leakage) is

6% of total water production. Therefore, this figure of 6% was added to the water demand figures to derive a total water production figure for each catchment.

Assumptions:

- That reticulated network leakage across the entire Redlands region is consistent with monitoring data in 2009/2010, which found non-revenue water loss (system leakage) to be on average 6% of total water production; and
- For the purposes of water accounting, it is assumed that all reticulated network leakage is lost out of the system, and does not flow to groundwater or surface waters.

Stormwater Discharges

Stormwater discharges relate to surface runoff after rainfall events as well as groundwater flow (i.e. baseflow) from both urban and rural land uses in each catchment. In the water accounts, these stormwater discharges are represented by average annual flow volume and associated pollutant loads into receiving waterways at the bottom of each catchment.

To quantify stormwater discharges, results previous catchment modelling studies undertaken for the Redlands region were utilised (BMT WBM, 2008). Extracted results were interrogated to gather flow and water quality data for the RCC TWCM planning catchments.

In the catchment model, the modelled stormwater discharges also included wastewater discharges from sewage treatment plants (STPs), although these wastewater discharges were separated out in the water accounts, and are discussed further under *Wastewater Discharges*.

Flows and pollutant loads for each catchment are presented in Table A - 3.

Table A - 3 Stormwater Discharges per Catchment

Catchment	Stormwater Discharges (without STP loads)			
	Flow (ML/yr)	TSS (t/yr)	TN (t/yr)	TP (t/yr)
Tarradarrapin Creek	4,346	398	5.9	0.9
Hilliards Creek	8,764	630	11.2	1.4
Eprapah Creek	13,762	1,087	18.9	2.4
Cleveland and Thornlands	7,307	612	9.8	1.4
South Eastern Creeks	11,035	846	15.3	1.9
Southern Creeks	9,117	461	9.9	1.0
Upper Tingalpa	11,376	664	14.0	1.7
Lower Tingalpa & Coolnwynpin Creek	8,994	714	12.0	1.7
Southern Moreton Bay Islands	10,709	558	12.7	1.4
North Stradbroke Island	2,004	190	2.7	0.4
Total	**87,414**	**6,160**	**112.4**	**14.2**

Assumptions:

- That stormwater flows and pollutant loads modelled in 2008 are representative of existing (2012) conditions.

Wastewater Discharges

Wastewater generated by each Sewage Treatment Plant within the Redlands region was estimated using information provided by Allconnex and information contained in the Redlands' *Wastewater Treatment Plant Strategy to 2025* (Water Strategies 2010). Average Dry Weather Flow (ADWF) data between January and December 2011 was used to estimate the current annual wastewater discharged from each STP. A summary of current wastewater discharges for each STP is detailed in Table A - 4.

Table A - 4 Current (2012) STP Discharge (after reuse)

Catchment	STP	Licence Capacity (EP)	Current Capacity (EP)	Discharge (ML/yr)
Lower Tingalpa & Coolnwynpin Creek	Capalaba	50,000	27,071	1,629
	Thorneside	50,000	42,380	3,248
Hilliards Creek	Cleveland	50,000	34,588	2,683
Eprapah Creek	Victoria Point	50,000	30,374	2,294
Southern Creeks	Mt Cotton	50,000	3,433	276
North Stradbroke Island	Dunwich	1,500	898	54
	Point Lookout	4,000	2,931	93
Total Wastewater Discharge				***10,277***

Notes:

North Stradbroke Island STPs discharge to groundwater via land disposal

Approximately 50% of effluent from Cleveland STP is discharged to land

Recycled water not included in future discharges.

Existing 2011 data on the quality of wastewater effluent discharged from each STP (1/01/2011 – 31/12/2011) was used to estimate current pollutant loads discharged to receiving waters/land. Pollutant loads for Total Nitrogen (TN), Total Phosphorus (TP) and Total Suspended Solids (TSS) were estimated using the following method:

Annual Pollutant Load = ADWF Effluent x Median Pollutant Concentration x 365

The adopted effluent concentrations for each STP, based on existing data provided by Allconnex, is summarised in Table A - 5, and the resulting pollutant loads discharged by each STP is summarised in Table A - 6.

Table A - 5 Current (2012) Median STP Effluent Concentrations

Catchment	STP	Median Concentration (mg/L)		
		Total Suspended Solids	Total Nitrogen	Total Phosphorus
Lower Tingalpa & Coolnwynpin Creek	Capalaba	3	1.60	0.70
	Thorneside	3	1.20	0.30
Hilliards Creek	Cleveland	3	1.10	0.20
Eprapah Creek	Victoria Point	3	1.30	2.95
Southern Creeks	Mt Cotton	3	3.20	0.20
North Stradbroke Island	Dunwich	3	2.60	0.75
	Point Lookout	7	12.50	6.00

Table A - 6 Current (2012) Pollutant Loads Discharged (after reuse)

Catchment	STP	Annual Loads (kg/yr)		
		Total Suspended Solids	Total Nitrogen	Total Phosphorus
Lower Tingalpa & Coolnwynpin Creek	Capalaba	4,887	2,606	1,140
	Thorneside	9,744	3,898	974
Hilliards Creek	Cleveland	8,050	2,952	537
Eprapah Creek	Victoria Point	6,883	2,983	6,768
Southern Creeks	Mt Cotton	827	882	55
North Stradbroke Island	Dunwich	161	140	40
	Point Lookout	651	1,162	558
Total		***31,203***	***14,623***	***10,072***

Notes:

North Stradbroke Island STPs discharge pollutant loads to groundwater via land disposal

Approximately 50% of pollutant loads from Cleveland STP is discharged to land

In estimating the annual pollutant loads and flows discharged to receiving waters from each STP, reuse of effluent was also accounted for. The quantities of wastewater reused (i.e. recycled water)

were based on estimates provided through discussions with Allconnex and from information contained in the project brief, and are discussed further under *Recycled Water.*

It should be noted that although wastewater will be generated in each catchment, for the purposes of establishing the current water balance and quantifying pollutant loads to receiving waters in each catchment, wastewater has been accounted for in the particular catchment that effluent is discharged within. Where more than one STP exists in a catchment, the sum of the flows and pollutant loads for each STP has been calculated for that catchment (i.e. Capalaba and Thorneside STPs both discharge to Tingalpa Creek in the Lower Tingalpa and Coolnwynpin Creek Catchment, therefore the existing catchment account reflects flows and pollutant loads for both STPs.)

Effluent and pollutant loads generated from septic systems and discharged to land within the Redlands region has been estimated for inclusion in the catchment accounts. A summary of existing septic generated pollutant loads is detailed in Table A - 7.

Although conservative estimates have been undertaken to quantify septic pollutant loads discharged to land, it is unknown what proportion of these loads will eventually be discharged to receiving waters through the soil profile.

Table A - 7 Estimate of Septic Loads Discharged to Land

Catchment	Effluent (ML/yr)	TSS (t/yr)	TN (t/yr	TP (t/yr
Tarradarrapin	0	0	0	0
Hilliards	58	7	3	0.9
Eprapah	96	12	6	1.5
Cleveland & Thornlands	65	8	4	1.0
South Eastern Creeks	44	5	3	0.7
Southern Creeks	29	4	2	0.5
Upper Tingalpa Creek	100	12	6	1.6
Lower Tingalpa Creek	123	15	7	2.0
Southern Moreton Bay Islands	390	48	23	6.2
North Stradbroke Island	148	18	9	2.4
Total	**1,052**	**129**	**63**	**16.8**

Assumptions:

- Wet weather overflows are not accounted for due to their highly variable nature and the difficulty in accurately quantifying such flows and pollutant loads. However wet weather pollutant loads, while locally significant, are not expected to significantly affect catchment pollutant loads, as they make up a small proportion of total STP flows/pollutant loads;
- For deriving septic effluent discharges, the following assumptions were used:
  1. RCC mapping data used to identify properties potentially using septic systems.
  2. 2.9 EP/dwelling (assume detached dwellings) from Redland population and housing profile (Queensland Treasury 2011)
  3. Average sewage generation in Redlands is 210 L/EP/day (Water Strategies, 2010)

4. All on site systems are septic and treat to primary standard only, with average effluent quality as follows: 123 mg/L TSS, 60 mg/L TN, 16 mg/L TP (derived from Qld Plumbing and Wastewater Code (2010) & On Site Sewerage Facilities Guidelines for Effluent Quality (2004), Department of Local Government and Planning)

Recycled Water

Volumes of recycled water (i.e. reused wastewater) currently used at each STP have been accounted for in each catchment based on estimated quantities provided in the project brief and from discussion with Allconnex staff. These reuse figures are presented in Table A - 8 below.

Pollutant loads have been estimated assuming the concentrations in Table A - 5 applied to the volumes of recycled water used. As per wastewater discharges, the water account for flow volumes and pollutant loads of recycled water have been assigned to those catchments that the STP would normally discharge to. Recycled water flows and pollutant loads have been subtracted from STP discharges, as previously discussed.

Table A - 8 Current (2012) Recycled Water Use

Catchment	STP	Recycled Water (ML/yr)	Notes
Lower Tingalpa & Coolnwynpin Creek	Capalaba	0	Capalaba STP has recently constructed a Class A recycled water plant (240 kL/day capacity) however currently not operational.
	Thorneside	0	
Hilliards Creek	Cleveland	7.3	Used for construction, dust suppression, quantity varies depending on demand. Not monitored, Allconnex estimate only.
Eprapah Creek	Victoria Point	255	Used for golf course irrigation, Allconnex estimate only
Southern Creeks	Mt Cotton	0	Used for golf course irrigation however quantity unknown and not classified as reuse by DERM.
North Stradbroke Island	Dunwich	0	
	Point Lookout	0	

Assumptions:

- Recycled water use based on quantities provided by Allconnex and information within project brief;

Population

Current population predictions were derived from the Allconnex GIS demand model, which includes the residential and non-residential EP within reticulated water network catchments. Hence, these population estimates predominantly relate to the urban population as rural areas are generally not connected to the reticulated water network. Residential population was assumed to be equivalent to the PIFU medium growth scenario (2011), so that the difference between the demand model EP and the PIFU population projection was assumed to be the non-residential EP. The non-residential EP was then proportionately removed from each of the Redlands catchments with anticipated non-

residential demands, to estimate the existing residential population within each planning catchment. Existing residential population for each catchment is outlined in Table A - 9.

Table A - 9 Existing Population

Catchment	Population
Eprapah Creek Catchment	11,706
Lower Tingalpa and Coolnwynpin Creek Catchment	28,543
Tarradarrapin Creek Catchment	21,061
Upper Tingalpa Creek Catchment	1,573
Hilliards Creek Catchment	18,500
Cleveland and Thornlands Catchment	24,934
South Eastern Creeks	12,142
Southern Creeks	7,430
Coochiemudlo and SMB Islands	14,053
North Stradbroke Island	5,932
Total	**145,874**

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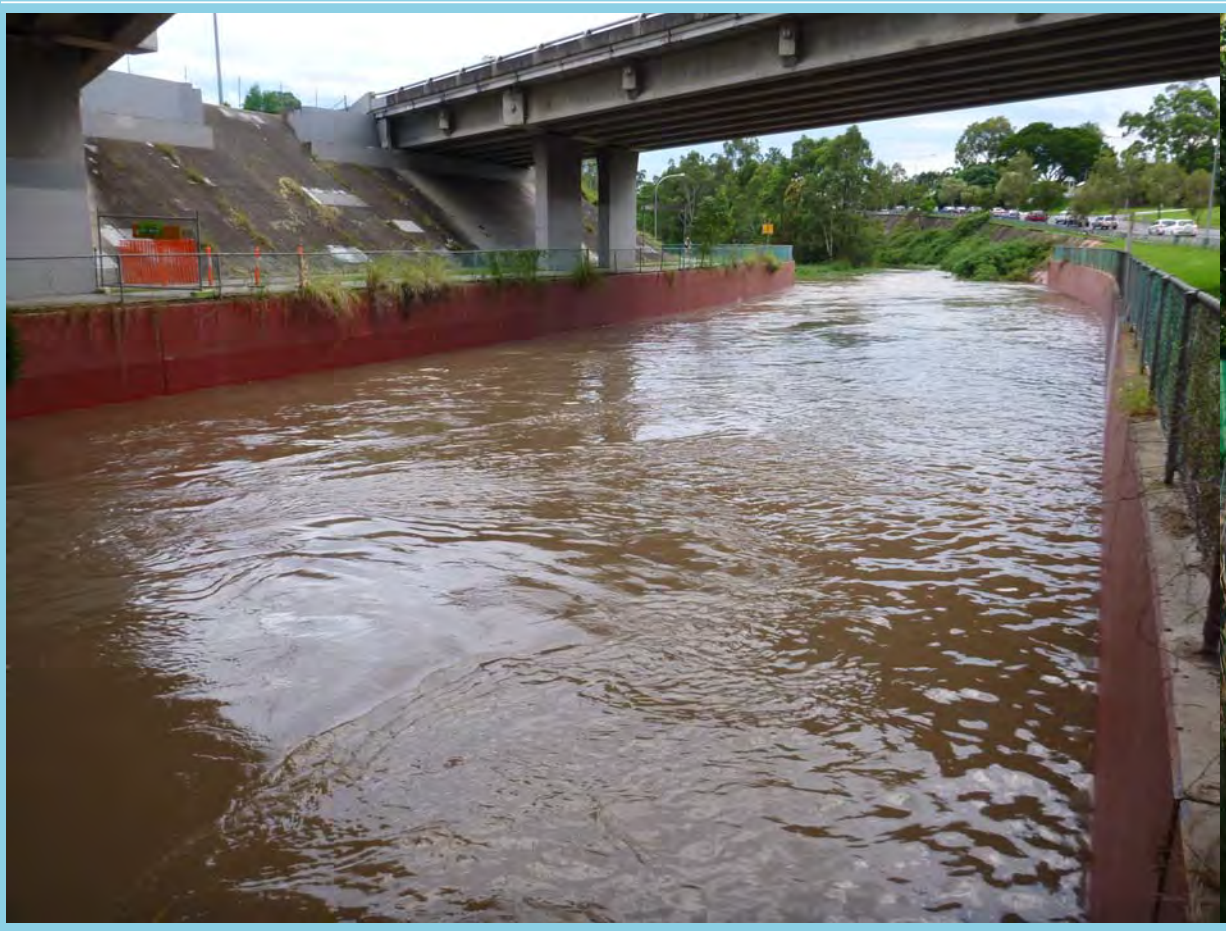
Appendix B



Future Water Account Methodology

APPENDIX B: FUTURE WATER ACCOUNT METHODOLOGY

This section presents the methodology used to develop the future water accounts. The future water accounts represent a 2031 future scenario and were developed assuming that development and water cycle management practices would follow a 'business as usual' (i.e. current practices) path. This will assist in the identification of potential water cycle management pressures / issues and management options.

WATER ACCOUNTING METHODOLOGY

For each of the 10 catchments, future water cycle accounting was undertaken by quantifying each of the following elements:

- **Rainfall** – accounts for all rainfall on the catchment, based on catchment area and average annual rainfall;
- **Evapotranspiration** – volume of water evaporating from the ground and surface waters, along with transpiration losses from vegetation;
- **Groundwater drainage loss** – volume of water lost out of the system in the form of groundwater infiltration. This water does not flow back into surface waters;
- **Rural extractions** – volume of water extracted from both surface water and groundwater for irrigation and stock watering purposes;
- **Reticulated water yield** – volume of potable water available in each catchment from surface water and groundwater storages, and also from the SEQ Water Grid;
- **Reticulated water demand** – residential and non-residential reticulated water demand within reticulated water network catchments.
- **Exported reticulated water** – volume of reticulated water exported out of the catchment in trunk water infrastructure (i.e. SEQ Grid);
- **Imported reticulated water** – volume of reticulated water imported into the catchment;
- **Reticulated network leakage** (non-revenue water) – volume of water lost from reticulated network infrastructure due to leakage;
- **Stormwater discharges** – surface runoff and groundwater (baseflow) entering receiving waters;
- **Wastewater discharges** – volume of wastewater discharged from STPs into receiving waters; and
- **Recycled water** – wastewater treated at STPs and recycled back into the water network (e.g. through third pipe systems) as a substitute for potable water in some uses.
- **Population** – residential population for each planning catchment, assumed to be connected to the water grid

The methodology for calculating each of the above elements is included in the following sections.

Rainfall

Average annual rainfall volumes in 2031 were assumed to be the same as current accounts. Although climate change predictions suggest that rainfall may be impacted by 2031, with the uncertainty of the predictions it was assumed that rainfall volumes would remain relatively unchanged.

Assumptions:

- Annual rainfall volumes in 2031 remain similar to current accounts, which are based on average annual rainfall for the mainland catchments, rainfall at Russel Island BOM rainfall station (40185) for Coochiemudlo and SMBI catchment, and rainfall at Dunwich BOM rainfall station (40537) for North Stradbroke Island catchment.

Evapotranspiration

Water lost out of the system due to evapotranspiration was assumed to remain unchanged from current accounts. As with rainfall, climate change may potentially impact on potential evapotranspiration rates, however with no firm data to base it on it was decided that evapotranspiration would remain unchanged in the future accounts.

Assumptions:

- Annual average evapotranspiration rates in 2031 remain similar to current accounts.

Groundwater Drainage Loss

Groundwater drainage loss for future accounts was estimated using the same methodology applied to existing accounts. Using the water balance method to estimate future groundwater drainage loss, catchments with development pressures were generally noted to have reduced groundwater drainage loss from current conditions. This is due to development pressures resulting in increased impervious areas, in turn increasing surface runoff and reducing groundwater infiltration.

Assumptions:

- The groundwater drainage loss estimate derived from the water balance assumes all other losses to the system have been accounted for, with the remaining loss attributed to groundwater drainage. In reality, other unaccounted for losses (i.e. from unlicensed rural extractions) and the accuracy of available data will affect the accuracy of this estimate.

Rural Extractions

Volume of water extracted for rural applications was assumed to remain unchanged in 2031. This is due to the rural land use remaining relatively unchanged, hence the volume of rural water extractions remaining constant. It is noted that this assumes mining will continue on North Stradbroke Island.

Assumptions:

- Rural management practices, including irrigation rates, remain unchanged from current levels;
- Water use for mining on NSI remains unchanged; and

- In line with the 'business as usual' approach to future water accounting, no rural water is supplemented by other sources such as recycled water.

Reticulated Water Yield

For future accounts, reticulated water yield remained consistent with current accounts for the most part. This assumed that surface and groundwater storages remained the same.

The only varying factors in the reticulated water yield calculations were rainwater tanks. Due to an increase in urban development as part of the future scenario, rainwater tank yields increased based on an increased population. The assumptions used for predicting future rainwater tank yields (e.g. % uptake, internal water use, etc.) were assumed to remain consistent with existing. :

Table B - 1 presents the estimated rainwater tank yields for existing scenario (2010) and future scenario (2031) based on the assumptions used.

Table B - 1 Current and Future Estimated Rainwater Tank Yields

Catchment	Rainwater Tank Yield (ML/yr)	
	2010	2031
Eprapah Creek Catchment	15	23
Lower Tingalpa and Coolnwynpin Creek Catchment	37	40
Tarradarrapin Creek Catchment	27	29
Upper Tingalpa Creek Catchment	2	2
Hilliards Creek Catchment	24	32
Cleveland and Thornlands Catchment	32	38
South Eastern Creeks	16	25
Southern Creeks	10	12
Coochiemudlo and SMB Islands	18	31
North Stradbroke Island	8	11
Total	**188**	**243**

Assumptions:

- That climate change does not significantly impact on storage yields. Although it has been suggested that storage yields will decrease by 10%, with no definitive data it was deemed appropriate to keep the storage yields consistent with current accounts.

Reticulated Water Demand

Future reticulated water demand in each catchment was calculated using a GIS water demand model supplied by Allconnex. This model provides an estimation of the population in equivalent persons (EP) allocated to each lot in the Redlands region at ultimate development, assumed to be 2031.

The base unit of demand allocation is an equivalent person (EP). For residential water demand allocation, one EP is considered equal to one person. For non-residential demand allocation, one EP is defined as a person using the same amount of water as a person living in an equivalent tenement (ET) which has an area between 500 to 1,000 m2.

Using the estimates of 2031 EP in each catchment derived from the GIS water demand model, future water demand figures were calculated using an assumed water usage of 300 L/EP/day (based on the RCC PIP figure - which includes residential use, non-residential use and system losses).

Assumptions:

- Water use per EP in 2031 is assumed to be 300 L/EP/day in accordance with PIP figures. Based on existing water use data, current water use is approximately 180 L/EP/day. Therefore, the future case assumes that water use will be higher by 2031.

Exported Reticulated Water

The methodology used to calculate exported reticulated water for future accounts was similar to that used in the current accounts. The volume of water exported out of catchments such as Upper Tingalpa and North Stradbroke Island increased in response to increasing water demand from adjoining catchments.

Assumptions:

- This assumes that water exported to Brisbane from the EPI remains the same as current accounts (i.e. 1.2 GL/yr). While Brisbane will no doubt require more water due to increased population, it is assumed that reticulated water there will be sourced internally or from other areas of the SEQ water grid.

Imported Reticulated Water

The methodology used to calculate imported reticulated water for future accounts was similar to that used in the current accounts. The volume of imported water changed in response to increasing water demand in each catchment.

Assumptions:

- The increased volume of imported reticulated water assumes that trunk infrastructure has the required capacity to cope with the additional volume.
- It is assumed that all additional reticulated water required in the future accounts was sourced from latent capacity in Leslie Harrison Dam and North Stradbroke Island.

Reticulated Network Leakage

Reticulated network leakage was consistent with the methodology used in the current accounts, i.e. derived by calculating 6% of the total water production in each catchment.

Assumptions:

- As reticulated network leakage in future accounts is consistent with current accounts, it is assumed that network infrastructure is neither improved nor deteriorates, but is maintained at a current state.

Stormwater Discharges

Stormwater discharges for future accounts were quantified using results from previous catchment modelling studies undertaken by BMT WBM (2008). BMT WBM (2008) investigated catchment flows

and pollutant loads for a future scenario representative of 2023 conditions (land use). As this is the best information available characterising future catchment loads, it was adopted for use in the current study. As development in the Redlands region is expected to reach ultimate capacity by 2025, the modelling undertaken is considered to be a fair representation of future (2031) conditions.

In the catchment model, the modelled stormwater discharges also included wastewater discharges from sewage treatment plants (STPs), although these wastewater discharges were separated out in the water accounts, and are discussed further under *Wastewater Discharges*.

Flows and pollutant loads for each catchment are presented in Table B - 2.

Table B - 2 Stormwater Discharges per Catchment

Catchment	Stormwater Discharges (without STP loads)			
	Flow (ML/yr)	TSS (t/yr)	TN (t/yr)	TP (t/yr)
Tarradarrapin Creek	4,398	405	6.0	0.9
Hilliards Creek	8,981	648	11.2	1.5
Eprapah Creek	13,914	1,026	18.1	2.3
Cleveland and Thornlands	7,392	629	9.9	1.5
South Eastern Creeks	11,394	940	15.9	2.1
Southern Creeks	9,268	516	10.4	1.1
Upper Tingalpa	11,380	622	13.3	1.5
Lower Tingalpa & Coolnwynpin Creek	9,068	729	12.1	1.7
Southern Moreton Bay Islands	11,167	753	13.6	1.8
North Stradbroke Island	2,272	215	3.0	0.5
Total	**89,234**	**6,483**	**113.5**	**14.9**

Assumptions:

- That stormwater flows and pollutant loads modelled in 2023 are representative of future (2031) conditions.

Wastewater Discharges

Wastewater generated by each Sewage Treatment Plant within the Redlands region was estimated using information provided by Allconnex and information contained in the Redlands' *Wastewater Treatment Plant Strategy to 2025* (Water Strategies 2010). Predicted daily ADWF for STPs in 2025 (ultimate development case) documented by Water Strategies (2010) was used to estimate the future (2031) annual wastewater discharged from each STP. A summary of future wastewater discharges for each STP is detailed in Table B - 3.

Table B - 3 Future (2031) STP Discharge (after reuse)

Catchment	STP	Licence Capacity (EP)	Future Capacity (EP)	Future Discharge (ML/yr)
Lower Tingalpa & Coolnwynpin Creek	Capalaba	50,000	29,662	2,154
	Thorneside	50,000	47,572	3,979
Hilliards Creek	Cleveland	50,000	46,644	3,898
Eprapah Creek	Victoria Point	50,000	40,592	3,055
Southern Creeks	Mt Cotton	50,000	5,520	464
North Stradbroke Island	Dunwich	1,500	1,531	193
	Point Lookout	4,000	3,710	339
Total Wastewater Discharge				***14,082***

Notes:

North Stradbroke Island STPs discharge to groundwater via land disposal

Approximately 50% of effluent from Cleveland STP is discharged to land

Recycled water not included in future discharges. Recycled water use assumed to be the same as current.

Long term design treatment standards for the quality of wastewater effluent discharged from each STP were used to estimate future pollutant loads discharged to receiving waters/land. Pollutant loads for Total Nitrogen (TN), Total Phosphorus (TP) and Total Suspended Solids (TSS) were estimated using the following method:

Annual Pollutant Load = ADWF Effluent x Design Pollutant Concentration x 365

The adopted effluent concentrations for each STP, based on design treatment standard data, is summarised in Table B - 4, and the resulting pollutant loads discharged by each STP is summarised in Table B - 5.

Table B - 4 Future (2031) Median STP Effluent Concentrations

Catchment	STP	Median Concentration (mg/L)		
		Total Suspended Solids	Total Nitrogen	Total Phosphorus
Lower Tingalpa & Coolnwynpin Creek	Capalaba	15	5	2
	Thorneside	15	5	2
Hilliards Creek	Cleveland	15	5	1
Eprapah Creek	Victoria Point	10	3	5
Southern Creeks	Mt Cotton	15	5	2
North Stradbroke Island	Dunwich	10	10	2
	Point Lookout	30	12.5	6

Notes:

In absence of design data for Point Lookout STP, current median concentrations have been adopted for TN and TP

Table B - 5 Future (2031) Pollutant Loads Discharged (after reuse)

Catchment	STP	Annual Loads (kg/yr)		
		Total Suspended Solids	Total Nitrogen	Total Phosphorus
Lower Tingalpa & Coolnwynpin Creek	Capalaba	32,303	10,768	4,307
	Thorneside	59,678	19,893	7,957
Hilliards Creek	Cleveland	58,473	19,491	3,898
Eprapah Creek	Victoria Point	30,551	9,165	15,275
Southern Creeks	Mt Cotton	6,953	2,318	927
North Stradbroke Island	Dunwich	1,935	1,935	387
	Point Lookout	10,184	4,243	2,037
Total		***200,077***	***67,813***	***34,788***

Notes:

North Stradbroke Island STPs discharge pollutant loads to groundwater via land disposal

Assumes approximately 50% of pollutant loads from Cleveland STP is discharged to land

In estimating the annual pollutant loads and flows discharged to receiving waters from each STP, reuse of effluent was also accounted for. The quantities of wastewater reused (i.e. recycled water) were based on existing use estimates (assuming business as usual) provided through discussions with Allconnex and from information contained in the project brief, and are discussed further under *Recycled Water.*

Similar to existing accounts, although wastewater will be generated in each catchment, for the purposes of establishing the future water balance and quantifying pollutant loads to receiving waters in each catchment, wastewater has been accounted for in the particular catchment that effluent is discharged within.

Future effluent and pollutant loads generated from septic systems and discharged to land within the Redlands region has been assumed to remain as per current conditions, apart from conditions on the Southern Moreton Bay Islands. As the SMBIs are currently serviced by on site wastewater treatment systems only, population growth on the islands has been used to estimate additional effluent from on-site treatment systems. A summary of future pollutant loads generated from on-site wastewater treatment systems for SMBIs is detailed in Table B - 6.

Although conservative estimates have been undertaken to quantify septic pollutant loads discharged to land, it is unknown what proportion of these loads will eventually be discharged to receiving waters through the soil profile.

Table B - 6 Future On Site Wastewater Treatment System Loads on SMBIs

Catchment	Effluent (ML/yr)	TSS (t/yr)	TN (t/yr	TP (t/yr
Southern Moreton Bay Islands	632	55	32	8.7

Assumptions:

- Wet weather overflows are not accounted for due to their highly variable nature and the difficulty in accurately quantifying such flows and pollutant loads. However wet weather pollutant loads,

while locally significant, are not expected to significantly affect catchment pollutant loads, as they make up a small proportion of total STP flows/pollutant loads;

- For deriving effluent discharges from on-site wastewater treatment systems, the following assumptions were used:

  1. On site effluent generation in the future will remain unchanged from existing conditions, apart from SMBIs
  2. Average sewage generation in Redlands is 210 L/EP/day (Water Strategies, 2010)
  3. Future population growth on SMBIs will be serviced by new systems that require at minimum secondary treatment of wastewater, with average effluent quality as follows: 30 mg/L TSS, 35 mg/L TN, 10 mg/L TP (derived from Qld Plumbing and Wastewater Code (2010) & On Site Sewerage Facilities Guidelines for Effluent Quality (2004), Department of Local Government and Planning)

Recycled Water

Volumes of future recycled water (i.e. reused wastewater) used at each STP have been assumed to remain the same as existing quantities.

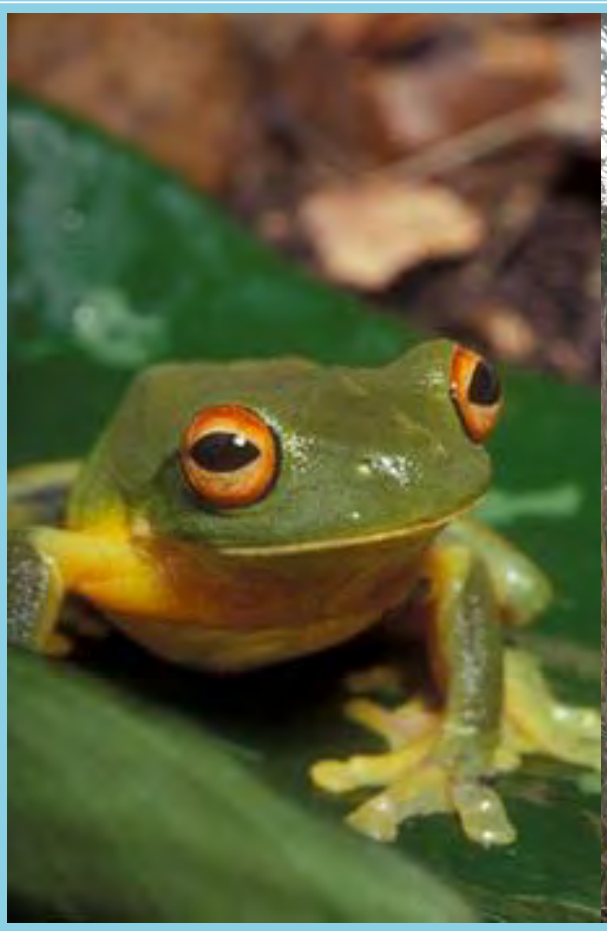
Population

Similar to the existing population estimates, future population predictions were derived from the Allconnex GIS demand model, which includes the residential and non-residential EP within reticulated water network catchments for the ultimate development scenario (2025). Hence, these population estimates predominantly relate to the urban population as rural areas are generally not connected to the reticulated water network. Residential population was assumed to be equivalent to the PIFU medium growth scenario (2031), so that the difference between the demand model EP and the PIFU population projection was assumed to be the non-residential EP. The non-residential EP was then proportionately removed from each of the Redlands catchments with anticipated non-residential demands, to estimate the future residential population within each planning catchment. Future residential population for each catchment is outlined in Table B - 7.

Table B - 7 Future Population

Catchment	Population
Eprapah Creek Catchment	17,915
Lower Tingalpa and Coolnwynpin Creek Catchment	30,770
Tarradarrapin Creek Catchment	22,561
Upper Tingalpa Creek Catchment	1,556
Hilliards Creek Catchment	24,996
Cleveland and Thornlands Catchment	29,535
South Eastern Creeks	19,374
Southern Creeks	9,096
Coochiemudlo and SMB Islands	24,121
North Stradbroke Island	8,548
Total	**188,471**

Appendix C



RCC Risk Assessment Tables

APPENDIX C: RCC RISK ASSESSMENT TABLES

For each water cycle management pressure identified within the planning catchments (and described in Section 3), specific issues were further identified during a stakeholder workshop. A risk assessment workshop was then convened on 19 March 2012 with key stakeholders from RCC and Allconnex. Additional internal workshops were held by Council to finalise the risk assessment.

The purpose of the risk assessment workshop was to identify any high to extreme risk water cycle management issues which will require future detailed TWCM planning studies to address. The risk assessment was undertaken in accordance with the Australian Standards for risk management (AS/NZ 31000:20009).

A summary of the key steps undertaken during the risk assessment workshop is outlined below:

Step 1: Review water cycle management issues, and consider the implications of these issues. Consider whether implications differ amongst catchments.

Step 2: Identify any additional issues/risks, and the implications of these issues.

Step 3: Identify current or planned (and formally adopted) management measures/strategies to address the water cycle management issue.

Step 4: Considering current management measures/strategies to address the issue (from Step 3), identify the likelihood that the issue will be addressed by the management measures and whether the issue will still occur (perhaps to a lesser extent) in each applicable catchment. Assign likelihood using definitions provided in Redland City Council's Likelihood Table for guidance (RCC Risk Assessment Handbook 2011a).

Step 5: Using RCC's Consequence rating tables for guidance discuss the implications of the issue, and the severity (consequence) rating of the issue occurring in relevant catchments was identified.

Step 6: Using the likelihood and consequence ratings, assign an issue risk rating for each catchment, using RCC's Risk Rating Table. Review and discuss the final risk ratings to confirm that an appropriate risk assessment of the issue had been undertaken.

It is noted that for Steps 4 and 5, the likelihood and consequence of each risk was assessed by stakeholders and reviewed/discussed until a general consensus was reached.

The risk assessment process outlined above identified those water cycle management issues that are considered by stakeholders to have high to extreme risk ratings. These are the issues that have been identified as requiring further detailed planning studies to address.

A copy of the RCC risk tables and risk ratings used are provided below.

Redland City Council – Likelihood Table			
Likelihood	**Quantification**	**% Probability**	**Description**
Almost Certain	0-12 months	95% - 100%	Expected to occur in most circumstances.
Likely	1-3 years	65% - 95%	Will probably occur in most circumstances.
Possible	3-6 years	35% - 65%	Might occur at some time.
Unlikely	6-10 years	5% - 35%	Could occur at some time but it is improbable.
Rare	Beyond 10 years	< 5%	May occur only in exceptional circumstances.

The consequence table provides guidance on the severity rating of Environmental Risks.

Severe CMC, State Govt and EPA involvement	Significant environmental impact with long term effects or irreversible damage ▪ Serious Environmental Harm (Irreversible, high impact, widespread, causes >$50,000 damage) ▪ Offence under the legislation (e.g. 1665 to 4165 penalty units)* ▪ Immediate containment required, extensive cleanup, extensive or ongoing remediation required ▪ Major impact to a protected species or habitat greatly contributing to or causing localised extinction risk (in the Shire), requiring long term recovery efforts. (>40% loss of an ecosystem type, >40% loss of a species, locally).
Major CMC, State Govt and EPA involvement	Significant medium to long term impact, potentially reversible ▪ Material Environmental Harm (Significant effect and extent, causes $20,001 - $50,000 damage) ▪ Offence under the legislation (e.g. 835 to 1665 penalty units)* ▪ Immediate containment required, large cleanup, significant remediation required Serious impact to a protected species or habitat significantly contributing to local (in the Shire) extinction pressures, requiring medium to long term recovery efforts (5-40% loss of an ecosystem type, 5-40% loss of a species, locally).
Medium State Govt and EPA advised	Significant short to medium-term impact, can be reversed ▪ Material Environmental Harm (Significant effect and extent, causes $5,001 - $20,000 damage) ▪ Offence under the legislation (e.g. 165 to 835 penalty units)* ▪ Immediate containment required, medium cleanup, some remediation required Impact to a protected species or habitat, requiring short term recovery efforts (in the immediate area). (<5% loss of an ecosystem type, <5% loss of a species, locally).
Low EPA advised matter handled internally	Minor short-term impact, almost no effect, potentially cumulative if not cleaned up, reversible ▪ Environmental Nuisance (Offensive, causes $3000-$5,000 damage) ▪ Offence under the legislation (e.g. 67 to165 penalty units)* ▪ Containment required, minor cleanup, no remediation required Minor impact to a protected species or habitat, no recovery efforts required
Insignificant EPA advised matter handled internally	Very minor, no real effect, reversible. No impact or potential impact off site ▪ Environmental Nuisance (Offensive, causes <$3000 damage) ▪ Offence under the legislation (e.g. up to 67 penalty units)* ▪ Minor cleanup, no remediation required Insignificant impact to a protected species or habitat, no recovery efforts required

***Note: Refer to EP Act Chapter 8 – for current value of penalty unit.**

The consequence table provides guidance on the severity rating of a Risk should it occur.

Strategic	Operational	Activity	Priority	Consequence
> $5m recurrent reduction in Council budget (2%) > $10m one off loss (10% of current assets)	> 5% recurrent reduction in Group budget	> 10% recurrent reduction in Unit budget	Severe	**Legal and regulatory:** Serious breach resulting in significant prosecution and fines. **People**: Fatality(s), sustained and serious industrial action, loss of multiple key staff at once. **Operational:** Key services disrupted for over 60 days. **Environmental**: Significant environmental impact with long term effects. **Strategic**: Most Council objectives cannot be achieved. **Ethical:** Systemic fraud and corruption, major external investigation with adverse findings. **Reputation**: Significant and widespread public outcry, sustained negative metro or national media coverage.
$2.5m to $5m recurrent reduction in Council budget $5m to $10m one off loss	3% to 5% recurrent reduction in Group budget	5% to %10 recurrent reduction in Unit budget	Major	**Legal and regulatory:** Major breach resulting in significant legal action. **People**: Serious injury(s), hospitalisation of multiple people, staff turnover well above 20%, ongoing industrial action. **Operational:** Key services disrupted for between 20 and 60 days. **Environmental**: Significant impact on natural or built environment, external investigation. **Strategic**: Some important Council objectives cannot be achieved. **Ethical:** Major one off fraud and corruption by senior person. **Reputation**: Significant outcry from residents, significant negative state level media coverage.
$1m to $2.5m recurrent reduction in Council budget $2m to $5m one off loss	2% to 3% recurrent reduction in Group budget	3% to 5% recurrent reduction in Unit budget	Medium	**Legal and regulatory:** Breach resulting in investigation, ongoing legal issues not easily addressed. **People**: Minor medical treatment required, staff turnover slightly higher than 20%, one off industrial issues. **Operational:** Key services disrupted for between 2 and 20 days. **Environmental**: Medium term effects on environment from single incident. **Strategic**: Some Council objectives cannot be achieved. **Ethical:** Planned unethical action by one or more staff. **Reputation**: Concerns from cross section of residents, ongoing negative metro media coverage.
$100k to $1m recurrent reduction in Council budget $0.5m to $2m one off loss	1% to 2% recurrent reduction in Group budget	2% to 3% recurrent reduction in Unit budget	Low	**Legal and regulatory:** Minor legal issues or non-compliance easily remedied. **People**: Minor injuries treated by first aid, routine industrial issues. **Operational:** Key services disrupted for between 1 and 2 days. **Environmental**: Short term effect on built or natural environment easily remedied. **Strategic**: Minor setbacks that are easily remedied. **Ethical:** Opportunistic incident involving several people. **Reputation**: Heightened concerns from narrow group of residents; one off negative metro media coverage.
<$100k recurrent reduction in Council budget <$0.5m one off loss	<1% recurrent reduction in Group budget	<2% recurrent reduction in Unit budget	Insignificant	**Legal and regulatory:** Minor breach of standards or guidelines, one off minor legal matters. **People**: Minor incidents or issues dealt with according to routine procedures. **Operational:** Key services disrupted for less than 1 day, usual scheduled interruptions. **Environmental**: Minor breach of environmental guidelines or standards. **Strategic**: Negligible impact on Council objectives. **Ethical:** Minor opportunistic incident involving single person. **Reputation**: Insignificant adverse local media or public comment.

RISK LEVELS							
Likelihood			Consequences				
			Level 1 Insignificant	Level 2 Low	Level 3 Medium	Level 4 Major	Level 5 Severe
Likelihood	5	Almost Certain	M-10	H-20	H-30	E-40	E-50
	4	Likely	M-8	M-16	H-24	E-32	E-40
	3	Possible	L-6	M-12	M-18	H-24	E-30
	2	Unlikely	L-4	L-8	M-12	M-16	H-20
	1	Rare	L-2	L-4	L-6	M-8	M-10

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Appendix D

Overarching Corporate Strategic Objectives for TWCM

APPENDIX D: OVERARCHING CORPORATE STRATEGIC OBJECTIVES FOR TWCM

Reference[1]	Strategic Objectives (Key Outcomes, Strategies, Targets)
High Level TWCM Role Objective	***Redland City Council's (RCC) TWCM Plan will provide an overarching document that draws together water cycle management related objectives from all RCC plans. It is a holistic document that aims to manage all elements of the water cycle in a way that strives to meet the community's aspirations and legislative requirements.*** ***The TWCM Plan will identify water cycle management priorities (through a risk assessment process) and provide direction for addressing these issues in a way that optimises environmental and social benefits within the Redlands region and minimises cost.***
1. Healthy Natural Environment: *A diverse and healthy natural environment, with an abundance of native flora and fauna and rich ecosystems will thrive through our awareness, commitment and action in caring for the environment.*	
1.6	Address the decline in the health of Redlands waterways and improve water quality, aquatic populations and their biodiversity
1.1	Increase biodiversity by taking informed action to protect, enhance and manage our local ecosystems
1.3	Protect our natural environment by recovering degraded landscapes, contaminated land (waters), and managing hazards
1.4	Improve residents' understanding, respect and enjoyment of the local environment through stewardship and partnerships
1.5	Co-ordinate effective management of the conservation estate on all (private and public) lands in Redlands
Key Target 1	**Halt and then reverse the declining trend in the health of Redlands waterways and Moreton Bay, returning the native fish and macro-invertebrates to our (freshwater) waterways.**
2. Green Living: *Our green living choices will improve our quality of life and our children's lives, through our sustainable and energy efficient use of resources, transport and infrastructure, and our well informed responses to risks such as climate change.*	
2.1	Achieve sustainability through strong leadership and innovation, and by effective planning and managing our services, assets and resources
2.2	Promote, support and encourage commitment to green living achieving greater water conservation and efficiency
2.6	Council and communities to conserve energy and water, improve efficiency and reduce greenhouse gas emissions resulting from Council's energy consumption
2.9	Protect our community and the natural environment by managing environmental harm and nuisance caused by industry, business, development from past and present activities
Key Target 2	**Daily water consumption per person is less than the target set by the Queensland Water Commission (200 litres per person per day as at December 2009).**

Reference[1]	Strategic Objectives (Key Outcomes, Strategies, Targets)
3. Embracing the Bay: *The benefits of the unique ecosystems, visual beauty, spiritual nourishment and coastal lifestyle provided by the islands, beaches, foreshores and water catchments of Moreton Bay will be valued, protected and celebrated.*	
3.3	Ensure the ongoing health of the bay by managing creeks, wetlands and stormwater and by protecting natural areas surrounding the bay
3.4	Promote enjoyment of the bay by improving access for environmentally sensitive recreation activities, education, economic opportunities and ecotourism
4. Quandamooka country: *The rich Aboriginal heritage of the Redlands (Quandamooka) and the Traditional Owners' ongoing custodianship of Quandamooka land and waters will be widely understood and respected, and we will work together for the future of Quandamooka Country.*	
4.1	Improve community understanding and promote respect for the Quandamooka peoples' relationship with the land and waters of Redlands
5. Wise planning and design: *We will carefully manage population pressures and use land sustainably while advocating and taking steps to determine limits of growth and carrying capacity on a local and national basis, recognising environmental sensitivities and the distinctive character, heritage and atmosphere of local communities. A well-planned network of urban, rural and bushland areas and responsive infrastructure and transport systems will support strong, healthy communities.*	
5.1	Incorporate TWCM Planning outcomes into the new planning scheme
5.3	Advocate strongly to all levels of government about the impacts of an increased population on the city and the region's liveability and natural systems
5.4	Review Council's and the community's climate change preparedness, ensuring all risks are understood and plans are activated to deal with expected outcomes
5.6	Manage the built environment in a way that creates accessible and user friendly spaces and maintains our local character and identity, ensuring all new developments use high quality design that reflects our sub-tropical climate, promotes health, community harmony and wellbeing
5.10	Maintain the quality and liveability of residential areas and protect natural resources
5.13	Enhance the city's liveability and enable people to enjoy outdoor activities, social gatherings and community events through planning, providing and managing high quality parks and open spaces
6. Supportive and vibrant economy: *Businesses will thrive and jobs will grow from opportunities generated by low impact industries, cultural and outdoor lifestyle activities, eco-tourism and quality educational experiences*	
6.6	Promote Redlands as a high quality tourism destination and encourage the development of sustainable nature based heritage and eco-tourism
7. Strong & Connected Communities: *Our health, wellbeing and strong community spirit will be supported by a full range of services, programs, organisations and facilities, and our values of caring and respect will extend to people of all ages, cultures, abilities and needs.*	
8. Inclusive and ethical governance: *Deep engagement, quality leadership at all levels, transparent and accountable democratic processes and a spirit of partnership between the community and Council will enrich residents' participation in local decision making to achieve the community's Redlands 2030 vision and goals.*	

Reference[1]	Strategic Objectives (Key Outcomes, Strategies, Targets)
9. Water Supply & Wastewater Objectives	
	TWCM: Total water cycle management acknowledges that all components of the water cycle are interdependent and should be considered both separately and combined to ensure that water is used optimally. The key principles of total water cycle management include: (i) planning and managing water as a valuable and finite resource; (ii) consideration of all water sources in water planning; (iii) sustainable and equitable use of all water sources; (iv) consideration of all water users; (v) integration of water use and natural water processes; and (vi) a whole-of-catchment use and management.
	Sustainability: Utilise a Quadruple bottom line approach to ensure environmental, economic and social sustainability in our decision-making and in the delivery of our products and service**s**
	System reliability: provide water and wastewater services as normally expected by our customers in accordance with our Customer Service Standards. Key areas of system reliability are: (i) planning; (ii) redundancy; (iii) robust design; (iv) material use; (v) testing and commissioning; (vi) failure mode avoidance; and (vii) monitoring
	Delivering a quality product: New water and wastewater quality challenges are emerging with the introduction of new water sources and the increasing complexity of the SEQ water grid. These challenges include managing a diverse range of water supply sources, varying standards, and increasing community expectations. They require a proactive approach to managing product quality with a focus on prevention and early diagnosis of potential problems to ensure standards are maintained.
	Commitment to customers: Maintain an unrelenting focus on customers and ensure customers' standards for safe and reliable products and services are achieved. Aim to make it easy for customers through understanding, educating and supporting them to manage water effectively and meet their legislative requirements.
	Prudent and efficient management: Deliver prudent and efficient management of the business and an increased cost consciousness resulting in value for money outcomes for customers.
10. Wastewater Management Objectives	
	To encourage waste minimisation and cleaner production, including waste prevention, recycling, and pre-treatment.
	To safeguard public health and the environment
	To equitably recover the cost of services to commerce and industry including the cost of conveyance, treatment and disposal and, maintenance and repair of damage to the sewerage system.

[1] Reference to RCC Strategic and Community Plan

Appendix E

Solution Descriptions

APPENDIX E: SOLUTION DESCRIPTIONS

This appendix provides detailed descriptions of the potential solutions given in Section 5 of the report.

W: Waterway Rehabilitation

W1: Rehabilitation of waterways - Riparian buffer zones

The riparian zone for waterways is the interface between the waterway and adjacent land, and provides several functions critical to the health of waterways. These functions include water quality improvement (e.g. through filtration), habitat provision, reducing erosion, and flow attenuation. Anthropogenic pressures (e.g. development, farming) can have a negative impact on riparian areas through various mechanisms, including works/ activities within riparian areas and changed upstream catchment hydrology (e.g. increased runoff frequency, volume and velocity).

In this solution, waterways would be rehabilitated to a more 'natural' condition, which may include activities such as revegetation, delineation/ protection of riparian areas (e.g. with fencing).

Opportunities for this solution focus on private lands only.

W2: Rehabilitation of waterways - Habitat restoration (around banks, applies to Council land only)

This solution is similar to solution W1, however as it applies only to Council owned land, where it recognises that habitat restoration can also be provided as part of rehabilitation works. Waterways can provide habitat to a wide range of biota, but these habitat values can be significantly decreased (typically through anthropogenic pressures, contributing to impacts such as altered channel form and reduced vegetation). This solution would aim to improve the habitat values around the banks of waterways where Council owns the land, as part of waterway rehabilitation works.

W3: Rehabilitation of waterways - Bank Stability Works

Anthropogenic pressures can have a direct impact to the stability of waterway banks through various mechanisms, including changed upstream catchment hydrology (e.g. increased runoff frequency, volume and velocity) causing bank erosion with sediment loads transported downstream. Typical works required to improve bank stability may include grade control (e.g. rock chutes, rock placement), battering back banks, bank stabilisation and riparian revegetation.

W4: Rehabilitation of waterways - In-Stream Improvement works

In-stream improvement works can be implemented within waterways to provide multiple benefits, including increased habitat values and biodiversity and improved water quality. These works can include activities such as in-stream revegetation and integration of pool-and-riffle systems.

W5: Increased riparian protection for waterways (buffer/waterway corridor widths) ie through planning policy

The riparian zone for waterways is the interface between the waterway and adjacent land, and provides several functions critical to the health of waterways. These functions include water quality improvement (e.g. through filtration), habitat provision, reducing erosion, and flow attenuation. Anthropogenic pressures (e.g. development) can encroach into riparian areas and significantly reduce their benefits.

Planning policies already exist to provide some protection to riparian areas. This solution would aim to provide further protection to riparian areas (and subsequently enhance their function and associated benefits) through enhanced planning policies (e.g. increased 'set-backs' from waterways for new development).

W6: Assess and prioritise waterway fish barrier locations

Fish barriers can be physical structures (e.g. weirs), hydraulic (e.g. areas of high velocity flow or turbulence), chemical (e.g. pollution plumes) and behavioural obstructions (e.g. dark tunnels or unnatural substrates created by pipes). These barriers can adversely impact on native fish by interrupting spawning or seasonal migrations, restricting access to preferred habitat and food resources, increasing the chance of predation and disease and reducing genetic flow between populations through population fragmentation (NSW DPI, 2012).

For this solution, an assessment would be made of in-stream structures on their potential/ likely impact to fish passage within the region. The structures would be subsequently prioritised in order of importance and presented options for their remediation (e.g. complete removal of the structure, bridges for waterway crossings).

W7: Restrict unauthorised 4WD Access e.g. fencing / barriers

4WD vehicles and other off-trail vehicles (e.g. motorbikes) accessing forested are other undeveloped areas can have significant negative impacts to natural vegetation, wildlife and waterways. These impacts can include habitat loss, erosion and poor water quality.

This solution would attempt to restrict unauthorised access of 4WD's into forested/ undeveloped areas through the use of physical barriers (e.g. bollards, fencing).

W8: Policing unauthorised 4WD Access e.g. Cameras for access identification / fines

Similar to solution W7, this solution would attempt to restrict unauthorised access of 4WD's into forested/ undeveloped areas through increased surveillance and enforcement. This could include the use of cameras to identify unauthorised access, signage/ education to notify that any access to given areas is illegal (and subject to penalties), and increased inspections/ patrols of forested areas (and issuing penalties for any unauthorised access).

W9: Develop localised WQOs for Native Dog and Serpentine Creeks

This solution was identified by stakeholders during the solution workshop. It involves using the management framework identified in ANZECC/ ARMCANZ (2000), which would include the collection of site specific data (from local reference sites) to enable the derivation of locally relevant water quality objectives. The derivation of locally relevant environmental values and water quality

objectives will assist to ensure catchment management strategies are appropriate for protecting the environmental values of receiving waters.

W10: Investigations to better define sustainable groundwater yields

This solution would involve undertaking investigations to provide a better understanding of what groundwater extractions can be undertaken without having an unacceptable impact on groundwater-dependent ecosystems or the ability of other/ future stakeholders to utilise groundwater resources.

W11: Investigations / monitoring to better define waterway health

Investigations are currently (and have previously been) undertaken to investigate/ monitor the health of waterways within the region. These investigations could be continued and/ or extended (e.g. to additional areas and/ or monitoring parameters) to improve stakeholder's understanding of the health of waterways within the region.

W12: Monitoring to evaluate effectiveness of management solutions

The performance of management solutions could be assessed and the results communicated to relevant stakeholders for use in future decision-making (e.g. identify improvements). Monitoring requirements would be obviously dependent on the type of solution implemented. For example, the benefits of a regional stormwater harvesting strategy could be assessed by monitoring the volume of water supplied to meet non-potable demands.

D: Diffuse Pollution Management

D1: Increased implementation / enforcement of E&SC management practices and capacity building through education

Sediment laden-runoff from construction sites can have a major negative impact to waterway health and stormwater infrastructure. These impacts can be significantly mitigated through the implementation of appropriate erosion and sediment control (E&SC) management practices (e.g. minimising disturbance areas, buffer strips, mulch bunds).

In this solution, the implementation of appropriate E&SC management practices would be improved through capacity building initiatives (e.g. education to construction industry personnel) and enforcement of E&SC requirements (e.g. Council officers frequently inspecting construction sites and, where appropriate, providing appropriate education and/ or penalties in response to poor performance).

D2: Rural BMP for grazing land - fencing off stock & revegetation around 1st & 2nd order streams

Without appropriate restrictions, grazing cattle can access waterways and have several negative impacts to the health of the waterways, including the loss of vegetation cover, soil compaction

and erosion, bank instability, and poor downstream water quality (e.g. increased turbidity, nutrients).

This solution would attempt to mitigate these potential negative impacts through the supported implementation of rural best management practices for grazing land. This could include providing suitable fencing (i.e. to limit access to waterways), stable watering points (e.g. on the river or off-stream such as troughs or dams), off-stream shade and shelter (to compensate for loss of access to riparian vegetation) and properly constructed waterway crossings for stock.


Image Source: Central West Catchment Management Authority

D3: Rural BMP for horticultural land - implementation of filter/buffer strips

Horticultural activities generally involve the application of nutrient fertilisers and irrigation to grow crops such as in market gardens, greenhouse flowers, turf farms, vineyards, orchards and nurseries. The altered hydrology and pollutant export characteristics of the land can result in an increase in stormwater flows and pollutant loads from these areas (relative to a 'natural'/ forested site).

Impacts to downstream waterway health from these activities can be mitigated through the use of filter/ buffer strip. These would typically be vegetated areas of land located downstream of horticultural activities to provide treatment to sheet runoff from these areas (prior to flowing downstream, e.g. into waterways). Through processes such as filtration, enhanced sedimentation and biological activity, these filter/ buffer strips would act to reduce stormwater pollutant loads, particularly sediment and (to a lesser extent) nutrients.

This solution would attempt to encourage the implementation of these filter/ buffer strips through mechanisms such as incentive schemes and education.

D4: Integrate WSUD into government capital infrastructure works eg road/ park upgrades

This solution would involve integrating WSUD Best Management Practices into capital infrastructure works (undertaken by local and state government). For example, opportunities to integrate streetscape bioretention systems could be identified and implemented in conjunction with road upgrades undertaken by Council. Subsequently, any additional costs associated with the integration of WSUD BMPs would be significantly reduced and the capital infrastructure works could achieve additional benefits (e.g. improved waterway health).

D5: Improved waterway health asset management system (e.g. appropriate management of stormwater treatment devices)

Assets associated with the protection and conservation of waterway health (e.g. stormwater management measures) typically require ongoing and pro-active maintenance and management to maintain optimal performance and aesthetics. This requires an appropriate asset management system, including a suitable asset register (e.g. defining the type of asset and maintenance

requirements), suitable budget planning and appropriately skilled personnel (with sufficient training and resources).

Under this solution, the existing waterway health asset management system would be improved, including the development of a suitable asset register, budget planning and resourcing, and ongoing capacity building.

D6: Future development to achieve better than SPP Water requirements (for WSUD)

State Planning Policy 4/10 for Healthy Waters and its supporting guideline *(Urban Stormwater Quality Planning Guidelines 2010)* addresses urban stormwater quality management in the state planning policy's development assessment code. This code includes criteria related to stormwater-related aspects of 'Water Sensitive Urban Design' (including stormwater quality and quantity) that is required for new development (above a given area and/ or number of dwellings). For example, any new residential development in South-East Queensland is greater than 2500m^2 or that involves 6 or more additional dwellings is required to achieve a reduction in annual stormwater pollutant loads of 80%, 60%, 45% and 90% for Total Suspended Solids, Total Phosphorus, Total Nitrogen and Gross Pollutants respectively (relative to unmitigated development) in Redland Shire Council. This typically involves stormwater management measures (e.g. bioretention) integrated into the development.

For this potential action, new development would need to achieve a higher performance in terms of stormwater quality and/ or quantity management. For example, this could include pollutant load removal targets higher than those given above.

D7: Naturalising land currently degraded by human activities (e.g. tree planting in rural areas void of vegetation)

This solution would involve rehabilitating land that that is currently degraded by previous human activities (e.g. clearing for grazing/ cropping). As a result, the land would be more 'naturalised' and be more similar to its pre-development state – providing multiple benefits, including improved catchment hydrology (e.g. increased infiltration, reduced stormwater pollutant export (e.g. sediment-laden runoff entering downstream waterways) and improved habitat values.

D8: Water Sensitive Urban Design Retrofit (beyond capital works infrastructure upgrades)

This solution would involve integrating WSUD Best Management Practices into Council or State-owned land, but not as part of other capital infrastructure works (as proposed for solution 'D4', but rather where the primary objective is to integrate WSUD principles/ strategies into a given area). For example, opportunities to integrate stormwater treatment wetlands into Council-owned open space areas could be identified and implemented by Council.

H: Pollutant Hot Spot Management

H1: BMP for poultry farms - EMP review

This solution would involve encouraging and supporting poultry farms to implement best management practices to mitigate any potential impacts to downstream waterway health (particularly associated with stormwater and/ or wastewater discharges from the farm). This could include inspecting individual farms and reviewing their environmental management plans (and, if appropriate, identifying any necessary improvements to environmental performance).

H2: Rehabilitation of poorly performing waterbodies (e.g. toxic dams/lakes)

Waterbodies (e.g. farm dams, urban lakes) can experience operational problems that can significantly impact on the values within and downstream of the waterbody. Common operational problems include algal blooms and negative impacts to downstream water quality. This solution would involve identifying poorly performing waterbodies and, where appropriate, developing and implementing rehabilitation strategies.

H3: Improved leachate management & treatment systems

In this solution, existing landfill leachate management and treatment systems within the Redlands would be assessed, and appropriate mitigation actions recommended (as required). It is noted that Council has recently commissioned a Landfill Leachate Management Options and Viability Study to identify STP process risks and recommend management actions to address non-complying parameters.

H4: Investigate sources of hot spot pollution & identify targeted treatment strategies

A pollution 'hot spot' is any location and/ or area where there is a high concentration and/or loading of a pollutant and a high risk of the pollutant leaving the location and/or area and entering a water body (e.g. river, lake, estuary, groundwater or the marine environment) to cause water pollution.

This solution would involve assessing waterbodies (e.g. rivers, lakes, estuaries, groundwater or marine environments) that are known to experience poor water quality and/ or associated impacts (e.g. algal blooms, fish kills). The source(s) of these issues, and appropriate strategies to specifically mitigate these issues, would also be identified.

H5: Nutrient Trading

Nutrient trading is a market-based approach for protecting and improving water quality. Two steps are involved: (1) setting a goal for the total amount of nutrients that enter waters in a catchment; and (2) allowing the sources of these nutrients to trade in ways that meet the given goals.

This can provide sources with low-cost pollution reduction options with increased incentive to reduce nutrient loads beyond what is required of them and to sell excess credits to sources with higher control costs. Through a series of trades, pollution reduction efforts get re-allocated to the sources that have the lowest-cost opportunities to reduce pollution. This flexibility can greatly reduce the total cost of improving water quality (*adapted from World Resources Institute, 2012*).

H6: Improved management of unsealed roads

Unsealed roads can lead to significant erosion problems and the potential for stormwater quality issues through a combination of exposed surfaces and concentrated stormwater. The management of unsealed roads could be improved through a variety of methods, including sealing roads (particularly near waterway crossings) and vegetated drains and buffer areas.

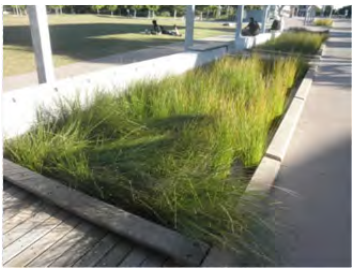
E: Education & Capacity Building

E1: Education & /or capacity building and investment in incentive schemes

Stakeholders (e.g. residents, businesses, land-owners) could receive education (and/ or other capacity building) about existing and/ or planned schemes to encourage the implementation of TWCM principles (e.g. rainwater tank rebates).

E2: Active Extension Program Idea: Raingardens in backyards

‘Rain gardens’ (or ‘bioretention systems’) are soil and plant-based stormwater management measures that be integrated into areas to provide multiple benefits, including self-watered landscaped areas and improved waterway health. They can be integrated into areas at various scales/ sizes, including backyards.



For example, residents could be encouraged to integrate rain gardens into their own yards through incentive schemes (e.g. reduced rates, government contribution). This could be integrated into the existing "Your Backyard Garden" extension program. Melbourne Water has a similar scheme that could be used as a basis: http://raingardens.melbournewater.com.au/

E3: Improved marketing around TWCM initiatives

This solution would involve promoting initiatives that are currently and/ or will be undertaken by stakeholders within the Redlands area (e.g. Council, Allconnex) initiatives that implement TWCM principles (e.g. natural cycles, sustainable limits, demand management, diversity in new supplies,

water quality). This promotion could be achieved through a variety of mediums, including awards, media reports/ articles, and educational signage.

E4: Encourage the use of Rainwater tanks in existing developed areas for non-potable uses (e.g. incentive scheme)

Runoff from roof areas in developed areas can be 'harvested' in tanks for subsequent use. This has multiple benefits, including, including reducing mains water demands (and associated costs), improving catchment hydrology (through runoff retention) and reduced pollutant load discharges to waterways.

The use of rainwater tanks could be encouraged through several mechanisms, such as incentive schemes and education.

E5: Improved connectivity to waterways through education & participation in waterway improvement projects

The 'connectivity' of the community to its waterways can be improved through various mechanisms, including provision of recreational infrastructure (e.g. bikeways, picnic areas) near waterways. This improved connectivity can benefit the health of the waterway as the community is more likely to apply more value to, and have a greater sense of ownership of, the waterway. The community is subsequently more likely to want to protect/ conserve the health of the waterway.

E6: Education campaign to address flooding and storm tide issues - Mapping made available to public

The appropriate management of risks associated with flooding and storm tide issues includes ensuring that the public has a greater awareness of the potential risk of flooding in areas of interest to them (e.g. their homes). Flood mapping can be undertaken to indicate the risk of flooding by, for example, showing the extent of inundation during extreme climatic events of a given frequency (e.g. "100-year flood") and/ or historical floods.

This solution would involve the development of flood maps (e.g. showing the extent of flooding inundation during different climatic events, e.g. 5, 10, 20, 50, 100-year events) and the communication of this information to the public (e.g. through maps and supporting descriptive information available 'on-line' through Council's website).

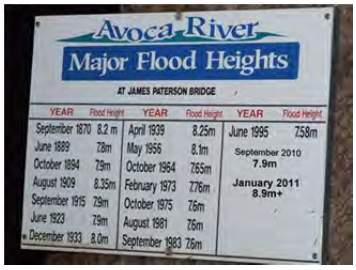
E7: Education campaign to address flooding and storm tide issues - Include notes on rates

In this solution, information related to the likelihood and/ or extent of flooding of individual properties could be communicated to property occupants via rates notices (e.g. from Council and/ or Allconnex). This information could describe whether any part of the property would be predicted to be inundated during different climatic events (e.g. 5, 10, 20, 50, 100-year events) or was inundated during previous

flood events. It could also refer readers to relevant websites where further information, such as mapping, is available.

As per solution E6 and E8, this would improve the community's awareness of the potential risk of flooding and subsequently support them to appropriately mitigate any potential risks.

E8: Education campaign to address flooding and storm tide issues - Install historical flood marks/signs



In this solution, the community could be reminded about the extent/ severity of flooding via marks/ signage indicating the height of inundation during historical flood events. Supporting imagery could also be utilised to illustrate the extent/ severity of previous flood events.

As per solution E6 and E7, this would improve the community's awareness of the potential risk of flooding and subsequently support them to appropriately mitigate any potential risks, increasing public safety.

DM: Water Supply & Demand Management

DM1: Stormwater harvesting for POS

This solution would involve infrastructure to 'harvest'/ retain stormwater flows for the subsequent irrigation of public open space. This solution have multiple benefits, including reduced mains water demand, security of water supply for open space areas, and reduced pollutant loads discharged to waterways.

DM2: Stormwater harvesting for dual reticulation (greenfield)

This solution would involve infrastructure to 'harvest'/ retain stormwater flows to supplement non-potable water demands within 'greenfield' developments. The stormwater would likely be collected in waterbodies and/ or underground storage tanks, require treatment (e.g. reduction in pathogens) and distribution via an additional ('third') pipe infrastructure system. This solution would have multiple benefits, including reduced mains water demand and reduced pollutant loads discharged to waterways.

DM3: Rainwater harvesting communal tanks (greenfield)

Runoff from roof areas in developed areas can be 'harvested' in communal tanks (i.e. tanks receiving flows from multiple dwellings) for subsequent use. This would have multiple benefits, including reducing mains water demands (and associated costs), improving catchment hydrology (through runoff retention) and reduced pollutant load discharges to waterways.

DM4: Recycled water supplied to large agricultural/ industrial users

In this solution, recycled water (i.e. 'waste' water such as sewage that is treated 'fit for purpose') could be transported to agricultural or industrial businesses with large demands to supplement their demands for non-potable water. This would have multiple benefits, including reduced mains water demands and reduced pollutant loads discharged to waterways.

DM5: Recycled water supplied to urban users (public open space)

In this solution, recycled water (i.e. 'waste' water such as sewage that is treated 'fit for purpose') could be transported to urban areas (e.g. via pipe infrastructure) to supplement the irrigation demands of public open space areas.

DM6: Recycled water disposed to land (nb limited feasible due to koala habitat & land shortage)

In this solution, this water would be 'disposed' by irrigating it over large areas of land (at a rate low enough to prevent any likelihood of the water discharging to waterways, e.g. via runoff). The feasibility of this is anticipated to be limited, however, due to the lack of available land for irrigation.

DM7: Indirect potable reuse of Purified Recycled Water (PRW)

Purified recycled water (PRW) is water than has been filtered, cleaned and purified to a very high standard using advanced technologies such as microfiltration, reverse osmosis and ultraviolet disinfection. In this solution, PRW would be discharged into storages (e.g. dams) for untreated water – where it would mix/ combine with (and be stored) with other water (e.g. runoff from the upstream catchment) retained by the dam. This combined water would subsequently be appropriately treated (to satisfy drinking water quality standards) and transported within the water supply infrastructure (and be utilised for both potable and non-potable usages).

DM8: Recycled water supplied to urban users (dual reticulation)

In this solution, recycled water (i.e. 'waste' water such as sewage that is treated 'fit for purpose') could be transported to urban areas to supplement the non-potable water demands (e.g. laundry, irrigation) of urban areas demands. The recycled water would be distributed to individual dwellings via an additional ('third') pipe infrastructure system (in urban areas, this pipe network is typically cleared identified with a purple colour to minimise any risks associated with incorrect usage). This solution would have multiple benefits, including reduced mains water demand and reduced pollutant loads discharged to waterways.

DM9: Upgrade WTP process (i.e trihalomethanes) at Capalaba Treatment Plant

In this solution, the water treatment process at the Capalaba Treatment Plan would be upgraded. Amongst other improvements to its performance, the upgrade would be anticipated to reduce water supply concentrations of trihalomethanes ('THMs', a by-product of the use of chlorine in water disinfection that has been associated with some adverse health effects in consumers).

DM10: Investigate and reduce leakage 'losses' from potable water infrastructure

Significant quantities of water can be 'lost' from underground water supply infrastructure via leakage (with 'leaked' water discharging into the surrounding soil and/ or groundwater environment). In this

solution, investigations will be undertaken to identify leaks (e.g. via acoustic devices) and reduce the amount of water 'lost' via leakage (e.g. by repairing/ replacing pipes and reducing water pressure).

DM11: Desalinisaton plant for water supply

In this solution, a desalinisation plant would be constructed and operated to supplement mains water demands. The desalinisation plant would likely utilise reverse osmosis technology, producing potable water and a brine/ concentrate (which is typically discharged to the ocean).

DM12: New/ upgraded water supply infrastructure (e.g. dams, weirs, pipeline, bores)

This solution would involve improving the capacity of water supply infrastructure (i.e. improving the ability to supply, store, treat and transport water to satisfy existing and future water demands). This could include works such as the construction and/ or replacement of dams, weirs, reservoirs and pipelines.

S: Sewerage

S1: Provide sewerage infrastructure for unsewered areas

Several areas within the region are 'unsewered' (i.e. are not connected to any centralised sewage treatment plant). Instead, sewage generated in developed areas is discharged to on-site wastewater systems (e.g. septic tanks).

In this solution, sewerage infrastructure (e.g. pipes, pump stations) would be extended/ provided to unsewered areas to allow sewage from these areas transferred to a new or existing Sewage Treatment Plant (for appropriate treatment and disposal/ re-use).

S2: Inspections and improved management of on site wastewater systems

As outlined above, several developed areas within the region are 'unsewered' with sewage discharged to on-site wastewater systems (e.g. septic tanks). This solution would be aimed at achieving the management of these on-site wastewater systems through inspections, incentives and/ or education to augment the appropriate operation/ management of these systems.

S3: Improved nutrient treatment processess of STPs (particularly TN at Victoria Point STP (Eprapah Crk)

In this solution, the ability of the STPs to remove nutrients would be improved (e.g. by new and/ or upgraded infrastructure). In particular, there is a need to improve the ability of the Victoria Point STP to reduce concentrations of total nitrogen in its discharges (to Eprapah Creek).

S4: Improve Treatment capacity of STP to facilitate treatment of landfill leachate

This solution would involve increasing/ improving the capacity of existing Sewage Treatment Plants to provide adequate treatment to landfill leachate collected collected from landfills and transported to the STP.

S5: Improve prevention of illegal stormwater inflow connections to sewer

Stormwater infrastructure (e.g. guttering/ pipework collecting runoff from roof areas) should be connected to the stormwater system, and it is illegal to connect stormwater infrastructure to the sewerage system. Nevertheless, stormwater illegal inflow connections to the sewerage system often occur.

The illegal connection of stormwater infrastructure to the sewerage system significantly increases the volume of water in the sewerage systems, which can result in the capacity of the network being exceeded. This can cause the network to overflow, resulting in environmental harm and creating risks to human health. Major capital expenditure is also required to mitigate this through the construction of larger pipes, pump stations and treatment plants.

In this solution, increased activities would be undertaken to reduce the likelihood of illegals stormwater connections to sewer. These increase activities could include more inspections of new and existing infrastructure and could have multiple benefits (e.g. reduced sewage overflows/ flooding).

S6: Pump station EMPs / upgrades to reduce likelihood of wet weather overflow

During wet weather periods, there are increased flows through the sewerage system. This is largely due to illegal stormwater connections (as described above) and rainfall infiltrating through the ground into leaky sewers. As described above, these increased flows can cause the sewerage system to overflow – and a significant portion of this overflow occurs at sewage pump stations.

This solution would involve upgrades and/ or improvements to existing sewage pump stations to reduce the frequency of overflows occurring during wet weather events.

S7: Sewerage upgrades to improve storage/conveyance of wet weather flows

As described above, the capacity of the sewerage system can be exceeded during wet weather events. In this solution, the sewerage system would be upgraded to improve its ability to store and/ or convey wet weather flows. This could include new and or upgraded infrastructure, such as pipes, pump stations and/ or storage tanks to capture sewage overflows (for subsequent return to the sewerage system following the wet weather event).

S8: Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation / smart sewers in greenfield areas)

One cause of wet weather overflows is rainfall infiltrating through the ground into leaky sewers. In this solution, wet weather infiltration to sewerage infrastructure would be reduced through the repair/ rehabilitation of existing pipelines or the application of 'smart' sewers in greenfield areas.

S9: Wastewater infrastructure rates charged on mains water consumption basis

This solution would involve implementing a rates system that charged customers an amount based on the amount of mains water they used. This would give customers a financial incentive to reduce their water usage (and associated wastewater generation), possibly reducing mains water demands and wastewater generation rates.

S10: Further investigate sustainable wastewater treatment options for new development

Sustainable wastewater treatment options for new development could include a range of decentralised treatment technologies and reuse strategies.

F: Flooding & Stormtide

F1: Flood mitigation investigation / works implemented

This solution would involve investigations (e.g. flood risk management plans) and works (e.g. upgrades to stormwater infrastructure) to mitigate/ manage the risk of flooding in areas that are currently or predicted to be at future risk of flooding.

F2: Constraints on future land development to address flooding and storm tide issues

This solution could involve applying further restrictions on the future development of land that is anticipated to be flood-prone. These constraints could include new provisions in the planning scheme to ensure development / redevelopment does not occur on flood prone land, and more stringent conditions related to flooding (e.g. required levels of flood protection, higher sea levels and/ or rainfall intensities for climate change scenarios).

F3: Acquisition of land inundated by flooding / storm tide

This solution would involve the purchase (by government) of privately owned-land that is inundated by flooding/ storm tide – either currently or predicted to be in the near future. The purchased land would subsequently be retained as non-developable land and utilised for other purposes (e.g. public open space).

DC: Development Control

DC1: Cap on population growth

This solution would aim to place an upper limit on the population within the region. This could potentially be achieved by applying a limit to the extent and type/ intensity of new development that could occur within the region.

DC2: Increased restrictions on development extent and intensity for proposed development areas

As per DC1, this solution would involve applying a limit to the extent and type/ intensity of new development that could occur within the region.

DC3: Investigations to more accurately define population growth for future planning purposes

This solution would involve further investigations to more accurately define population growth for future planning purposes (e.g. water supply infrastructure requirements).

For the purposes of this TWCMP, population growth has been estimated using the Allconnex Demand model and PIFU medium growth scenario predictions (refer to Appendix A for further details).

FS: Funding to Implement Solutions

FS1: Develop business case for healthy waterways to support solutions

This report has provided an estimate of the likely economic costs associated with the implementation of various actions aimed at improving waterway health. However, no assessment has been undertaken of the economic benefits of the implementation of the identified related actions (e.g. economic benefits associated with reduced pollutant loads, premiums on land values due to enhanced amenity values and local and regional water quality). Subsequently, no business case has been prepared to determine how the benefits of the various actions compare to their costs (and if the benefits outweigh the costs, or not).

This solution would subsequently aim to develop a business case for healthy waterways to better support decision making associated with waterway management.

FS2: Increase / re-prioritise funding to support TWCM solutions

In this solution, it is proposed that funding be increased or re-proportioned to supplement funding requirements for the implementation of recommended TWCM-related actions. This was identified to be a politically sensitive issue, however it was noted during the solutions workshop (using previous experience from the outcomes of MBRC's TWCM planning project) that the cost to protect waterway health is not anticipated to be much greater than current costs.

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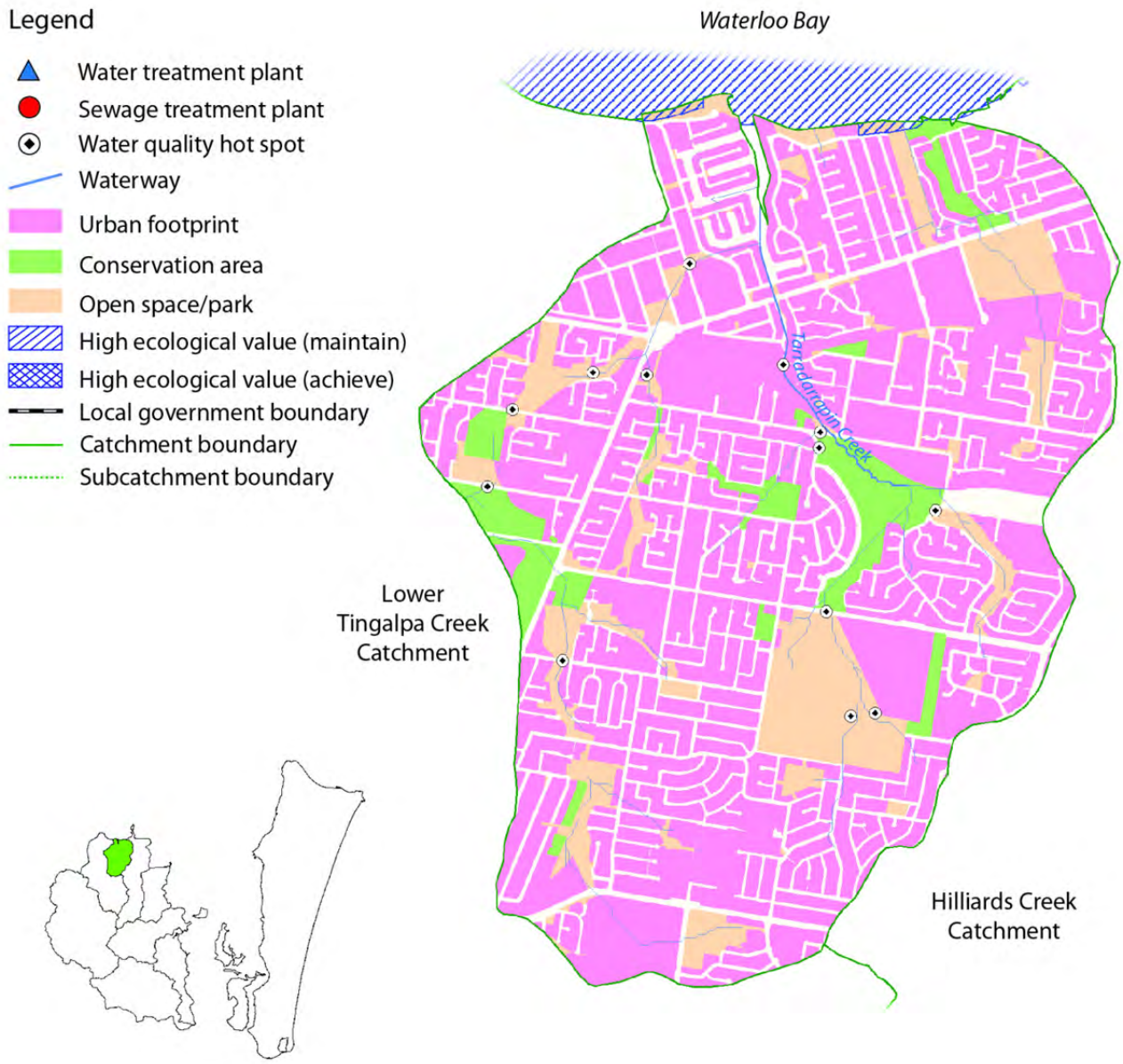
Appendix F

North Stradbroke Island (Photo Courtesy of Tourism Queensland)

Asessment of Costs & Benefits

APPENDIX F: ASSESSMENT OF SOLUTION COSTS AND BENEFITS

Tarradarrapin Creek Catchment

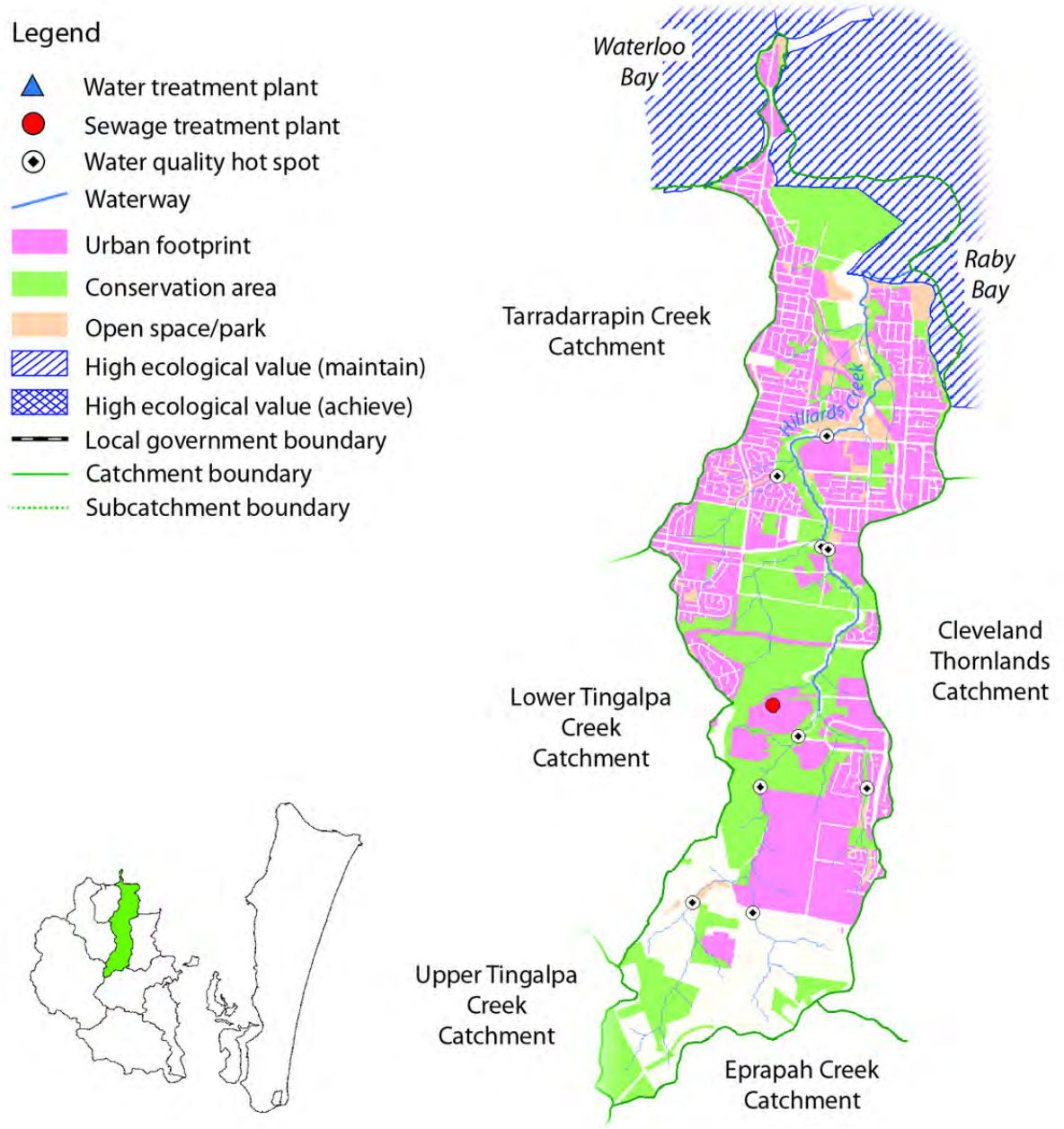


	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate Good		1= 2 = 3 =
W	**Waterway Rehabiliation**													
W1	Rehabilitation of waterways - Riparian buffer zones (private land)	• $10/m^2 ($100,000/ha). • $250,000 for poor - very poor condition waterways on private land • Further investigation required	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate moderate overall improvement, constitutes 1.3% of poor waterways in RCC, and 70% of poor waterways within local catchment	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	2	**4**
W2	Rehabilitation of waterways - Habitat restoration (Council land)	• $10/m^2 ($100,000/ha). • $100,000 for poor - very poor condition waterways on RCC/State land • Further investigation required	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate marginal overall improvement, constitutes 0.5% of poor waterways in RCC, and 30% of poor waterways within local catchment	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	1	**3**
W3	Rehabilitation of waterways - Bank Stability Works	No known, study specific	No known, study specific	• Avoided costs associated with flood remediation works	• TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health		• Improved community amenity & recreational benefits				2	2	**4**
W4	Rehabilitation of waterways - In-Stream Improvement works	No known, study specific	No known, study specific	• Avoided costs associated with bank stabilisation and flood remediation works	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved in-stream habitat value		• Improved community amenity & recreational benefits				2	2	**4**
W5	Increased riparian protection for waterways (buffer/waterway corridor widths) e.g.	• Low cost to amend planning policy		• Avoided waterway	• Primarily TSS treatment benefits	• Improved in-stream health		• Improved community	• Community planting	• Potential		3	1	**4**
W6	Identify and prioritise waterway fish barrier locations	• $12,000 (Mick Holland to confirm)				• Potential for future improvement to fish passage and ecological health of waterways (if solutions to barriers are identified and implemented).					Note technology may not be available to implement solutions to identified fish barriers	1	2	**3**
W12	Monitoring to evaluate effectiveness of management solutions	• $1,000 per site (ambient monitoring), study specific		• Savings through identifying cost effective solutions	• Monitoring will assist to confirm the most effective solutions to improve water quality	• Monitoring will assist to confirm the most effective solutions to improve waterway health		• Improve community connectivity to waterways (through education)	• Results to educate community on waterway health (Waterway Recovery Report)			2	3	**5**
D	**Diffuse Pollution Management**													
D1	Increased implementation / enforcement of E&SC management practices and capacity building through education	• $400	• $4,000 ($100,000 for all catchments)	• Avoided waterway rehabilitation and maintenance / monitoring costs • Avoided loss of profits to tourism industry (from decline in waterway health)	• Significant coarse sediment removal • TSS removal performance 40% • Nutrient removal assumed minor	• Improved habitat value through decreasing water turbidity and protecting sea-grass habitat from being smothered		• Maintain community amenity, recreational and tourism benefits, particularly in receiving waters (Moreton Bay) • Improved connectivity to waterways	• Capacity building and education for council, land developers and contractors			3	1	**4**
D4	Integrate WSUD into government capital infrastructure works e.g. road/ park upgrades	• Unknown, dependent on amount of capital infrastructure works scheduled. • Will be more significantly more cost effective than retrofit, so should be integrated where possible.	$1-5/m2 (bioretention and swales)	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Depends on extent of capital upgrades in catchment • Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity	Effectiveness will depend on uptake through future works, which is unknown.	3	2	**5**
D5	Improved waterway health asset management system	• $10,000 to create asset register and maintenance schedule (Approx $100K for whole Redlands region)	$1-5/m2	• $150,000 avoided asset rectification • Avoided costs associated with waterway rehabilitation works	• Optimal treatment performance for well maintained bioretention systems: 85% TSS; 70% TP and 45% TN removal • If not well maintained, could act as a source of pollution • Potential to ensure to significant water quality improvement	• Maintain in-stream health • Maintain in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values			Costing based on bioretention area estimate	3	3	**6**
D6	Future development to achieve better than SPP Water requirements (for WSUD)	• $600,000	• $6,000	• Avoided costs associated with waterway rehabilitation works	• Achieve no future worsening in catchment pollutant loads i.e. maintain or improve on existing loads generated • Small amount of future regional development (4%) hence improvements expected to be minor	• Maintain / improve in-stream health • Maintain / improve in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values	• Community planting and waterway health education opportunities		This solution will be more applicable to catchments with sensitive receiving environments, as it's not as cost effective as traditional WSUD	1	1	**2**
D8	Water Sensitive Urban Design Retrofit (beyond capital infrastructure works)	• $2.3 Million	• $23,000	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal, however difficult to achieve in retrofit scenarios • Potential to significantly improve water quality	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity		1	3	**4**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate Good	1= 2 = 3 =	
H	**Pollutant Hot Spot Management**													
H2	Rehabilitation of poorly performing water bodies (e.g. toxic dams/lakes)	• $65,000 to finalise management framework (all catchments) (2013/14) • Additional funding will be dependent on number and type of works required	• Dependent on works, however maintenance will be required	• Avoided costs associated with waterway rehabilitation works • Cost savings through nutrient trading scheme	• Note water bodies have been identified as a possible hot spot for pollutant load generation in catchment • Only a small proportion of Redlands' water bodies are in this catchment, hence benefits are likely to be minor	• Improved in-stream health • Improved habitat value		• Improved amenity, active and passive recreational values • Improved connectivity to waterways • Increased land values	• Waterway health education opportunities on Council owned land (e.g. signage)		Firstly requires assessment and prioritisation of water bodies to rehabilitate	2	2	**4**
H3	Improved landfill capping /leachate management & treatment systems	• Estimated at $4-7M with an approx split of 15%ops 85% capital and 20% contingency	• Current annual trucking operations - $700k to $1.2M	• Avoided costs associated with waterway rehabilitation works • Current annual trucking operations - $700k to $1.2M	• Note landfills have been identified as a possible hot spot for pollutant load generation in catchment • Potential to greatly improve water quality and reduce landfill contaminants from entering waterways	• Improved in-stream health • Improved habitat value		• Potential to improve amenity and passive recreational values through use of treatment wetlands	• Waterway health education opportunities (e.g. signage)			2	3	**5**
H4	Investigate sources of hot spot pollution & identify targeted treatment strategies	Minor initial expenditure associated with expanded program, but this is incorporated into annual/ ongoing costs.	• $100,000 for annual program (Assumes 60 sites for whole of Redlands, laboratory expenses comprise 50%)	• Avoided costs associated with waterway rehabilitation works	• Note 2 hot spots have been identified as key pollutant generation sources in the catchment • Potential to improve water quality	• Improved in-stream habitat value						3	2	
E	**Education & Capacity Building**													
E1	Education & /or capacity building and investment in incentive schemes	• This will be dependent on the adopted solutions and how they can each be supported. Low anticipated costs. • Currently adopted Habitat Protection Programs may be used to support some solutions. These total $320K and include: • Waterways Extension • Land For Wildlife • Voluntary Conservation Agreement • Rural Support	Low	• Avoided costs associated with improved waterway outcomes	• Potential to improve water quality at low cost	• Potential to improve waterway health (e.g. reduced erosion, silt and weeds, improved riparian vegetation) at low cost	• Potential to save water at low cost	• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Education and capacity building to support other solutions	• Benefits to Council's reputation • Increased stewardship over land	This solution is generic and may be applied in support of other solutions e.g. waterway rehabilitation, WSUD retrofit etc.	3	3	**6**
E2	Active Extension Programs Idea: Rain gardens in backyards	• $15,000 for program development, may be more if rebates offered • Note could be added to current "Your Backyard Garden" extension program	Low	• Avoided costs associated with waterway rehabilitation works	• Potential to improve water quality at low cost • Typical water quality improvement for rain gardens/ bioretention systems 85% TSS; 70% TP and 45% TN removal • High proportion of existing urban area, therefore high potential for improvement (dependent on uptake)	• Improved in-stream health • Improved in-stream habitat value	Potential landscape irrigation water savings		• Significant opportunity for community capacity building and waterway health education	• Benefits to Council's reputation • Increased stewardship over land		3	2	**5**
E3	Improved marketing around TWCM initiatives	• $5-20K - Basic marketing • $5-50K - Use of Healthy Waterways resources • $60+K - Waterways brand and marketing campaign • $20-$30K - Waterways Festival			• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Potential to improve community 'connectivity' to waterways	• Significant opportunity for community education and improved waterway health education • Increased awareness of Council initiatives improves Council's reputation	Benefits to Council's reputation		3	2	**5**
E4	Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	• $2.4 Million • Dependent on subsidy and number of houses without tanks that it could be applied to. Cost per lot (5kL tank internally plumbed) $3,560	• $14,000 ($20/ tank)	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• 950 kg/yr TSS • 90 kg/yr TN • 6.1 kg/yr TP	• Improved in-stream health • Improved in-stream habitat value	• 47 ML/yr water savings (70 kL/yr/tank).	• Potential to improve amenity during times when mains water restrictions are in place (i.e. access to rainwater)	• Water conservation educational opportunity	Benefits to Council's reputation	Estimate only, will be largely dependent on community uptake	1	3	**4**
E5	Improved connectivity to waterways through education & participation in waterway improvement projects	• Low, to be considered in support of other projects e.g. waterway rehabilitation • Note Waterway Extension Program (WEP) provides improved connectivity to waterways through education and onground improvements in hot spot catchments. The total budget for WEP is $141K (12/13).		• Labour costs for planting projects	• Potential to improve water quality at low cost	• Potential to improve waterway health at low cost		• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Opportunity to secure community support for funding solutions through education	Benefits to Council's reputation		3	2	**5**
E6	Education campaign to address flooding and storm tide issues - Mapping made available to public	• Low $5,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	2	**5**
E7	Education campaign to address flooding and storm tide issues - Include notes on rates	• Low $5,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	2	**5**
E8	Education campaign to address flooding and storm tide issues - Install historical flood marks/signs	• Low $10,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	3	**6**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate Good		1= 2 = 3 =
DM	**Water Supply & Demand Management**													
DM1	Stormwater harvesting for POS	• Judy Holt Park ($2.50/kL) • Further investigation of opportunities required	• $1.50/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• Improved water quality, through reduced catchment stormwater runoff • 279,000 kg/yr TSS • 3,400 kg/yr TN • 630 kg/yr TP	• Reduced volume and frequency of runoff	• 1,850 ML water/yr • Assumes use of 7ML/ha/yr (irrigation)	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity • 'Breakthrough' demonstration project with capacity building opportunities	Benefits to Council's reputation		2	2	**4**
S	**Sewerage**													
S5	Improve prevention of illegal stormwater inflow connections to sewer	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Potential education opportunity for reducing illegal connections	• Protect public health • Improve Council's reputation		2	2	**4**
s6	Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		2	2	**4**
S7	Sewerage upgrades to improve storage/conveyance of wet weather flows	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		1	2	**3**
S8	Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	Input from Redland Water required		• Avoided clean up cost of sewage overflows • Cost savings from reduced pipe sizes for smart sewers	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Community and developer capacity building opportunity for smart sewers	• Protect public health • Improve Council's reputation		1	2	**3**
S9	Wastewater infrastructure rates charged on mains water consumption basis	Input from Redland Water required			• Potential financial incentive to reduce sewage generation • Primarily protection of receiving waters from nutrients from reduced effluent discharges	• Potential to improve waterway health	• Potential financial incentive to reduce water use		• Assist to educate community about cost of wastewater infrastructure	• Primarily funding mechanism for solutions that improve the performance of sewerage infrastructure		3	1	**4**
F	**Flooding & Storm tide**													
F1	Flood mitigation investigation/works implemented (western branch Tarradarrapin Creek) (NB: note flooding not identified as high risk issue in catchment, so this solution is not required. Assumes issues have been addressed)	• Approx $40,000 - Flood mitigation options investigation to be undertaken as part of Integrated Waterway Management Plan		• Avoided insurance claims • Avoided litigation costs • Avoided clean up costs				Reduced flood impacts to public and private assets		• Protect public health and safety		1	3	**4**
F2	Constraints on future land development to address flooding and storm tide issues	Low, implement through planning scheme		• Avoided insurance claims • Avoided litigation costs • Avoided clean up costs				Reduced flood impacts to public and private assets		• Protect public health and safety		3	3	**6**
FS	**Funding to Implement Solutions**													
FS1	Develop business case for healthy waterways to support solutions	• $ 80,000 (regional, applies to all catchments)			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through justifying uptake of solutions	• Potential to save water through justifying uptake of solutions	• Potential to improve recreation and amenity values through justifying uptake of solutions	• Opportunity to educate community about the benefits of solutions and increase willingness to pay			3	3	**6**
FS2	Increase / re-prioritise funding to support TWCM solutions	No cost			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through funding uptake of solutions	• Potential to save water through funding uptake of solutions	• Potential to improve recreation and amenity values through funding uptake of solutions		• Funding mechanism to support uptake of solutions		2	3	**5**

Hilliards Creek Catchment



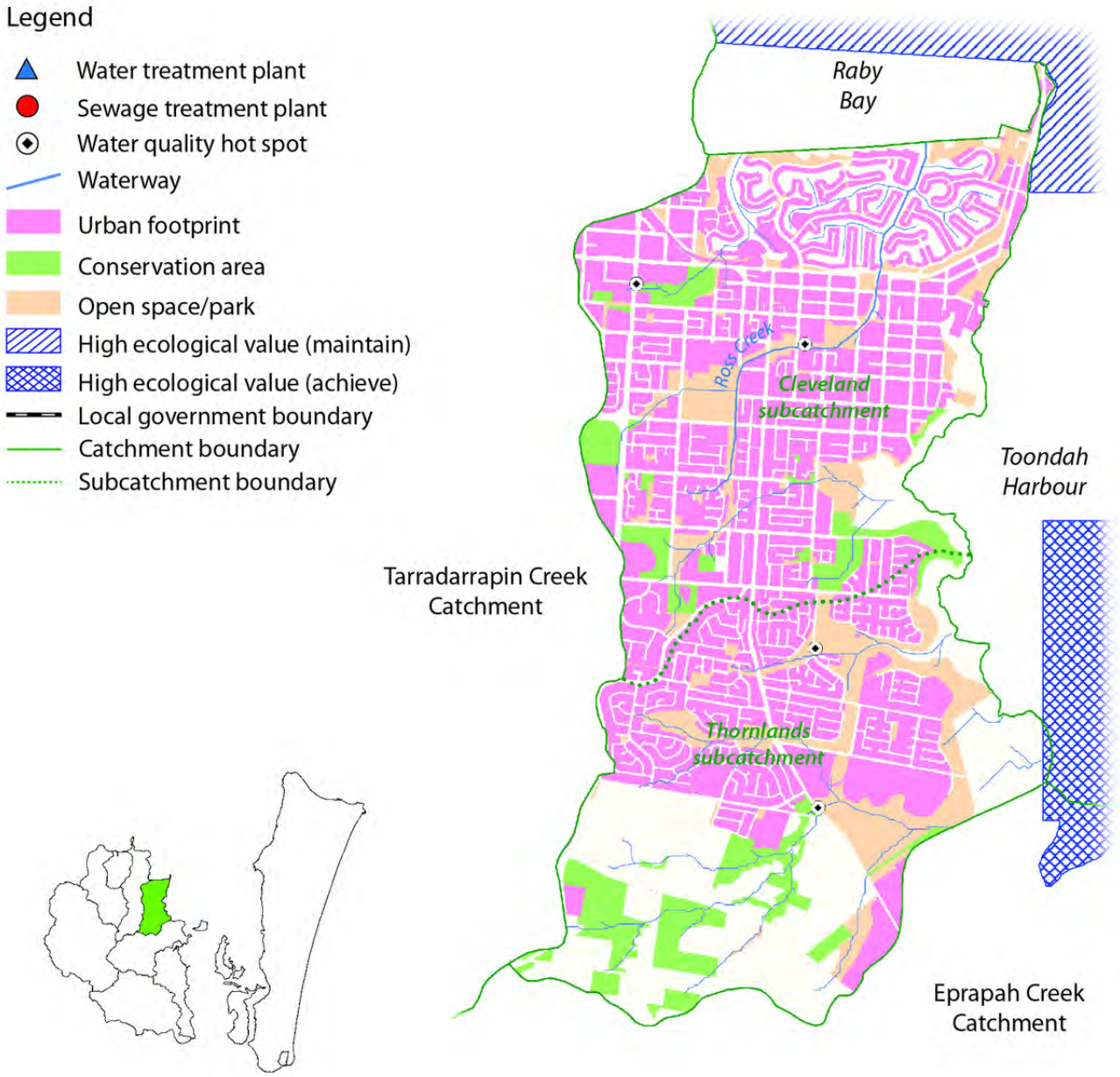
	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate Good		1= 2 = 3 =
W	**Waterway Rehabilitation**													
W1 - W4	Rehabilitation of waterways - Implement recommendations from Hilliards Creek Rehabilitation Plan (JWP 2007)	• $2.6 Million (includes solution costs W1 ,W2, W3, W4) • Note some actions may have been undertaken		• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading)	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	2	4
W1	Rehabilitation of waterways - Riparian buffer zones (private land) • Refer recommendations JWP (2007)	• $10/m^2 ($100,000/ha). • $860,000 for poor - very poor condition waterways on RCC/State land • Further investigation required	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate good overall improvement, constitutes 4.5% of poor waterways in RCC, and 60% of poor waterways within local [illegible]	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	2	4
W2	Rehabilitation of waterways - Habitat restoration (Council land) • Refer recommendations JWP (2007)	• $10/m^2 ($100,000/ha). • $590,000 for poor - very poor condition waterways on RCC/State land • Further investigation required	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate good overall improvement, constitutes 3% of poor waterways in RCC, and 40% of poor waterways within local [illegible]	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	2	4
W3	Rehabilitation of waterways - Bank Stability Works • Refer recommendations JWP (2007)	• Further detailed investigation required		• Avoided costs associated with flood remediation works	• TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health		• Improved community amenity & recreational benefits				2	2	4
W4	Rehabilitation of waterways - In-Stream Improvement works • Refer recommendations JWP (2007)	• Further detailed investigation required		• Avoided costs associated with bank stabilisation and flood remediation works	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved in-stream habitat value		• Improved community amenity & recreational benefits				2	2	4
W6	Identify and prioritise waterway fish barrier locations	• $12,000 (Mick Holland to confirm)				• Potential for future improvement to fish passage and ecological health of waterways (if solutions to barriers are identified and implemented).					Note technology may not be available to implement solutions to identified fish barriers	1	2	3
W5	Increased riparian protection for waterways (buffer/waterway corridor widths) e.g. through planning policy, voluntay Conservation Agreements	• Low cost to amend planning policy • Voluntary Conservation Agreements $18,500/yr for all catchments combined		• Avoided waterway rehabilitation and maintenance costs	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset		3	2	5
W12	Monitoring to evaluate effectiveness of management solutions	• $1,000 per site (ambient monitoring), study specific	• $15,000 for monitoring waterway rehabilitation	• Savings through identifying cost effective solutions	• Monitoring will assist to confirm the most effective solutions to improve water quality	• Monitoring will assist to confirm the most effective solutions to improve waterway health		• Improve community connectivity to waterways (through education)	• Results to educate community on waterway health (Waterway Recovery Report)			2	3	5
D	**Diffuse Pollution Management**													
D1	Increased implementation / enforcement of E&SC management practices and capacity building through education	• $1,500	• $15,000 ($100,000 for all catchments)	• Avoided waterway rehabilitation and maintenance / monitoring costs • Avoided loss of profits to tourism industry (from decline in waterway health)	• Significant coarse sediment removal • TSS removal performance 40% • Nutrient removal assumed minor • Significant development pressures in this catchment hence significant water quality benefits expected	• Improved habitat value through decreasing water turbidity and protecting sea-grass habitat from being smothered		• Maintain community amenity, recreational and tourism benefits, particularly in receiving waters (Moreton Bay) • Improved connectivity to waterways	• Capacity building and education for council, land developers and contractors			3	3	6
D3	Rural BMP for horticultural land - implementation of filter/buffer strips	• $154,000 ($1,600/ha)	• $38,000 ($390/ha)	• Avoided costs associated with waterway rehabilitation works	• 84% Removal TSS • 75% Removal of TP • 70% Removal TN • Landuse constitutes 3% of catchment, expect localised improvements to water quality	• Improved in-stream health • Improved in-stream habitat value		• Improved connectivity to waterways	• Community planting and waterway health education opportunities		• Literature values used. • Site specific investigations required to more accurately estimate • Requires support by private land owners	2	3	5
D4	Integrate WSUD into government capital infrastructure works e.g. road/ park upgrades	• Unknown, dependent on amount of capital infrastructure works scheduled. • Will be more significantly more cost effective than retrofit, so should be integrated where possible.	$1-5/m2 (bioretention and swales)	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Depends on extent of capital upgrades in catchment • Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity	Effectiveness will depend on uptake through future works, which is unknown.	3	2	5
D5	Improved waterway health asset management system	• $10,000 to create asset register and maintenance schedule (Approx $100K for whole Redlands region)	$1-5/m2	• $810,000 avoided asset rectification • Avoided costs associated with waterway rehabilitation works	• Optimal treatment performance for well maintained bioretention systems: 85% TSS; 70% TP and 45% TN removal • If not well maintained, could act as a source of pollution • Potential to ensure to significant water quality improvement	• Maintain in-stream health • Maintain in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values			Costing based on bioretention area estimate	3	3	6
D6	Future development to achieve better than SPP Water requirements (for WSUD)	• $3 Million	• $30,000	• Avoided costs associated with waterway rehabilitation works	• Achieve no future worsening in catchment pollutant loads i.e. maintain or improve on existing loads generated • Signficiant amount of future development hence improvements expected to be large	• Maintain / improve in-stream health • Maintain / improve in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values	• Community planting and waterway health education opportunities		This solution will be more applicable to catchments with sensitive receiving environments, as it's not as cost effective as traditional WSUD	2	3	5

D7	Naturalising land currently degraded by human activities (e.g. tree planting in rural areas void of vegetation)	• Revegetation cost $8/m^2. Further investigation required to identify areas. Note: Rural Support and Waterways Extension programs Council carries out revegetation projects on individual and sometimes joint properties. Budget of both programs is $231,500	N/A (reveg. cost includes maintenance)	• Avoided costs associated with waterway rehabilitation works • Carbon credits	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction	• Improved in-stream health • Improved in-stream habitat value		• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Increased Bio-diversity • Carbon offset		1	2	3
D8	Water Sensitive Urban Design Retrofit (beyond capital infrastructure works)	• $12 Million • Note Hilliards Creek CMP identifies some locations for end of pipe treatment measures ($7.1 Million). Further investigation required to identify 'streetscape' solutions that treat stormwater at source	• $119,000	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal, however difficult to achieve in retrofit scenarios • Hilliards Creek CMP modelled 43% TSS, 41% TP and 21% TN removal • Potential to significantly improve water quality	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity		1	3	4
H	**Pollutant Hot Spot Management**													
H1	BMP for poultry farms - EMP review	•$18,000 ($3,000 / farm)		• Avoided costs associated with waterway rehabilitation works	• Note poultry farms have been identified as a possible hot spot for pollutant load generation in catchment • Approx. 6 farms identified in catchment, moderate potential to improve water quality	• Improved in-stream health • Improved in-stream habitat value						3	2	5
H2	Rehabilitation of poorly performing water bodies (e.g. toxic dams/lakes)	• $65,000 to finalise management framework (all catchments) (2013/14) • Additional funding will be dependent on number and type of works required	• Dependent on works, however maintenance will be required	• Avoided costs associated with waterway rehabilitation works • Cost savings through nutrient trading scheme	• Note water bodies have been identified as a possible hot spot for pollutant load generation in catchment • A fair proportion of Redlands' water bodies are in this catchment, hence benefits are likely to be high	• Improved in-stream health • Improved habitat value		• Improved amenity, active and passive recreational values • Improved connectivity to waterways • Increased land values	• Waterway health education opportunities on Council owned land (e.g. signage)		Firstly requires assessment and prioritisation of water bodies to rehabilitate	2	3	5
H4	Investigate sources of hot spot pollution & identify targeted treatment strategies	Minor initial expenditure associated with expanded program, but this is incorporated into annual/ ongoing costs.	• $100,000 for annual program (Assumes 60 sites for whole of Redlands, laboratory expenses comprise 50%)	• Avoided costs associated with waterway rehabilitation works	• Note 4 hot spots have been identified as key pollutant generation sources in the catchment • Potential to significantly improve water quality.	• Improved in-stream habitat value						3	3	6
H5	Nutrient Trading	Not known. Likely to be cost effective as targets least cost strategy to remove pollutants from catchment. e.g. funding of rural BMPs to address hot spots instead of upgrade to STP.	Not known	• Cost savings through targeting most cost effective management solutions	• Unknown however likely to be high water quality improvement benefits	• Improved in-stream health • Improved in-stream habitat value		• Potential to improve amenity and passive recreational values				3	2	5
E	**Education & Capacity Building**													
E1	Education & /or capacity building and investment in incentive schemes	• This will be dependent on the adopted solutions and how they can each be supported. Low anticipated costs. • Currently adopted Habitat Protection Programs may be used to support some solutions. These total $320K and include: • Waterways Extension • Land For Wildlife	Low	• Avoided costs associated with improved waterway outcomes	• Potential to improve water quality at low cost	• Potential to improve waterway health (e.g. reduced erosion, silt and weeds, improved riparian vegetation) at low cost	• Potential to save water at low cost	• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Education and capacity building to support other solutions	• Benefits to Council's reputation • Increased stewardship over land	This solution is generic and may be applied in support of other solutions e.g. waterway rehabilitation, WSUD retrofit etc.	3	3	6
E2	Active Extension Programs Idea: Rain gardens in backyards	• $15,000 for program development, may be more if rebates offered • Note could be added to current "Your Backyard Garden" extension program	Low	• Avoided costs associated with waterway rehabilitation works	• Potential to improve water quality at low cost • Typical water quality improvement for rain gardens/ bioretention systems 85% TSS; 70% TP and 45% TN removal • High proportion of existing urban area, therefore high potential for improvement (dependent on uptake)	• Improved in-stream health • Improved in-stream habitat value	Potential landscape irrigation water savings		• Significant opportunity for community capacity building and waterway health education	• Benefits to Council's reputation • Increased stewardship over land		3	2	5
E3	Improved marketing around TWCM initiatives	• $5-20K - Basic marketing • $5-50K - Use of Healthy Waterways resources • $60+K - Waterways brand and marketing campaign • $20-$30K - Waterways Festival			• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Potential to improve community 'connectivity' to waterways	• Significant opportunity for community education and improved waterway health education • Increased awareness of Council initiatives improves Council's reputation	Benefits to Council's reputation		3	2	5
E4	Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	• $2.12 Million • Dependent on subsidy and number of houses without tanks that it could be applied to. Cost per lot (5kL tank internally plumbed) $3,560	• $12,000 ($20/ tank)	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• 830 kg/yr TSS • 80 kg/yr TN • 5.4 kg/yr TP	• Improved in-stream health • Improved in-stream habitat value	• 42 ML/yr water savings (70 kL/yr/tank).	• Potential to improve amenity during times when mains water restrictions are in place (i.e. access to rainwater)	• Water conservation educational opportunity	Benefits to Council's reputation	Estimate only, will be largely dependent on community uptake	1	3	4
E5	Improved connectivity to waterways through education & participation in waterway improvement projects	• Low, to be considered in support of other projects e.g. waterway rehabilitation • Note Waterway Extension Program (WEP) provides improved connectivity to waterways through education and onground improvements in hot spot catchments. The total budget for WEP is $141K (12/13).		• Labour costs for planting projects	• Potential to improve water quality at low cost	• Potential to improve waterway health at low cost		• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Opportunity to secure community support for funding solutions through education	Benefits to Council's reputation		3	2	5

DM	**Water Supply & Demand Management**													
DM1	Stormwater harvesting for POS	• $2.50/kL • Further investigation of opportunities required	• $1.50/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• Improved water quality, through reduced catchment stormwater runoff • 150 kg TSS per ML reuse • 2 kg TN per ML reuse • 0.3 kg TP per ML reuse	• Reduced volume and frequency of runoff	• Approximately 7ML/ha/yr (irrigation)	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity • 'Breakthrough' demonstration project with capacity building opportunities	Benefits to Council's reputation		2	2	4
DM2	Stormwater harvesting for dual reticulation (greenfield - Kinross Road)	• $4.50/kL • Further investigation of opportunities required	• $3/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades • Avoided cost for individual household tanks	• Improved water quality, through reduced catchment stormwater runoff • 8,210 kg/yr TSS • 100 kg/yr TN • 18.4 kg/yr TP	• Reduced volume and frequency of runoff	• 54.4 ML/yr	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity • 'Breakthrough' demonstration project with capacity building opportunities			2	3	5
DM3	Rainwater harvesting communal tanks (greenfield)	• $10/kL • Further investigation of opportunities required	$3.30/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades • Avoided cost for individual household tanks	• Improved water quality, through reduced catchment stormwater runoff • 2,200 kg/yr TSS • 200 kg/yr TN • 14 kg/yr TP	• Reduced volume and frequency of runoff	• 111 ML/yr	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity • 'Breakthrough' demonstration project with capacity building opportunities		Further detailed studies required to quantify water savings and water quality benefits	1	2	3
DM4	Recycled water supplied to large industrial users • Cleveland Industrial Estate Concept Report (KBR 2006)	• $1.2 Million (/kL) (approx $9.35/kL)	$2.50/kL	• Potential avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades for water supply	**Reuse Nutrient Reduction:** • 112 kg/yr TSS (560 kg/yr design) • 41 kg/yr TN (186 kg/yr design) • 7.4 kg/yr TP (37.2 kg/yr design)	• Improved in-stream health • Improved in-stream habitat value	• 37 ML/yr					1	2	3
DM6	Recycled water irrigated to woodlots. This was the prefferred option as investigated by Redland Water (2009) in the Thornlands Total Water Cycle Management investigation. Note limitations since identified inlcude: • limited feasible due to land shortage for allocating woodlands • Thornlands Integrated Enterprise Area no longer going ahead	• $50.2 Million (Cleveland STP)	• $1.2 Million	• Potential avoided costs associated with waterway rehabilitation works	**Woodland Irrigation Nutrient Reduction:** • 5,100 kg/yr TSS (18,500 kg/yr design) • 1,400 kg/yr TN (5,700 kg/yr design) • 235 kg/yr TP (1,120 kg/yr design)	• Improved in-stream health • Improved in-stream habitat value	N/A	• Potential to improve visual amenity through woodlot planting	• Potential waterway health education opportunity for woodlot reuse	• Carbon offset benefits for woodlots • Increased biodiversity for woodlots • Potential to Improve habitat connectivity for woodlots		1	3	4
DM8	Recycled water supplied to urban users using Cleveland STP (dual reticulation): • Option investigated by Redland Water (2009) in Thornlands Total Water Cycle Management investigation. Note not preferred option. Includes dual reticualtion for the following future residential developments: • Kinross Road • South East Thornlands • Double Jump and Bunker Road • Option also includes upgrade to Victoria Point STP to reduce Total Nitrogen from 3 to 1.3 mg/L	• $59.8 Million (inlcludes upgrade to TN treatment process) • NB estimated cost KBR (2007) $5.90/kL (2007) with CAPEX $23.7 Million - did not include VP STP upgrade	• $1.9 Million	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades for water supply	**Dual Reticulation Nutrient Reduction:** • 1,400 kg/yr TSS (7,100 kg/yr design) • 520 kg/yr TN (2,360 kg/yr design) • 95 kg/yr TP (470 kg/yr design) **Upgraded STP TN Reduction for Victoria Point STP:** • 5,800 kg/yr TN (assumes design standard)	• Improved in-stream health • Improved in-stream habitat value	• 472 ML/yr	• Potential to improve amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity • 'Breakthrough' demonstration project with capacity building opportunities			1	3	4
S	**Sewerage**													
S1	Provide sewerage infrastructure for unsewered areas	• $2 Million ($7,900 / ET)	• $60,000 ($250 / ET)	• Avoided costs for waterway health / groundwater quality remediation	• Protection of receiving waters from nutrients and pathogen contamination • Moderate improvement to water quality expected	• Improve waterway health		• Maintain current amenity and recreational values that may be detrimentally affected by poor sewage disposal practices		• Protect public health		1	2	3
S2	Inspections and improved management of on site wastewater systems	Minor initial expenditure associated with program, but this is incorporated into annual/ ongoing costs.	• $35,000	• Avoided costs for waterway health / groundwater quality remediation	• Protection of receiving waters from nutrients and pathogen contamination • Moderate improvement to water quality expected	• Improve waterway health		• Maintain current amenity and recreational values that may be detrimentally affected by poor sewage disposal practices	• Community capacity building on operation and maintenance of on site systems • Waterway health educational opportunity	• Protect public health		3	2	5
S5	Improve prevention of illegal stormwater inflow connections to sewer	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Potential education opportunity for reducing illegal connections	• Protect public health • Improve Council's reputation		2	2	4
S6	Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		2	2	4
S7	Sewerage upgrades to improve storage/conveyance of wet weather flows	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		1	2	3
S8	Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	Input from Redland Water required		• Avoided clean up cost of sewage overflows • Cost savings from reduced pipe sizes for smart sewers	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Community and developer capacity building opportunity for smart sewers	• Protect public health • Improve Council's reputation		1	2	3
S9	Wastewater infrastructure rates charged on mains water consumption basis	Input from Redland Water required			• Potential financial incentive to reduce sewage generation • Primarily protection of receiving waters from nutrients from reduced effluent discharges	• Potential to improve waterway health	• Potential financial incentive to reduce water use		• Assist to educate community about cost of wastewater infrastructure	• Primarily funding mechanism for solutions that improve the performance of sewerage infrastructure		3	1	4

DC	**Development Control**													
DC1	Cap on population growth	• Low - planning policy. • Poential economic impacts		• Avoid costs associated with upgraded / new infrastructure	• Reduced pressures on water quality	• Reduced pressures on waterway health	• Reduced demand for water				Dependent on planned population growth	2	3	**5**
DC2	Increased restrictions on development extent and intensity for proposed development areas	• Low - planning policy. • Poential economic impacts			• Reduced pressures on water quality	• Reduced pressures on waterway health	• Reduced demand for water	• Increase land area for amenity and recreation			Dependent on planned development	2	3	**5**
DC3	Investigations to more accurately define population growth for future planning purposes	• $100,000		• More accurate forward planning can result in cost savings from deferred infrastructure upgrades								3	3	**6**
FS	**Funding to Implement Solutions**													
FS1	Develop business case for healthy waterways to support solutions	• $ 80,000 (regional, applies to all catchments)			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through justifying uptake of solutions	• Potential to save water through justifying uptake of solutions	• Potential to improve recreation and amenity values through justifying uptake of solutions	• Opportunity to educate community about the benefits of solutions and increase willingness to pay			3	3	**6**
FS2	Increase / re-prioritise funding to support TWCM solutions	No cost			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through funding uptake of solutions	• Potential to save water through funding uptake of solutions	• Potential to improve recreation and amenity values through funding uptake of solutions		• Funding mechanism to support uptake of solutions		2	3	**5**

Cleveland & Thornlands Catchment



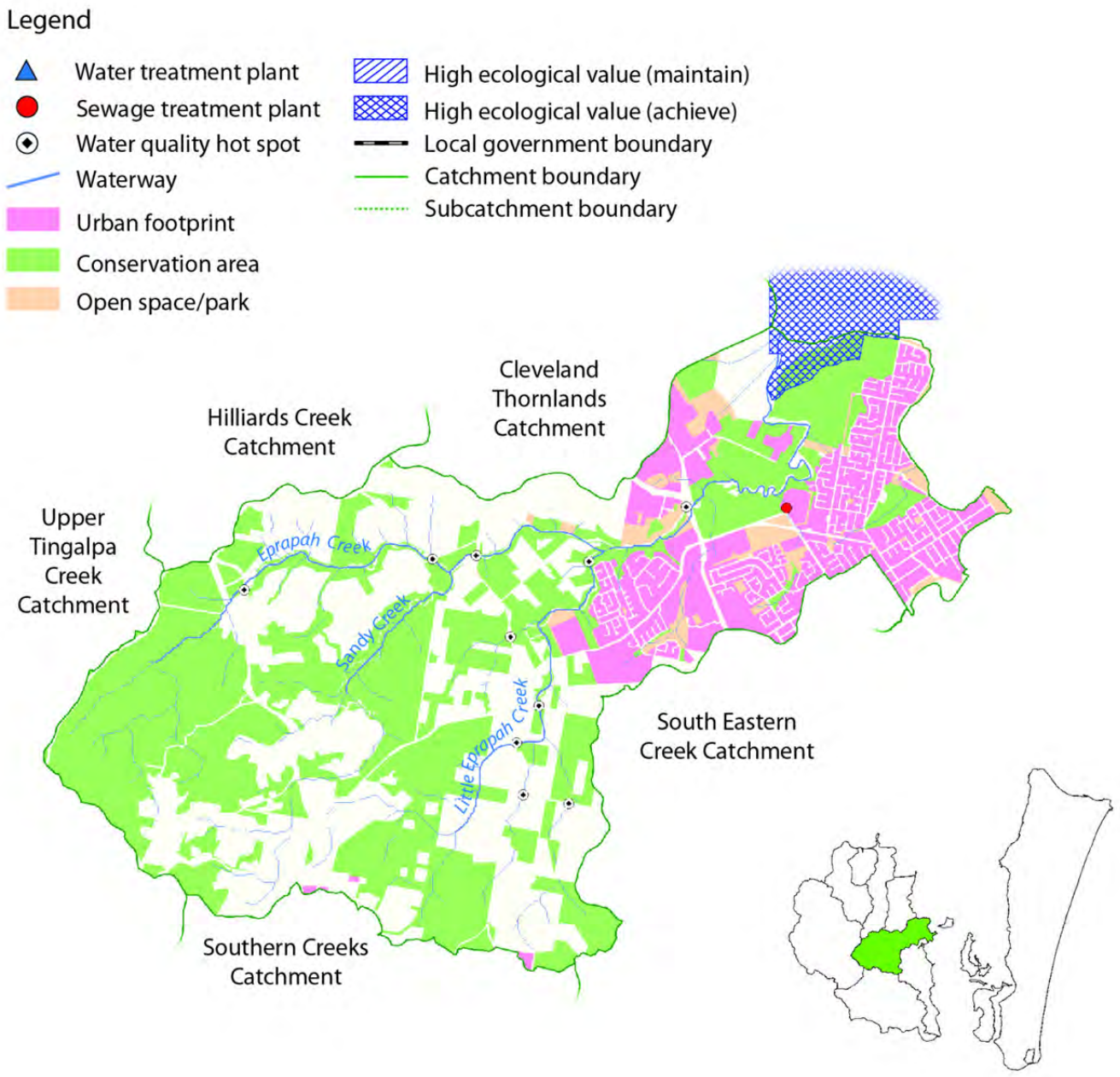
	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate Good	1= 2 = 3 =	
W	**Waterway Rehabilitation**													
W1	Rehabilitation of waterways - Riparian buffer zones (private land)	• $10/m^2 ($100,000/ha). • $1.42 Million for poor - very poor condition waterways on RCC/State land • Further investigation required, note some land looks to be on Council easements	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate good overall improvement, constitutes 7.5% of poor waterways in RCC, and 65% of poor waterways within local catchment. • Potential to stabilise alluvial soils with high nutrient content	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	3	**5**
W2	Rehabilitation of waterways - Habitat restoration (Council land)	• $10/m^2 ($100,000/ha). • $760,000 for poor - very poor condition waterways on RCC/State land • Further investigation required	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate fair overall improvement, constitutes 4% of poor waterways in RCC, and 35% of poor waterways within local catchment. • Potential to stabilise alluvial soils with high nutrient content	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	3	**5**
W3	Rehabilitation of waterways - Bank Stability Works	No known, study specific	No known, study specific	• Avoided costs associated with flood remediation works	• TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health		• Improved community amenity & recreational benefits				2	2	**4**
W4	Rehabilitation of waterways - In-Stream Improvement works	No known, study specific	No known, study specific	• Avoided costs associated with bank stabilisation and flood remediation works	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved in-stream habitat value		• Improved community amenity & recreational benefits				2	2	**4**
W5	Increased riparian protection for waterways (buffer/waterway corridor widths)	• Low cost to amend planning policy • Voluntary Conservation Agreements $18,500/yr for all catchments combined		• Avoided waterway rehabilitation and maintenance costs	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset		3	2	**5**
W6	Identify and prioritise waterway fish barrier locations	• $12,000 (Mick Holland to confirm)				• Potential for future improvement to fish passage and ecological health of waterways (if solutions to barriers are identified and implemented).					Note technology may not be available to implement solutions to identified fish barriers	2	1	**3**
W12	Monitoring to evaluate effectiveness of management solutions	• $1,000 per site (ambient monitoring), study specific		• Savings through identifying cost effective solutions	• Monitoring will assist to confirm the most effective solutions to improve water quality	• Monitoring will assist to confirm the most effective solutions to improve waterway health		• Improve community connectivity to waterways (through education)	• Results to educate community on waterway health (Waterway Recovery Report)			2	3	**5**
D	**Diffuse Pollution Management**													
D1	Increased implementation / enforcement of E&SC management practices	• $1,100	• $11,000 ($100,000 for all catchments)	• Avoided waterway rehabilitation and maintenance / monitoring costs • Avoided loss of profits to tourism industry (from decline in waterway health)	• Significant coarse sediment removal • TSS removal performance 40% • Nutrient removal assumed minor	• Improved habitat value through decreasing water turbidity and protecting sea-grass habitat from being smothered		• Maintain community amenity, recreational and tourism benefits, particularly in receiving waters (Moreton Bay) • Improved connectivity to waterways	• Capacity building and education for council, land developers and contractors			3	3	**6**
D2	Rural BMP for grazing land - fencing off stock & revegetation around 1st & 2nd order streams	• $240,000 ($233 K per km of creek)	$340/ha	• Avoided costs associated with bank stabilisation and flood remediation works	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate marginal overall improvement, constitutes 1% of poor waterways in RCC, and 9% of poor waterways within local catchment • Potential to stabilise alluvial soils with high nutrient content	• Improved in-stream health • Improved habitat value		• Improved amenity and passive recreational values • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential flood mitigation benefits to downstream urban areas (through slowing and detaining flows)	• Literature values used. • Site specific investigations required to more accurately estimate • Requires support by private land owners	2	2	**4**
D3	Rural BMP for horticultural land - implementation of filter/buffer strips	• $100,000 ($1,600/ha)	• $24,000 ($390/ha)	• Avoided costs associated with waterway rehabilitation works	• 84% Removal TSS • 75% Removal of TP • 70% Removal TN • Landuse constitutes 3% of catchment, expect localised improvements to water quality • Potential to stabilise alluvial soils with high nutrient content.	• Improved in-stream health • Improved in-stream habitat value		• Improved connectivity to waterways	• Community planting and waterway health education opportunities		• Literature values used. • Site specific investigations required to more accurately estimate • Requires support by private land owners	2	2	**4**
D4	Integrate WSUD into government capital infrastructure works e.g. road/ park upgrades	• Unknown, dependent on amount of capital infrastructure works scheduled. • Will be more significantly more cost effective than retrofit, so should be integrated where possible.	$1-5/m2 (bioretention and swales)	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Depends on extent of capital upgrades in catchment • Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity	Effectiveness will depend on uptake through future works, which is unknown.	3	2	**5**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate Good		1= 2 = 3 =
D5	Improved waterway health asset management system	• $10,000 to create asset register and maintenance schedule (Approx $100K for whole Redlands region)	$1-5/m2	• $470,000 avoided asset rectification • Avoided costs associated with waterway rehabilitation works	• Optimal treatment performance for well maintained bioretention systems: 85% TSS; 70% TP and 45% TN removal • If not well maintained, could act as a source of pollution • Potential to ensure to significant water quality improvement	• Maintain in-stream health • Maintain in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values			Costing based on bioretention area estimate	3	3	**6**
D6	Future development to achieve better than SPP Water requirements (for WSUD)	• $1.7 Million	• $17,000	• Avoided costs associated with waterway rehabilitation works	• Achieve no future worsening in catchment pollutant loads i.e. maintain or improve on existing loads generated • Fair amount of future development hence improvements expected to be moderate	• Maintain / improve in-stream health • Maintain / improve in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values	• Community planting and waterway health education opportunities		This solution will be more applicable to catchments with sensitive receiving environments, as it's not as cost effective as traditional WSUD	1	2	**3**
D7	Naturalising land currently degraded by human activities	• Revegetation cost $8/m^2. Further investigation required to identify areas. • Note: Rural Support and Waterways Extension programs Council carries out revegetation projects on individual and sometimes joint properties. Budget of both programs is $231,500	N/A (reveg. cost includes maintenance)	• Avoided costs associated with waterway rehabilitation works • Carbon credits	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction	• Improved in-stream health • Improved in-stream habitat value		• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Increased Bio-diversity • Carbon offset		1	2	**3**
D8	Water Sensitive Urban Design Retrofit (beyond capital infrastructure works)	• $7 Million	• $70,000	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal, however difficult to achieve in retrofit scenarios • Potential to significantly improve water quality	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity		1	3	**4**
H	**Pollutant Hot Spot Management**													
H1	BMP for poultry farms - EMP review	• $3,000 ($3K per property)		• Avoided costs associated with waterway rehabilitation works	• Note poultry farms have been identified as a possible hot spot for pollutant load generation in catchment • Only 1 poultry farm identified in catchment, so expect benefits to be localised and minor	• Improved in-stream health • Improved in-stream habitat value						3	1	**4**
H2	Rehabilitation of poorly performing water bodies	• $65,000 to finalise management framework (all catchments) (2013/14) • Additional funding will be dependent on number and type of works required	• Dependent on works, however maintenance will be required	• Avoided costs associated with waterway rehabilitation works • Cost savings through nutrient trading scheme	• Note water bodies have been identified as a possible hot spot for pollutant load generation in catchment • Approximately 7% of Redlands' water bodies are in this catchment, hence benefits are likely to be moderate	• Improved in-stream health • Improved habitat value		• Improved amenity, active and passive recreational values • Improved connectivity to waterways • Increased land values	• Waterway health education opportunities on Council owned land (e.g. signage)		Firstly requires assessment and prioritisation of water bodies to rehabilitate	2	2	**4**
H4	Investigate sources of hot spot pollution & identify targeted treatment strategies	Minor initial expenditure associated with expanded program, but this is incorporated into annual/ ongoing costs.	• $100,000 for annual program (Assumes 60 sites for whole of Redlands, laboratory expenses comprise 50%)	• Avoided costs associated with waterway rehabilitation works	• Note 4 hot spots have been identified as key pollutant generation sources in the catchment • Potential to improve water quality.	• Improved in-stream habitat value						3	3	**6**
E	**Education & Capacity Building**													
E1	Education & /or capacity building and investment in incentive schemes	• This will be dependent on the adopted solutions and how they can each be supported. Low anticipated costs. • Currently adopted Habitat Protection Programs may be used to support some solutions. These total $320K and include: • Waterways Extension • Land For Wildlife • Voluntary Conservation Agreement • Rural Support	Low	• Avoided costs associated with improved waterway outcomes	• Potential to improve water quality at low cost	• Potential to improve waterway health (e.g. reduced erosion, silt and weeds, improved riparian vegetation) at low cost	• Potential to save water at low cost	• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Education and capacity building to support other solutions	• Benefits to Council's reputation • Increased stewardship over land	This solution is generic and may be applied in support of other solutions e.g. waterway rehabilitation, WSUD retrofit etc.	3	3	**6**
E2	Active Extension Programs Idea: Rain gardens in backyards	• $15,000 for program development, may be more if rebates offered • Note could be added to current "Your Backyard Garden" extension program	Low	• Avoided costs associated with waterway rehabilitation works	• Potential to improve water quality at low cost • Typical water quality improvement for rain gardens/ bioretention systems 85% TSS; 70% TP and 45% TN removal • High proportion of existing urban area, therefore significant potential for improvement (dependent on uptake)	• Improved in-stream health • Improved in-stream habitat value	Potential landscape irrigation water savings		• Significant opportunity for community capacity building and waterway health education	• Benefits to Council's reputation • Increased stewardship over land		3	2	**5**
E3	Improved marketing around TWCM initiatives	• $5-20K - Basic marketing • $5-50K - Use of Healthy Waterways resources • $60+K - Waterways brand and marketing campaign • $20-$30K - Waterways Festival			• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Potential to improve community 'connectivity' to waterways	• Significant opportunity for community education and improved waterway health education • Increased awareness of Council initiatives improves Council's reputation	Benefits to Council's reputation		3	2	**5**
E4	Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	• $2.85 Million • Dependent on subsidy and number of houses without tanks that it could be applied to. Cost per lot (5kL tank internally plumbed) $3,560	• $16,000 ($20/ tank)	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• 1,120 kg/yr TSS • 100 kg/yr TN • 7.2 kg/yr TP	• Improved in-stream health • Improved in-stream habitat value	• 56 ML/yr water savings (70 kL/yr/tank).	• Potential to improve amenity during times when mains water restrictions are in place (i.e. access to rainwater)	• Water conservation educational opportunity	Benefits to Council's reputation	Estimate only, will be largely dependent on community uptake	1	3	**4**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate Good	1= 2 = 3 =	
E5	Improved connectivity to waterways through education & participation in waterway improvement projects	• Low, to be considered in support of other projects e.g. waterway rehabilitation • Note Waterway Extension Program (WEP) provides improved connectivity to waterways through education and onground improvements in hot spot catchments. The total budget for WEP is $141K (12/13).		• Labour costs for planting projects	• Potential to improve water quality at low cost	• Potential to improve waterway health at low cost		• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Opportunity to secure community support for funding solutions through education	Benefits to Council's reputation		3	2	**5**
E6	Education campaign to address flooding and storm tide issues - Mapping made available to public	• Low $5,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	2	**5**
E7	Education campaign to address flooding and storm tide issues - Include notes on rates	• Low $5,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	2	**5**
E8	Education campaign to address flooding and storm tide issues - Install historical flood marks/signs	• Low $10,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	3	**6**
DM	**Water Supply & Demand Management**													
DM1	Stormwater harvesting for POS	• $2.50/kL for following breakthrough projects: • Redland Showgrounds • Pinklands Sporting Fields	• $1.50/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• Improved water quality, through reduced catchment stormwater runoff • 267,000 kg/yr TSS • 3,200 kg/yr TN • 600 kg/yr TP	• Reduced volume and frequency of runoff	• 1,770 ML water/yr • Assumes use of 7ML/ha/yr (irrigation)	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity • 'Breakthrough' demonstration project with capacity building opportunities	Benefits to Council's reputation		2	3	**5**
S	**Sewerage**													
S2	Inspections and improved management of on site wastewater systems	Minor initial expenditure associated with program, but this is incorporated into annual/ ongoing costs.	• $35,000	• Avoided costs for waterway health / groundwater quality remediation	• Protection of receiving waters from nutrients and pathogen contamination • Moderate benefits to water quality expected	• Improve waterway health		• Maintain current amenity and recreational values that may be detrimentally affected by poor sewage disposal practices	• Community capacity building on operation and maintenance of on site systems • Waterway health educational opportunity	• Protect public health		3	2	**5**
S5	Improve prevention of illegal stormwater inflow connections to sewer	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Potential education opportunity for reducing illegal connections	• Protect public health • Improve Council's reputation		2	2	**4**
S6	Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		2	2	**4**
S7	Sewerage upgrades to improve storage/conveyance of wet weather flows	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		1	2	**3**
S8	Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	Input from Redland Water required		• Avoided clean up cost of sewage overflows • Cost savings from reduced pipe sizes for smart sewers	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Community and developer capacity building opportunity for smart sewers	• Protect public health • Improve Council's reputation		1	2	**3**
S9	Wastewater infrastructure rates charged on mains water consumption basis	Input from Redland Water required			• Potential financial incentive to reduce sewage generation • Primarily protection of receiving waters from nutrients from reduced effluent discharges	• Potential to improve waterway health	• Potential financial incentive to reduce water use		• Assist to educate community about cost of wastewater infrastructure	• Primarily funding mechanism for solutions that improve the performance of sewerage infrastructure		3	1	**4**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate Good	1= 2 = 3 =	
F	**Flooding & Storm tide**													
F1	Flood mitigation investigation/works implemented	• $40,000 to undertake flood study and recommend mitigation options for Cleveland catchment (Thornlands investigated)		• Avoided insurance claims • Avoided litigation costs • Avoided clean up costs				Reduced flood impacts to public and private assets		• Protect public health and safety		1	3	**4**
FS	**Funding to Implement Solutions**													
FS1	Develop business case for healthy waterways to support solutions	• $ 80,000 (regional, applies to all catchments)			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through justifying uptake of solutions	• Potential to save water through justifying uptake of solutions	• Potential to improve recreation and amenity values through justifying uptake of solutions	• Opportunity to educate community about the benefits of solutions and increase willingness to pay			3	3	**6**
FS2	Increase / re-prioritise funding to support TWCM solutions	No cost			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through funding uptake of solutions	• Potential to save water through funding uptake of solutions	• Potential to improve recreation and amenity values through funding uptake of solutions		• Funding mechanism to support uptake of solutions		2	3	**5**

Eprapah Creek Catchment



	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key 1= Poor 2 = Moderate 3 = Good		
W	**Waterway Rehabilitation**													
W1	Rehabilitation of waterways - Riparian buffer zones (private land)	• $10/m^2 ($100,000/ha). • $1.88 Million for poor - very poor condition waterways on RCC/State land • Further investigation required	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate good overall improvement, constitutes 10% of poor waterways in RCC, and 36% of poor waterways within local catchment • Potential to stabilise alluvial soils with high nutrient content	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	3	**5**
W2	Rehabilitation of waterways - Habitat restoration (Council land)	• $10/m^2 ($100,000/ha). • $490,000 for poor - very poor condition waterways on RCC/State land • Further investigation required	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate moderate overall improvement, constitutes 2.6% of poor waterways in RCC, and 10% of poor waterways within local catchment • Potential to stabilise alluvial soils with high nutrient content	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	**2**	**3**	**5**
W3	Rehabilitation of waterways - Bank Stability Works	• Further detailed investigation required		• Avoided costs associated with flood remediation works	• TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health		• Improved community amenity & recreational benefits				**2**	**2**	**4**
W4	Rehabilitation of waterways - In-Stream Improvement works	• Further detailed investigation required		• Avoided costs associated with bank stabilisation and flood remediation works	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved in-stream habitat value		• Improved community amenity & recreational benefits				**2**	**2**	**4**
W5	Increased riparian protection for waterways (buffer/waterway corridor widths) e.g. through planning policy, voluntay Conservation Agreements	• Low cost to amend planning policy • Voluntary Conservation Agreements $18,500/yr for all catchments combined		• Avoided waterway rehabilitation and maintenance costs	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset		**3**	**2**	**5**
W6	Identify and prioritise waterway fish barrier locations (already undertaken for Eprapah Catchment)					• Potential for future improvement to fish passage and ecological health of waterways (if solutions to barriers are identified and implemented).					Note technology may not be available to implement solutions to identified fish barriers	1	1	**2**
W12	Monitoring to evaluate effectiveness of management solutions	• $1,000 per site (ambient monitoring), study specific		• Savings through identifying cost effective solutions	• Monitoring will assist to confirm the most effective solutions to improve water quality	• Monitoring will assist to confirm the most effective solutions to improve waterway health		• Improve community connectivity to waterways (through education)	• Results to educate community on waterway health (Waterway Recovery Report)			2	3	**5**
D	**Diffuse Pollution Management**													
D1	Increased implementation / enforcement of E&SC management practices and capacity building through education	• $1,500	• $15,000 ($100,000 for all catchments)	• Avoided waterway rehabilitation and maintenance / monitoring costs • Avoided loss of profits to tourism industry (from decline in waterway health)	• Significant coarse sediment removal • TSS removal performance 40% • Nutrient removal assumed minor • Significant development pressures in this catchment hence significant water quality benefits expected	• Improved habitat value through decreasing water turbidity and protecting sea-grass habitat from being smothered		• Maintain community amenity, recreational and tourism benefits, particularly in receiving waters (Moreton Bay) • Improved connectivity to waterways	• Capacity building and education for council, land developers and contractors			3	3	**6**
D2	Rural BMP for grazing land - fencing off stock & revegetation around 1st & 2nd order streams	• $2.69 Million ($233 K per km of creek)	$340/ha	• Avoided costs associated with bank stabilisation and flood remediation works	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate good overall improvement, constitutes 12% of poor waterways in RCC, and 45% of poor waterways within local catchment	• Improved in-stream health • Improved habitat value		• Improved amenity and passive recreational values • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential flood mitigation benefits to downstream urban areas (through slowing and detaining flows)	• Literature values used. • Site specific investigations required to more accurately estimate • Requires support by private land owners	2	3	**5**
D3	Rural BMP for horticultural land - implementation of filter/buffer strips	• $493,000 ($1,600/ha)	• $120,000 ($390/ha)	• Avoided costs associated with waterway rehabilitation works	• 84% Removal TSS • 75% Removal of TP • 70% Removal TN • Landuse constitutes 8% of catchment, expect fair improvements to water quality	• Improved in-stream health • Improved in-stream habitat value		• Improved connectivity to waterways	• Community planting and waterway health education opportunities		• Literature values used. • Site specific investigations required to more accurately estimate • Requires support by private land owners	2	2	**4**
D4	Integrate WSUD into government capital infrastructure works e.g. road/ park upgrades	• Unknown, dependent on amount of capital infrastructure works scheduled. • Will be more significantly more cost effective than retrofit, so should be integrated where possible.	$1-5/m2 (bioretention and swales)	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Depends on extent of capital upgrades in catchment • Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity	Effectiveness will depend on uptake through future works, which is unknown.	3	2	**5**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
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D5	Improved waterway health asset management system	• $10,000 to create asset register and maintenance schedule (Approx $100K for whole Redlands region)	$1-5/m2	• $830,000 avoided asset rectification • Avoided costs associated with waterway rehabilitation works	• Optimal treatment performance for well maintained bioretention systems: 85% TSS; 70% TP and 45% TN removal • If not well maintained, could act as a source of pollution • Potential to ensure to moderate water quality improvement	• Maintain in-stream health • Maintain in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values			Costing based on bioretention area estimate	3	3	6
D6	Future development to achieve better than SPP Water requirements (for WSUD)	• $3.1 Million	• $31,000	• Avoided costs associated with waterway rehabilitation works	• Achieve no future worsening in catchment pollutant loads i.e. maintain or improve on existing loads generated • Significant amount of future development hence improvements expected to be large	• Maintain / improve in-stream health • Maintain / improve in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values	• Community planting and waterway health education opportunities		This solution will be more applicable to catchments with sensitive receiving environments, as it's not as cost effective as traditional WSUD	1	3	4
D7	Naturalising land currently degraded by human activities (e.g. tree planting in rural areas void of vegetation)	• Revegetation cost $8/m^2. Further investigation required to identify areas. • Note: Rural Support and Waterways Extension programs Council carries out revegetation projects on individual and sometimes joint properties. Budget of both programs is $231,500	N/A (reveg. cost includes maintenance)	• Avoided costs associated with waterway rehabilitation works • Carbon credits	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction	• Improved in-stream health • Improved in-stream habitat value		• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Increased Bio-diversity • Carbon offset		1	2	3
H	**Pollutant Hot Spot Management**													
H1	BMP for poultry farms - EMP review	• $54,000 ($3,000 / farm)		• Avoided costs associated with waterway rehabilitation works	• Note poultry farms have been identified as a possible hot spot for pollutant load generation in catchment • Approx 18 farms identified in catchment, high potential to improve water quality	• Improved in-stream health • Improved in-stream habitat value						3	3	6
H2	Rehabilitation of poorly performing water bodies (e.g. toxic dams/lakes)	• $65,000 to finalise management framework (all catchments) (2013/14) • Additional funding will be dependent on number and type of works required	• Dependent on works, however maintenance will be required	• Avoided costs associated with waterway rehabilitation works • Cost savings through nutrient trading scheme	• Note water bodies have been identified as a possible hot spot for pollutant load generation in catchment • The highest proportion of Redlands' water bodies are located in this catchment, hence benefits are likely to be significant	• Improved in-stream health • Improved habitat value		• Improved amenity, active and passive recreational values • Improved connectivity to waterways • Increased land values	• Waterway health education opportunities on Council owned land (e.g. signage)		Firstly requires assessment and prioritisation of water bodies to rehabilitate	2	3	5
H4	Investigate sources of hot spot pollution & identify targeted treatment strategies	Minor initial expenditure associated with expanded program, but this is incorporated into annual/ ongoing costs.	• $100,000 for annual program (Assumes 60 sites for whole of Redlands, laboratory expenses comprise 50%)	• Avoided costs associated with waterway rehabilitation works	• Note 6 hot spots have been identified as key pollutant generation sources in the catchment • Potential to significantly improve water quality.	• Improved in-stream habitat value						3	3	6
H5	Nutrient Trading	Not known. Likely to be cost effective as targets least cost strategy to remove pollutants from catchment. e.g. funding of rural BMPs to address hot spots instead of upgrade to STP.	Not known	• Cost savings through targeting most cost effective management solutions	• Unknown however likely to be high water quality improvement benefits	• Improved in-stream health • Improved in-stream habitat value		• Potential to improve amenity and passive recreational values				3	2	5
E	**Education & Capacity Building**													
E1	Education & /or capacity building and investment in incentive schemes	• This will be dependent on the adopted solutions and how they can each be supported. Low anticipated costs. • Currently adopted Habitat Protection Programs may be used to support some solutions. These total $320K and include: • Waterways Extension • Land For Wildlife • Voluntary Conservation Agreement • Rural Support	Low	• Avoided costs associated with improved waterway outcomes	• Potential to improve water quality at low cost	• Potential to improve waterway health (e.g. reduced erosion, silt and weeds, improved riparian vegetation) at low cost	• Potential to save water at low cost	• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Education and capacity building to support other solutions	• Benefits to Council's reputation • Increased stewardship over land	This solution is generic and may be applied in support of other solutions e.g. waterway rehabilitation, WSUD retrofit etc.	3	3	6
E2	Active Extension Programs Idea: Rain gardens in backyards	• $15,000 for program development, may be more if rebates offered • Note could be added to current "Your Backyard Garden" extension program	Low	• Avoided costs associated with waterway rehabilitation works	• Potential to improve water quality at low cost • Typical water quality improvement for rain gardens/ bioretention systems 85% TSS; 70% TP and 45% TN removal • Moderate proportion of existing urban area, therefore fair potential for improvement (dependent on uptake)	• Improved in-stream health • Improved in-stream habitat value	Potential landscape irrigation water savings		• Significant opportunity for community capacity building and waterway health education	• Benefits to Council's reputation • Increased stewardship over land		3	2	5
E3	Improved marketing around TWCM initiatives	• $5-20K - Basic marketing • $5-50K - Use of Healthy Waterways resources • $60+K - Waterways brand and marketing campaign • $20-$30K - Waterways Festival			• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Potential to improve community 'connectivity' to waterways	• Significant opportunity for community education and improved waterway health education • Increased awareness of Council initiatives improves Council's reputation	Benefits to Council's reputation		3	2	5
E4	Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	• $1.34 Million • Dependent on subsidy and number of houses without tanks that it could be applied to. Cost per lot (5kL tank internally plumbed) $3,560	• $8,000 ($20/ tank)	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• 530 kg/yr TSS • 50 kg/yr TN • 3.4 kg/yr TP	• Improved in-stream health • Improved in-stream habitat value	• 26 ML/yr water savings (70 kL/yr/tank).	• Potential to improve amenity during times when mains water restrictions are in place (i.e. access to rainwater)	• Water conservation educational opportunity	Benefits to Council's reputation	Estimate only, will be largely dependent on community uptake	1	3	4

	Solution	Costs		Benefits						Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
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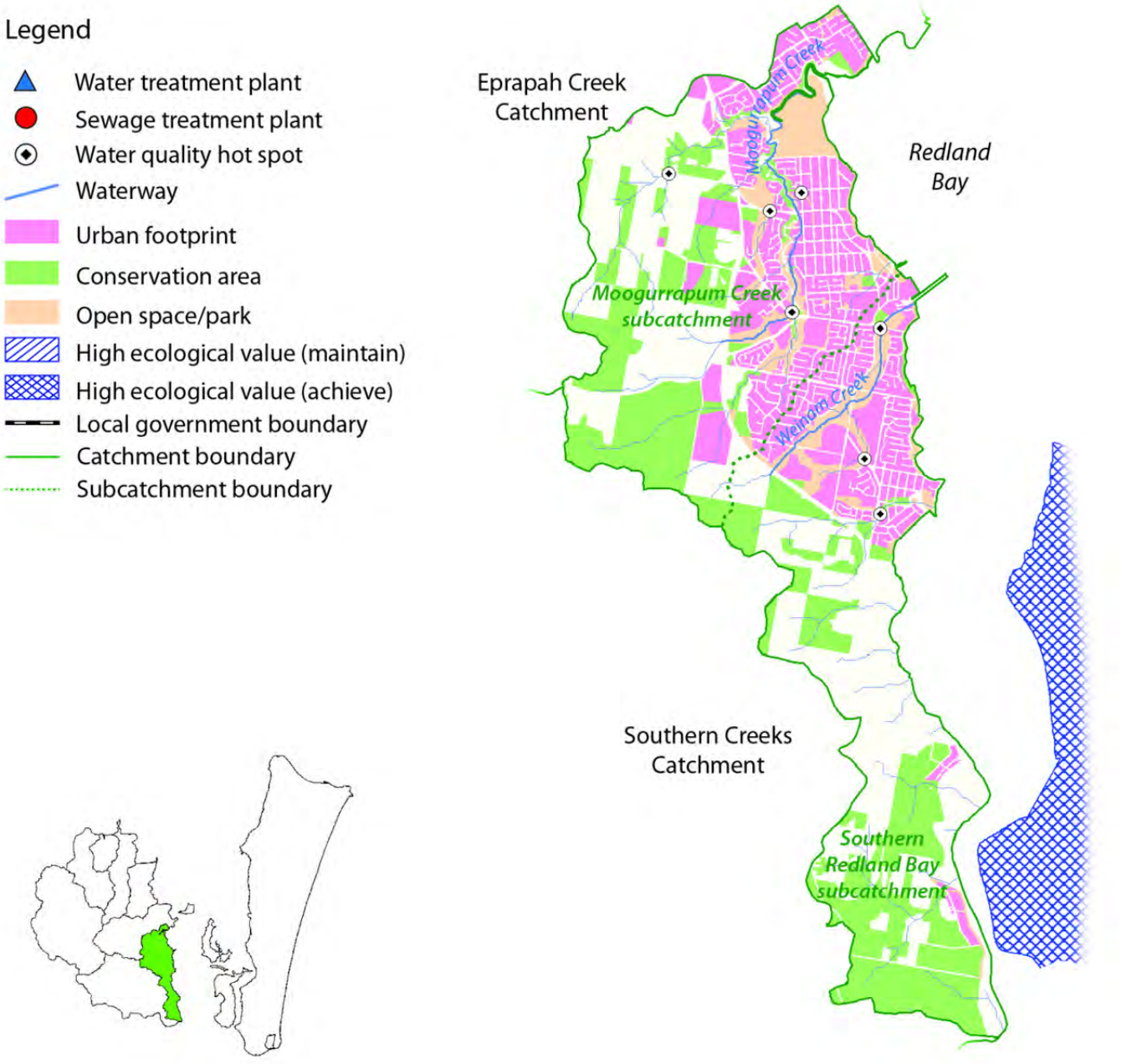
E5	Improved connectivity to waterways through education & participation in waterway improvement projects	• Low, to be considered in support of other projects e.g. waterway rehabilitation • Note Waterway Extension Program (WEP) provides improved connectivity to waterways through education and onground improvements in hot spot catchments. The total budget for WEP is $141K (12/13).		• Labour costs for planting projects	• Potential to improve water quality at low cost	• Potential to improve waterway health at low cost		• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Opportunity to secure community support for funding solutions through education	Benefits to Council's reputation		3	2	5
DM	**Water Supply & Demand Management**													
DM1	Stormwater harvesting for POS	• $2.50/kL • Further investigation of opportunities required	• $1.50/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• Improved water quality, through reduced catchment stormwater runoff • 150 kg TSS per ML reuse • 2 kg TN per ML reuse • 0.3 kg TP per ML reuse	• Reduced volume and frequency of runoff	• Approximately 7ML/ha/yr (irrigation)	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity • 'Breakthrough' demonstration project with capacity building opportunities	Benefits to Council's reputation		2	2	4
DM2	Stormwater harvesting for dual reticulation (greenfield) (assuming SET, Bunker and Double Jump Road developments serviced)	• $4.50/kL • Further investigation of opportunities required	• $3/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades • Avoided cost for individual household tanks	• Improved water quality, through reduced catchment stormwater runoff • 13,200 kg/yr TSS • 160 kg/yr TN • 29.6 kg/yr TP	• Reduced volume and frequency of runoff	• 87.4 ML/yr	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity • 'Breakthrough' demonstration project with capacity building opportunities			1	3	4
DM3	Rainwater harvesting communal tanks (greenfield) (assuming SET, Bunker and Double Jump Road developments serviced)	• $10/kL	$3.30/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades • Avoided cost for individual household tanks	• Improved water quality, through reduced effluent discharge: • 3,600 kg TSS/yr • 320 kg TN/yr • 23 kg TP/yr	• Reduced volume and frequency of runoff	• 178 ML/yr	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity • 'Breakthrough' demonstration project with capacity building opportunities		Further detailed studies required to quantify water savings and water quality benefits	1	2	3
DM4	Recycled water supplied to large agricultural/ industrial users. NB: KBR (2006) suggests limited opportunity (food processing industries have been eliminated due to the high potential for adverse publicity)	• $3.50/kL	$2.50/kL	• Potential avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades for water supply	• Improved water quality, through reduced effluent discharge: • 3-10 kg TSS per ML reuse • 1.3-3 kg TN per ML reuse • 3-5 kg TP per ML reuse	• Improved in-stream health • Improved in-stream habitat value	• Potential potable water savings, further studies required					2	1	3
DM5	Recycled water supplied to urban users (public open space)	• $11-19/kL		• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades for water supply	• Improved water quality, through reduced effluent discharge: • 3-10 kg TSS per ML reuse • 1.3-3 kg TN per ML reuse • 3-5 kg TP per ML reuse	• Improved in-stream health • Improved in-stream habitat value	• Potential potable water savings,however limited demand (27.9 ML/yr)	• Potential to improve amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)				1	1	2
DM6	Recycled water irrigated to woodlots. This was the prefferred option as investigated by Redland Water (2009) in the Thornlands Total Water Cycle Management investigation. Note limitations since identified inlcude: • limited feasible due to land shortage for allocating woodlands • Thornlands Integrated Enterprise Area no longer going ahead Note this solution applies to Hilliards Creek Catchment	• $50.2 Million (Cleveland STP)	• $1.2 Million	• Potential avoided costs associated with waterway rehabilitation works	Woodland Irrigation Nutrient Reduction: • 5,100 kg/yr TSS (18,500 kg/yr design) • 1,400 kg/yr TN (5,700 kg/yr design) • 235 kg/yr TP (1,120 kg/yr design) * Note assumes effluent sourced from Cleveland STP	• Improved in-stream health • Improved in-stream habitat value	N/A	• Potential to improve visual amenity through woodlot planting	• Potential waterway health education opportunity for woodlot reuse	• Carbon offset benefits for woodlots • Increased biodiversity for woodlots • Potential to Improve habitat connectivity for woodlots		1	3	4
DM8	Recycled water supplied to urban users using Victoria Point STP (dual reticulation): • Option investigated by Redland Water (2009) in Thornlands Total Water Cycle Management investigation. Note not preferred option. Includes dual reticualtion for the following future residential developments: • Kinross Road • South East Thornlands • Double Jump and Bunker Road • Option also includes upgrade to Victoria Point STP to reduce Total Nitrogen from 3 to 1.3 mg/L	• $59.8 Million (inlcludes upgrade to TN treatment process) • NB estimated cost KBR (2007) $5.90/kL (2007) with CAPEX $23.7 Million - did not include VP STP upgrade	• $1.9 Million	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades for water supply	**Dual Reticulation Nutrient Reduction:** • 1,400 kg/yr TSS (4,700 kg/yr design) • 614 kg/yr TN (1,400 kg/yr design) • 1,400 kg/yr TP (2,360 kg/yr design) **Upgraded STP TN Reduction for Victoria Point STP:** • 4,970 kg/yr TN (assumes design standard, and accounts for reuse)	• Improved in-stream health • Improved in-stream habitat value	• 472 ML/yr	• Potential to improve amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity • 'Breakthrough' demonstration project with capacity building opportunities			1	2	3
S	**Sewerage**													
S1	Provide sewerage infrastructure for unsewered areas	• $3.4 Million ($7,900 / ET)	• $110,000 ($250 / ET)	• Avoided costs for waterway health / groundwater quality remediation	• Protection of receiving waters from nutrients and pathogen contamination • Moderate to high improvement to water quality expected	• Improve waterway health		• Maintain current amenity and recreational values that may be detrimentally affected by poor sewage disposal practices		• Protect public health		1	3	4
S2	Inspections and improved management of on site wastewater systems	Minor initial expenditure associated with program, but this is incorporated into annual/ ongoing costs.	• $35,000	• Avoided costs for waterway health / groundwater quality remediation	• Protection of receiving waters from nutrients and pathogen contamination • Moderate to high improvement to water quality expected	• Improve waterway health		• Maintain current amenity and recreational values that may be detrimentally affected by poor sewage disposal practices	• Community capacity building on operation and maintenance of on site systems • Waterway health educational opportunity	• Protect public health		3	2	5

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key: Poor = 1, Moderate = 2, Good = 3		
S3	Improved nutrient treatment processes at Victorial Point STP	• $5.5 Million (GHD estimate to meet licence conditions)	• $40,000 to reduce current TP concentrations to 1 mg/L (Alum Dosing)	• Avoided costs associated with waterway rehabilitation works (e.g. lyngbya clean up costs). • Avoided loss of profits to tourism industry (from decline in waterway health)	• 4,970 kg/yr TP (up to 13,580 kg/yr for ultimate scenario) • 5,770 kg/yr TN (assumes design standard)	• Improve waterway health		• Maintain amenity and recreational values (e.g. through reduced lyngbya outbreaks)		• Protect public health through reduced lyngbya outbreaks		1	3	4
S5	Improve prevention of illegal stormwater inflow connections to sewer	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Potential education opportunity for reducing illegal connections	• Protect public health • Improve Council's reputation		2	2	4
S6	Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		2	2	4
S7	Sewerage upgrades to improve storage/conveyance of wet weather flows	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		1	2	3
S8	Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	Input from Redland Water required		• Avoided clean up cost of sewage overflows • Cost savings from reduced pipe sizes for smart sewers	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Community and developer capacity building opportunity for smart sewers	• Protect public health • Improve Council's reputation		1	2	3
S9	Wastewater infrastructure rates charged on mains water consumption basis	Input from Redland Water required			• Potential financial incentive to reduce sewage generation • Primarily protection of receiving waters from nutrients from reduced effluent discharges	• Potential to improve waterway health	• Potential financial incentive to reduce water use		• Assist to educate community about cost of wastewater infrastructure	• Primarily funding mechanism for solutions that improve the performance of sewerage infrastructure		3	1	4
DC	**Development Control**													
DC1	Cap on population growth	• Low - planning policy. • Poential economic impacts		• Avoid costs associated with upgraded / new infrastructure	• Reduced pressures on water quality	• Reduced pressures on waterway health	• Reduced demand for water				Dependent on planned population growth	2	3	5
DC2	Increased restrictions on development extent and intensity for proposed development areas	• Low - planning policy. • Poential economic impacts			• Reduced pressures on water quality	• Reduced pressures on waterway health	• Reduced demand for water	• Increase land area for amenity and recreation			Dependent on planned development	2	2	4
DC3	Investigations to more accurately define population growth for future planning purposes	• $100,000 (whole Redlands region)		• More accurate forward planning can result in cost savings from deferred infrastructure upgrades								3	3	6
FS	**Funding to Implement Solutions**													
FS1	Develop business case for healthy waterways to support solutions	• $ 80,000 (regional, applies to all catchments)			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through justifying uptake of solutions	• Potential to save water through justifying uptake of solutions	• Potential to improve recreation and amenity values through justifying uptake of solutions	• Opportunity to educate community about the benefits of solutions and increase willingness to pay			3	3	6
FS2	Increase / re-prioritise funding to support TWCM solutions	No cost			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through funding uptake of solutions	• Potential to save water through funding uptake of solutions	• Potential to improve recreation and amenity values through funding uptake of solutions		• Funding mechanism to support uptake of solutions		2	3	5

South Eastern Creeks Catchment



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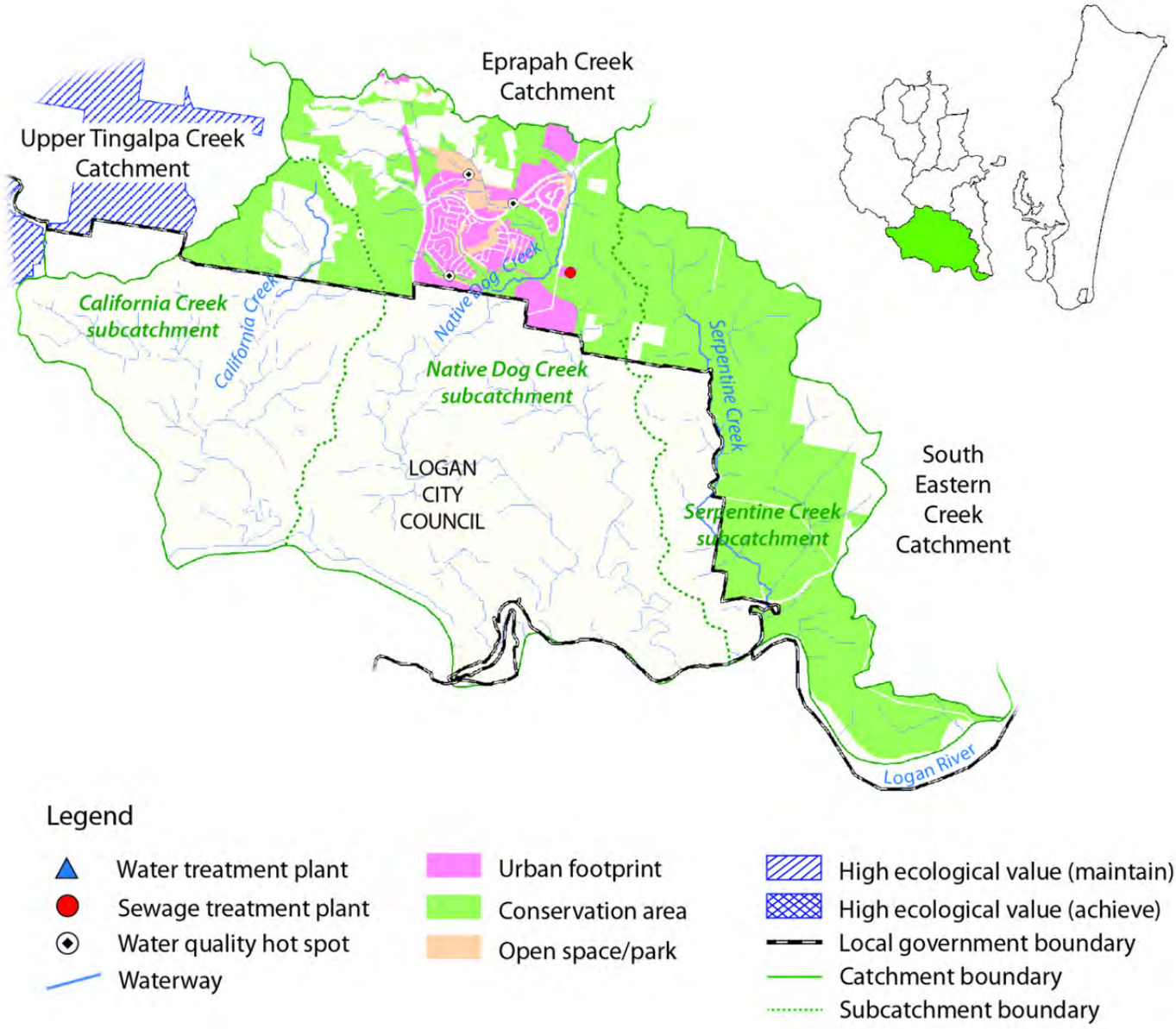
												Poor Moderate Good		
W	Waterway Rehabilitation													
W1	Rehabilitation of waterways - Riparian buffer zones (private land)	• $10/m^2 ($100,000/ha). • $2.1 Million for poor - very poor condition waterways on private land • Further detailed investigation required	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate good overall improvement, constitutes 11% of poor waterways in RCC, and 42% of poor waterways within local catchment • Small area with potential to stabilise alluvial	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	3	5
W2	Rehabilitation of waterways - Habitat restoration (Council land)	• $10/m^2 ($100,000/ha). • $1.01 Million for poor - very poor condition waterways on RCC/State land • Further detailed investigation required	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate good overall improvement, constitutes 5.5% of poor waterways in RCC, and 20% of poor waterways within local catchment • Potential to stabilise alluvial soils with high	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	3	5
W3	Rehabilitation of waterways - Bank Stability Works	• Further detailed investigation required • School of Arts Road Culverts $34,000	Not known, study specific	• Avoided costs associated with flood remediation works	• TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health		• Improved community amenity & recreational benefits				2	2	4
W4	Rehabilitation of waterways - In-Stream Improvement works	• Further detailed investigation required	Not known, study specific	• Avoided costs associated with bank stabilisation and flood remediation works	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved in-stream habitat value		• Improved community amenity & recreational benefits				2	2	4
W5	Increased riparian protection for waterways (buffer/waterway corridor widths) e.g. through planning policy, voluntay Conservation Agreements	• Low cost to amend planning policy • Voluntary Conservation Agreements $18,500/yr for all catchments combined		• Avoided waterway rehabilitation and maintenance costs	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset		3	2	5
W6	Identify and prioritise waterway fish barrier locations	• $12,000 (Mick Holland to confirm)				• Potential for future improvement to fish passage and ecological health of waterways (if solutions to barriers are identified and implemented).					Note technology may not be available to implement solutions to identified fish barriers	1	1	2
W12	Monitoring to evaluate effectiveness of management solutions	• $1,000 per site (ambient monitoring), study specific		• Savings through identifying cost effective solutions	• Monitoring will assist to confirm the most effective solutions to improve water quality	• Monitoring will assist to confirm the most effective solutions to improve waterway health		• Improve community connectivity to waterways (through education)	• Results to educate community on waterway health (Waterway Recovery Report)			2	3	5
D	**Diffuse Pollution Management**													
D1	Increased implementation / enforcement of E&SC management practices and capacity building through education	• $1,700	• $17,000 ($100,000 for all catchments)	• Avoided waterway rehabilitation and maintenance / monitoring costs • Avoided loss of profits to tourism industry (from decline in waterway health)	• Significant coarse sediment removal • TSS removal performance 40% • Nutrient removal assumed minor • Significant development pressures in this catchment hence significant water quality benefits expected	• Improved habitat value through decreasing water turbidity and protecting sea-grass habitat from being smothered		• Maintain community amenity, recreational and tourism benefits, particularly in receiving waters (Moreton Bay) • Improved connectivity to waterways	• Capacity building and education for council, land developers and contractors			3	3	6
D2	Rural BMP for grazing land - fencing off stock & revegetation around 1st & 2nd order streams	• $1.85 Million ($233 K per km of creek)	• $340/ha	• Avoided costs associated with bank stabilisation and flood remediation works	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate moderate overall improvement, constitutes 8% of poor waterways in RCC, and 31% of poor waterways within local catchment • Potential to stabilise alluvial soils with high	• Improved in-stream health • Improved habitat value		• Improved amenity and passive recreational values • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential flood mitigation benefits to downstream urban areas (through slowing and detaining flows)	• Literature values used. • Site specific investigations required to more accurately estimate • Requires support by private land owners	2	3	5
D3	Rural BMP for horticultural land - implementation of filter/buffer strips	• $402,000 ($1,600/ha)	• $98,000 ($390/ha)	• Avoided costs associated with waterway rehabilitation works	• 84% Removal TSS • 75% Removal of TP • 70% Removal TN • Landuse constitutes 8% of catchment, expect moderate improvements to water quality • Potential to stabilise alluvial soils with high nutrient content.	• Improved in-stream health • Improved in-stream habitat value		• Improved connectivity to waterways	• Community planting and waterway health education opportunities		• Literature values used. • Site specific investigations required to more accurately estimate • Requires support by private land owners	3	2	5
D4	Integrate WSUD into government capital infrastructure works e.g. road/ park upgrades	• Unknown, dependent on amount of capital infrastructure works scheduled. • Will be more significantly more cost effective than retrofit, so should be integrated where possible.	$1-5/m2 (bioretention and swales)	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Depends on extent of capital upgrades in catchment • Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity	Effectiveness will depend on uptake through future works, which is unknown.	3	2	5
D5	Improved waterway health asset management system	• $10,000 to create asset register and maintenance schedule (Approx $100K for whole Redlands region)	$1-5/m2	• $740,000 avoided asset rectification • Avoided costs associated with waterway rehabilitation works	• Optimal treatment performance for well maintained bioretention systems: 85% TSS; 70% TP and 45% TN removal • If not well maintained, could act as a source of pollution • Potential to ensure to significant water quality improvement	• Maintain in-stream health • Maintain in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values			Costing based on bioretention area estimate	3	3	6

	Solution	Costs		Benefits						Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other			
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education		Cost Performance Key Poor Moderate Good	Benefits 1= 2 = 3 =	Score
D6	Future development to achieve better than SPP Water requirements (for WSUD)	• $2.7 Million	• $27,000	• Avoided costs associated with waterway rehabilitation works	• Achieve no future worsening in catchment pollutant loads i.e. maintain or improve on existing loads generated • High amount of future development hence improvements expected to be significant	• Maintain / improve in-stream health • Maintain / improve in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values	• Community planting and waterway health education opportunities		This solution will be more applicable to catchments with sensitive receiving environments, as it's not as cost effective as traditional WSUD	1	3	4
D7	Naturalising land currently degraded by human activities (e.g. tree planting in rural areas void of vegetation)	• Revegetation cost $8/m^2. Further investigation required to identify areas. • Note: Rural Support and Waterways Extension programs Council carries out revegetation projects on individual and sometimes joint properties. Budget of both programs is $231,500	N/A (reveg. cost includes maintenance)	• Avoided costs associated with waterway rehabilitation works • Carbon credits	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction	• Improved in-stream health • Improved in-stream habitat value		• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Increased Bio-diversity • Carbon offset		1	2	3
D8	Water Sensitive Urban Design Retrofit (beyond capital infrastructure works)	• $11 Million	• $109,000	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal, however difficult to achieve in retrofit scenarios • Moderate potential to improve water quality	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity		1	2	3
H	**Pollutant Hot Spot Management**												
H1	BMP for poultry farms - EMP review	• $33,000 ($3,000 / farm)		• Avoided costs associated with waterway rehabilitation works	• Note poultry farms have been identified as a possible hot spot for pollutant load generation in catchment • 11 farms identified in catchment, high potential to improve water quality	• Improved in-stream health • Improved in-stream habitat value						3	3	6
H2	Rehabilitation of poorly performing water bodies (e.g. toxic dams/lakes)	• $65,000 to finalise management framework (all catchments) (2013/14) • Additional funding will be dependent on number and type of works required	• Dependent on works, however maintenance will be required	• Avoided costs associated with waterway rehabilitation works • Cost savings through nutrient trading scheme	• Note water bodies have been identified as a possible hot spot for pollutant load generation in catchment • A signficiant proportion of water bodies are located in this catchment, hence benefits are likely to be high	• Improved in-stream health • Improved habitat value		• Improved amenity, active and passive recreational values • Improved connectivity to waterways • Increased land values	• Waterway health education opportunities on Council owned land (e.g. signage)		Firstly requires assessment and prioritisation of water bodies to rehabilitate	2	3	5
H3	Improved landfill capping /leachate management & treatment systems	• Estimated at $4-7 Million with an approx split of 15%ops 85% capital and 20% contingency	• Current annual trucking operations - $700k to $1.2M	• Avoided costs associated with waterway rehabilitation works	• Note landfills have been identified as a possible hot spot for pollutant load generation in catchment • Potential to greatly improve water quality and reduce landfill contaminants from entering waterways	• Improved in-stream health • Improved habitat value		• Potential to improve amenity and passive recreational values through use of treatment wetlands	• Waterway health education opportunities (e.g. signage)			2	3	5
H4	Investigate sources of hot spot pollution & identify targeted treatment strategies	Minor initial expenditure associated with expanded program, but this is incorporated into annual/ ongoing costs.	• $100,000 for annual program (Assumes 60 sites for whole of Redlands, laboratory expenses comprise 50%)	• Avoided costs associated with waterway rehabilitation works	• Note 7 hot spots have been identified as key pollutant generation sources in the catchment • Potential to significantly improve water quality.	• Improved in-stream habitat value						3	3	6
H5	Nutrient Trading	Not known. Likely to be cost effective as targets least cost strategy to remove pollutants from catchment. e.g. funding of rural BMPs to address hot spots instead of upgrade to STP.	Not known	• Cost savings through targeting most cost effective management solutions	• Unknown however likely to be high water quality improvement benefits	• Improved in-stream health • Improved in-stream habitat value		• Potential to improve amenity and passive recreational values				3	2	5
H6	Improved management of unsealed roads	• Swale cost $21/m^2	• Swale maintenance costs $2.50/m^2 (grass, less for vegetated)	• Avoided costs associated with waterway rehabilitation works	• Typical water quality improvement for swale systems: 90% TSS; 62% TP and 13% TN removal • Identified as possibly contributing to high pollutant loads	• Improved in-stream health • Improved in-stream habitat value		• Potential to improve amenity and passive recreational values				1	3	4
E	**Education & Capacity Building**												
E1	Education & /or capacity building and investment in incentive schemes	• This will be dependent on the adopted solutions and how they can each be supported. Low anticipated costs. • Currently adopted Habitat Protection Programs may be used to support some solutions. These total $320K and include: • Waterways Extension • Land For Wildlife • Voluntary Conservation Agreement • Rural Support	Low	• Avoided costs associated with improved waterway outcomes	• Potential to improve water quality at low cost	• Potential to improve waterway health (e.g. reduced erosion, silt and weeds, improved riparian vegetation) at low cost	• Potential to save water at low cost	• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Education and capacity building to support other solutions	• Benefits to Council's reputation • Increased stewardship over land	This solution is generic and may be applied in support of other solutions e.g. waterway rehabilitation, WSUD retrofit etc.	3	3	6
E2	Active Extension Programs Idea: Rain gardens in backyards	• $15,000 for program development, may be more if rebates offered • Note could be added to current "Your Backyard Garden" extension program	Low	• Avoided costs associated with waterway rehabilitation works	• Potential to improve water quality at low cost • Typical water quality improvement for rain gardens/ bioretention systems 85% TSS; 70% TP and 45% TN removal • Moderate proportion of existing urban area, therefore moderate potential for improvement (dependent on uptake)	• Improved in-stream health • Improved in-stream habitat value	Potential landscape irrigation water savings		• Significant opportunity for community capacity building and waterway health education	• Benefits to Council's reputation • Increased stewardship over land		3	2	5
E3	Improved marketing around TWCM initiatives	• $5-20K - Basic marketing • $5-50K - Use of Healthy Waterways resources • $60+K - Waterways brand and marketing campaign • $20-$30K - Waterways Festival			• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Potential to improve community 'connectivity' to waterways	• Significant opportunity for community education and improved waterway health education • Increased awareness of Council initiatives improves Council's reputation	Benefits to Council's reputation		3	2	5

	Solution	Costs		Benefits						Other	Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social					Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate Good		1= 2 = 3 =
E4	Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	• $1.39 Million • Dependent on subsidy and number of houses without tanks that it could be applied to. Cost per lot (5kL tank internally plumbed) $3,560	• $8,000 ($20/ tank)	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• 550 kg/yr TSS • 50 kg/yr TN • 3.5 kg/yr TP	• Improved in-stream health • Improved in-stream habitat value	• 27 ML/yr water savings (70 kL/yr/tank).	• Potential to improve amenity during times when mains water restrictions are in place (i.e. access to rainwater)	• Water conservation educational opportunity	Benefits to Council's reputation	Estimate only, will be largely dependent on community uptake	1	3	**4**
E5	Improved connectivity to waterways through education & participation in waterway improvement projects	• Low, to be considered in support of other projects e.g. waterway rehabilitation • Note Waterway Extension Program (WEP) provides improved connectivity to waterways through education and onground improvements in hot spot catchments. The total budget for WEP is $141K (12/13).		• Labour costs for planting projects	• Potential to improve water quality at low cost	• Potential to improve waterway health at low cost		• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Opportunity to secure community support for funding solutions through education	Benefits to Council's reputation		2.5	2	**4.5**
E6	Education campaign to address flooding and storm tide issues - Mapping made available to public	• Low $5,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	2	**5**
E7	Education campaign to address flooding and storm tide issues - Include notes on rates	• Low $5,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	2	**5**
E8	Education campaign to address flooding and storm tide issues - Install historical flood marks/signs	• Low $10,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	3	**6**
DM	**Water Supply & Demand Management**													
DM1	Stormwater harvesting for POS	• $2.50/kL • Further investigation of opportunities required	• $1.50/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• Improved water quality, through reduced catchment stormwater runoff • 150 kg TSS per ML reuse • 2 kg TN per ML reuse • 0.3 kg TP per ML reuse	• Reduced volume and frequency of runoff	• Up to 7ML/ha/yr (irrigation)	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity	Benefits to Council's reputation		2	2	**4**
DM2	Stormwater harvesting for dual reticulation (greenfield development around Weinam Creek)	• $4.50/kL • Further investigation of opportunities required	• $3/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades • Avoided cost for individual household tanks	• Improved water quality, through reduced catchment stormwater runoff • 150 kg TSS per ML reuse • 2 kg TN per ML reuse • 0.3 kg TP per ML reuse	• Reduced volume and frequency of runoff	• Potential water savings, further investigations required	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity • 'Breakthrough' demonstration project with capacity building opportunities			1	3	**4**
DM3	Rainwater harvesting communal tanks (greenfield development around Weinam Creek)	• $10/kL • Further investigation of opportunities required	$3.30/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades • Avoided cost for individual household tanks	• Improved water quality, through reduced catchment stormwater runoff • 20 kg TSS per ML reuse • 2 kg TN per ML reuse • 0.1 kg TP per ML reuse	• Reduced volume and frequency of runoff	• Potential water savings, further investigations required	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity • 'Breakthrough' demonstration project with capacity building opportunities		Further detailed studies required to quantify water savings and water quality benefits	1	2	**3**
S	**Sewerage**													
S1	Provide sewerage infrastructure for unsewered areas	• $1.6 Million ($7,900 / ET)	• $50,000 ($250 / ET)	• Avoided costs for waterway health / groundwater quality remediation	• Protection of receiving waters from nutrients and pathogen contamination • Localised improvement to water quality expected - relatively low number of potential septic systems compared to other catchments	• Improve waterway health		• Maintain current amenity and recreational values that may be detrimentally affected by poor sewage disposal practices		• Protect public health		1	2	**3**
S2	Inspections and improved management of on site wastewater systems	Minor initial expenditure associated with program, but this is incorporated into annual/ ongoing costs.	• $35,000	• Avoided costs for waterway health / groundwater quality remediation	• Protection of receiving waters from nutrients and pathogen contamination • Localised improvement to water quality expected	• Improve waterway health		• Maintain current amenity and recreational values that may be detrimentally affected by poor sewage disposal practices	• Community capacity building on operation and maintenance of on site systems • Waterway health educational opportunity	• Protect public health		3	1	**4**
S5	Improve prevention of illegal stormwater inflow connections to sewer	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Potential education opportunity for reducing illegal connections	• Protect public health • Improve Council's reputation		2	2	**4**
S6	Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		2	2	**4**
S7	Sewerage upgrades to improve storage/conveyance of wet weather flows	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		1	2	**3**
S8	Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	Input from Redland Water required		• Avoided clean up cost of sewage overflows • Cost savings from reduced pipe sizes for smart sewers	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Community and developer capacity building opportunity for smart sewers	• Protect public health • Improve Council's reputation		1	2	**3**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate Good		1= 2 = 3 =
S9	Wastewater infrastructure rates charged on mains water consumption basis	Input from Redland Water required			• Potential financial incentive to reduce sewage generation • Primarily protection of receiving waters from nutrients from reduced effluent discharges	• Potential to improve waterway health	• Potential financial incentive to reduce water use		• Assist to educate community about cost of wastewater infrastructure	• Primarily funding mechanism for solutions that improve the performance of sewerage infrastructure		2	1	3
F	**Flooding & Storm tide**													
F1	Flood mitigation investigation/works implemented	• $5.7 Million to implement recommended flood mitigation measures in existing planning studies		• Avoided insurance claims • Avoided litigation costs • Avoided clean up costs				Reduced flood impacts to public and private assets		• Protect public health and safety		1	3	4
F2	Constraints on future land development to address flooding and storm tide issues	Low, implement through planning scheme		• Avoided insurance claims • Avoided litigation costs • Avoided clean up costs				Reduced flood impacts to public and private assets		• Protect public health and safety		3	3	6
DC	**Development Control**													
DC1	Cap on population growth	• Low - planning policy. • Poential economic impacts		• Avoid costs associated with upgraded / new infrastructure	• Reduced pressures on water quality	• Reduced pressures on waterway health	• Reduced demand for water				Dependent on planned population growth	2	3	5
DC2	Increased restrictions on development extent and intensity for proposed development areas	• Low - planning policy. • Poential economic impacts			• Reduced pressures on water quality	• Reduced pressures on waterway health	• Reduced demand for water	• Increase land area for amenity and recreation			Dependent on planned development	2	2	4
DC3	Investigations to more accurately define population growth for future planning purposes	• $100,000 (whole Redlands region)		• More accurate forward planning can result in cost savings from deferred								3	3	6
FS	**Funding to Implement Solutions**													
FS1	Develop business case for healthy waterways to support solutions	• $ 80,000 (regional, applies to all catchments)			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through justifying uptake of solutions	• Potential to save water through justifying uptake of solutions	• Potential to improve recreation and amenity values through justifying uptake of solutions	• Opportunity to educate community about the benefits of solutions and increase willingness to pay			3	3	6
FS2	Increase / re-prioritise funding to support TWCM solutions	No cost			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through funding uptake of solutions	• Potential to save water through funding uptake of solutions	• Potential to improve recreation and amenity values through funding uptake of solutions		• Funding mechanism to support uptake of solutions		2	3	5

Southern Creeks Catchment



	Solution	Costs		Benefits						Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate Good		1= 2 = 3 =
W	**Waterway Rehabilitation**													
W1	Rehabilitation of waterways - Implement recommendations from Native Dog Creek IWMP (EnGenY 2011)	$3 Million	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate fair overall improvement, constitutes 2.8% of poor waterways in RCC, and 20% of poor waterways within local catchment, with potential to stabilise alluvial soils with high nutrient content.	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	2	**4**
W2	Rehabilitation of waterways - Habitat restoration (Council land)	• $10/m^2 ($100,000/ha). • $640,000 for poor - very poor condition waterways on RCC/State land • Refer to Solution W1 - EnGenY (2011)	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate minor-fair overall improvement, constitutes 3.4% of poor waterways in RCC, and 20% of poor waterways within local	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	2	**4**
W3	Rehabilitation of waterways - Bank Stability Works	• Further detailed investigation required • Refer to Solution W1 - EnGenY (2011)		• Avoided costs associated with flood remediation works	• TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health		• Improved community amenity & recreational benefits				2	2	**4**
W4	Rehabilitation of waterways - In-Stream Improvement works	• Further detailed investigation required • Refer to Solution W1 - EnGenY (2011)		• Avoided costs associated with bank stabilisation and flood remediation works	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved in-stream habitat value		• Improved community amenity & recreational benefits				2	2	**4**
W5	Increased riparian protection for waterways (buffer/waterway corridor widths) e.g. through planning policy, voluntay Conservation Agreements	• Low cost to amend planning policy • Voluntary Conservation Agreements $18,500/yr for all catchments combined		• Avoided waterway rehabilitation and maintenance costs	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset		3	1	**4**
W6	Identify and prioritise waterway fish barrier locations	• $12,000 (Mick Holland to confirm)				• Potential for future improvement to fish passage and ecological health of waterways (if solutions to barriers are identified and implemented).					Note technology may not be available to implement solutions to identified fish barriers	1	1	**2**
W7	Restrict unauthorised 4WD Access e.g. fencing/barriers	• $14,900/km fencing	Not known		• Primarily localised TSS treatment benefits • Minor nutrient removal benefits	Improve waterway health						2	2	**4**
W8	Policing unauthorised 4WD Access e.g. Cameras for access identification/ fines	No known, study specific	Not known		• Primarily localised TSS treatment benefits • Minor nutrient removal benefits	Improve waterway health						1	1	**2**
W9	Develop localised WQOs for Native Dog and Serpentine Creeks (to inform EPP Water)	Approx $80K (will be dependent on existing data and sampling requirements)			No direct benefits, indirect benefits include assisting to better identify water quality issues and targeted solutions			Increased understanding of what may be required to protect community use EVs	Will assist to educate all stakeholders by establishing WQOs			2	2	**4**
W11	Investigations/monitoring to better define waterway health	$30,000 for ambient monitoring of 30 sites on a quarterly basis ($1K per site)		• Avoided cost for unnecessary works	• Assist to identify targeted water quality improvement strategies	• Assist to identify targeted waterway health improvement strategies		• Improve community connectivity to waterways (through education)	• Results to educate community on waterway health (Waterway Recovery Report)			2	3	**5**
W12	Monitoring to evaluate effectiveness of management solutions	• $1,000 per site (ambient monitoring), study specific		• Savings through identifying cost effective solutions	• Monitoring will assist to confirm the most effective solutions to improve water quality	• Monitoring will assist to confirm the most effective solutions to improve waterway health		• Improve community connectivity to waterways (through education)	• Results to educate community on waterway health (Waterway Recovery Report)			2	3	**5**
D	**Diffuse Pollution Management**													
D1	Increased implementation / enforcement of E&SC management practices and capacity building through education	• $400	• $4,000 ($100,000 for all catchments)	• Avoided waterway rehabilitation and maintenance / monitoring costs • Avoided loss of profits to tourism industry (from decline in waterway health)	• Significant coarse sediment removal • TSS removal performance 40% • Nutrient removal assumed minor	• Improved habitat value through decreasing water turbidity and protecting sea-grass habitat from being smothered		• Maintain community amenity, recreational and tourism benefits, particularly in receiving waters (Moreton Bay) • Improved connectivity to waterways	• Capacity building and education for council, land developers and contractors			3	1	**4**
D2	Rural BMP for grazing land - fencing off stock & revegetation around 1st & 2nd order streams (does not include Native Dog Creek)	• $1.35 Million ($233 K per km of creek)	$340/ha	• Avoided costs associated with bank stabilisation and flood remediation works	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate significant overall improvement, constitutes 9% of poor waterways in RCC, and 60% of poor waterways within local catchment • Potential to stabilise alluvial soils with high	• Improved in-stream health • Improved habitat value		• Improved amenity and passive recreational values • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential flood mitigation benefits to downstream urban areas (through slowing and detaining flows)	• Literature values used. • Site specific investigations required to more accurately estimate • Requires support by private land owners	2	3	**5**
D3	Rural BMP for horticultural land - implementation of filter/buffer strips	• $132,000 ($1,600/ha)	• $32,000 ($390/ha)	• Avoided costs associated with waterway rehabilitation works	• 84% Removal TSS • 75% Removal of TP • 70% Removal TN • Landuse constitutes 1% of catchment, expect localised improvements to water quality	• Improved in-stream health • Improved in-stream habitat value		• Improved connectivity to waterways	• Community planting and waterway health education opportunities		• Literature values used. • Site specific investigations required to more accurately estimate • Requires support by private land owners	2	1	**3**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate Good		1= 2 = 3 =
D4	Integrate WSUD into government capital infrastructure works e.g. road/ park upgrades	• Unknown, dependent on amount of capital infrastructure works scheduled. • Will be more significantly more cost effective than retrofit, so should be integrated where possible.	$1-5/m2 (bioretention and swales)	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Depends on extent of capital upgrades in catchment • Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity	Effectiveness will depend on uptake through future works, which is unknown.	3	2	**5**
D5	Improved waterway health asset management system	• $10,000 to create asset register and maintenance schedule (Approx $100K for whole Redlands region)	$1-5/m2	• $170,000 avoided asset rectification • Avoided costs associated with waterway rehabilitation works	• Optimal treatment performance for well maintained bioretention systems: 85% TSS; 70% TP and 45% TN removal • If not well maintained, could act as a source of pollution • Potential to ensure to water quality improvement	• Maintain in-stream health • Maintain in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values			Costing based on bioretention area estimate	3	2	**5**
D6	Future development to achieve better than SPP Water requirements (for WSUD)	• $600,000	• $6,000	• Avoided costs associated with waterway rehabilitation works	• Achieve no future worsening in catchment pollutant loads i.e. maintain or improve on existing loads generated • Small amount of future development hence improvements expected to be minor	• Maintain / improve in-stream health • Maintain / improve in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values	• Community planting and waterway health education opportunities		This solution will be more applicable to catchments with sensitive receiving environments, as it's not as cost effective as traditional WSUD	1	1	**2**
D7	Naturalising land currently degraded by human activities (e.g. tree planting in rural areas void of vegetation)	• Revegetation cost $8/m^2. Further investigation required to identify areas. • Note: Rural Support and Waterways Extension programs Council carries out revegetation projects on individual and sometimes joint properties. Budget of both programs is $231,500	N/A (reveg. cost includes maintenance)	• Avoided costs associated with waterway rehabilitation works • Carbon credits	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction	• Improved in-stream health • Improved in-stream habitat value		• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Increased Bio-diversity • Carbon offset		1	2	**3**
D8	Implement Water Sensitive Urban Design Retrofit (beyond capital infrastructure works) as per NDC IWMP, investigating opportunites for at source	• $2.5 Million	• $25,000	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal, however difficult to achieve in retrofit scenarios • Potential to improve water quality	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity		1	2	**3**
H	**Pollutant Hot Spot Management**													
H1	BMP for poultry farms - EMP review	• $18,000 ($3,000 / farm)		• Avoided costs associated with waterway rehabilitation works	• Note poultry farms have been identified as a possible hot spot for pollutant load generation in catchment • 6 farms identified in catchment, moderate potential to improve water quality	• Improved in-stream health • Improved in-stream habitat value						3	2	**5**
H2	Rehabilitation of poorly performing water bodies (e.g. toxic dams/lakes)	• $65,000 to finalise management framework (all catchments) (2013/14) • Additional funding will be dependent on number and type of works required	• Dependent on works, however maintenance will be required	• Avoided costs associated with waterway rehabilitation works • Cost savings through nutrient trading scheme	• Note water bodies have been identified as a possible hot spot for pollutant load generation in catchment • A large proportion of Redlands' water bodies are in this catchment, hence benefits are likely to be high	• Improved in-stream health • Improved habitat value		• Improved amenity, active and passive recreational values • Improved connectivity to waterways • Increased land values	• Waterway health education opportunities on Council owned land (e.g. signage)		Firstly requires assessment and prioritisation of water bodies to rehabilitate	2	3	**5**
H4	Investigate sources of hot spot pollution & identify targeted treatment strategies	Minor initial expenditure associated with expanded program, but this is incorporated into annual/ ongoing costs.	• $100,000 for annual program (Assumes 60 sites for whole of Redlands, laboratory expenses comprise 50%)	• Avoided costs associated with waterway rehabilitation works	• Note 4 hot spots have been identified as key pollutant generation sources in the catchment • Potential to significantly improve water quality.	• Improved in-stream habitat value						3	3	**6**
H5	Nutrient Trading	Not known. Likely to be cost effective as targets least cost strategy to remove pollutants from catchment. e.g. funding of rural BMPs to address hot spots instead of upgrade to STP.	Not known	• Cost savings through targeting most cost effective management solutions	• Unknown however likely to be high water quality improvement benefits	• Improved in-stream health • Improved in-stream habitat value		• Potential to improve amenity and passive recreational values				3	1	**4**
H6	Improved management of unsealed roads	• Swale cost $21/m^2	• Swale maintenance costs $2.50/m^2 (grass, less for vegetated)	• Avoided costs associated with waterway rehabilitation works	• Typical water quality improvement for swale systems: 90% TSS; 62% TP and 13% TN removal • Identified as possibly contributing to high pollutant loads	• Improved in-stream health • Improved in-stream habitat value		• Potential to improve amenity and passive recreational values				2	3	**5**
E	**Education & Capacity Building**													
E1	Education & /or capacity building and investment in incentive schemes	• This will be dependent on the adopted solutions and how they can each be supported. Low anticipated costs. • Currently adopted Habitat Protection Programs may be used to support some solutions. These total $320K and include: • Waterways Extension • Land For Wildlife • Voluntary Conservation Agreement • Rural Support	Low	• Avoided costs associated with improved waterway outcomes	• Potential to improve water quality at low cost	• Potential to improve waterway health (e.g. reduced erosion, silt and weeds, improved riparian vegetation) at low cost	• Potential to save water at low cost	• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Education and capacity building to support other solutions	• Benefits to Council's reputation • Increased stewardship over land	This solution is generic and may be applied in support of other solutions e.g. waterway rehabilitation, WSUD retrofit etc.	3	3	**6**
E2	Active Extension Programs Idea: Rain gardens in backyards	• $15,000 for program development, may be more if rebates offered • Note could be added to current "Your Backyard Garden" extension program	Low	• Avoided costs associated with waterway rehabilitation works	• Potential to improve water quality at low cost • Typical water quality improvement for rain gardens/ bioretention systems 85% TSS; 70% TP and 45% TN removal • Small proportion of existing urban area, therefore minor potential for improvement	• Improved in-stream health • Improved in-stream habitat value	Potential landscape irrigation water savings		• Significant opportunity for community capacity building and waterway health education	• Benefits to Council's reputation • Increased stewardship over land		3	1	**4**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
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E3	Improved marketing around TWCM initiatives	• $5-20K - Basic marketing • $5-50K - Use of Healthy Waterways resources • $60+K - Waterways brand and marketing campaign • $20-$30K - Waterways Festival			• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Potential to improve community 'connectivity' to waterways	• Significant opportunity for community education and improved waterway health education • Increased awareness of Council initiatives improves Council's reputation	Benefits to Council's reputation		3	2	**5**
E4	Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	• $850,000 • Dependent on subsidy and number of houses without tanks that it could be applied to. Cost per lot (5kL tank internally plumbed) $3,560	• $5,000 ($20/ tank)	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• 330 kg/yr TSS • 30 kg/yr TN • 2.2 kg/yr TP	• Improved in-stream health • Improved in-stream habitat value	• 17 ML/yr water savings (70 kL/yr/tank).	• Potential to improve amenity during times when mains water restrictions are in place (i.e. access to rainwater)	• Water conservation educational opportunity	Benefits to Council's reputation	Estimate only, will be largely dependent on community uptake	1	2	**3**
E5	Improved connectivity to waterways through education & participation in waterway improvement projects	• Low, to be considered in support of other projects e.g. waterway rehabilitation • Note Waterway Extension Program (WEP) provides improved connectivity to waterways through education and onground improvements in hot spot catchments. The total budget for WEP is $141K (12/13).		• Labour costs for planting projects	• Potential to improve water quality at low cost	• Potential to improve waterway health at low cost		• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Opportunity to secure community support for funding solutions through education	Benefits to Council's reputation		3	2	**5**
E6	Education campaign to address flooding and storm tide issues - Mapping made available to public	• Low $5,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	2	**5**
E7	Education campaign to address flooding and storm tide issues - Include notes on rates	• Low $5,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	2	**5**
E8	Education campaign to address flooding and storm tide issues - Install historical flood marks/signs	• Low $10,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	3	**6**
DM	**Water Supply & Demand Management**													
DM1	Stormwater harvesting for POS	• $2.50/kL • Further investigation of opportunities required	• $1.50/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• Improved water quality, through reduced catchment stormwater runoff • 150 kg TSS per ML reuse • 2 kg TN per ML reuse • 0.3 kg TP per ML reuse	• Reduced volume and frequency of runoff	• Up to 7ML/ha/yr (irrigation)	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity	Benefits to Council's reputation		2	1	**3**
DM4	Recycled water supplied to large agricultural/ industrial users	• $3.50/kL • Further investigation of opportunities required	$2.50/kL	• Potential avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades for water supply	• Improved water quality, through reduced STP discharge: • 3-15 kg TSS per ML reuse • 3-5 kg TN per ML reuse • 0.2-2 kg TP per ML reuse	• Improved in-stream health • Improved in-stream habitat value	• Potential water savings, further investigations required					2	2	**4**
DM5	Recycled water supplied to urban users (public open space)	• Further investigation of opportunities required	Existing RCC studies	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades for water supply	• Improved water quality, through reduced STP discharge: • 3-15 kg TSS per ML reuse • 3-5 kg TN per ML reuse • 0.2-2 kg TP per ML reuse	• Improved in-stream health • Improved in-stream habitat value	• Potential water savings, further investigations required	• Potential to improve amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)				1	2	**3**
DM6	Recycled water disposed to land or irrigated to woodlots (note limited feasible due to koala habitat & land shortage)	• Further investigation of opportunities required	Existing RCC studies	• Potential avoided costs associated with waterway rehabilitation works	• Improved water quality, through reduced STP discharge: • 3-15 kg TSS per ML reuse • 3-5 kg TN per ML reuse • 0.2-2 kg TP per ML reuse	• Improved in-stream health • Improved in-stream habitat value	N/A	• Potential to improve visual amenity through woodlot planting	• Potential waterway health education opportunity for woodlot reuse	• Carbon offset benefits for woodlots • Increased biodiversity for woodlots • Potential to Improve habitat connectivity for woodlots		2	2	**4**
S	**Sewerage**													
S2	Inspections and improved management of on site wastewater systems	Minor initial expenditure associated with program, but this is incorporated into annual/ ongoing costs.	• $35,000	• Avoided costs for waterway health / groundwater quality remediation	• Protection of receiving waters from nutrients and pathogen contamination • Localised improvement to water quality expected	• Improve waterway health		• Maintain current amenity and recreational values that may be detrimentally affected by poor sewage disposal practices	• Community capacity building on operation and maintenance of on site systems • Waterway health educational opportunity	• Protect public health		3	1	**4**
S3	Improved nutrient treatment processes of STPs (Mt Cotton STP)	Redland Water input requried		• Avoided costs associated with waterway rehabilitation works (e.g. lyngbya clean up costs). • Avoided loss of profits to tourism industry (from decline in waterway health)	• Nutrient removal benefits	• Improve waterway health		• Maintain amenity and recreational values (e.g. through reduced lyngbya outbreaks)		• Protect public health through reduced lyngbya outbreaks		1	3	**4**
S5	Improve prevention of illegal stormwater inflow connections to sewer	Redland Water input requried		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Potential education opportunity for reducing illegal connections	• Protect public health • Improve Council's reputation		2	2	**4**

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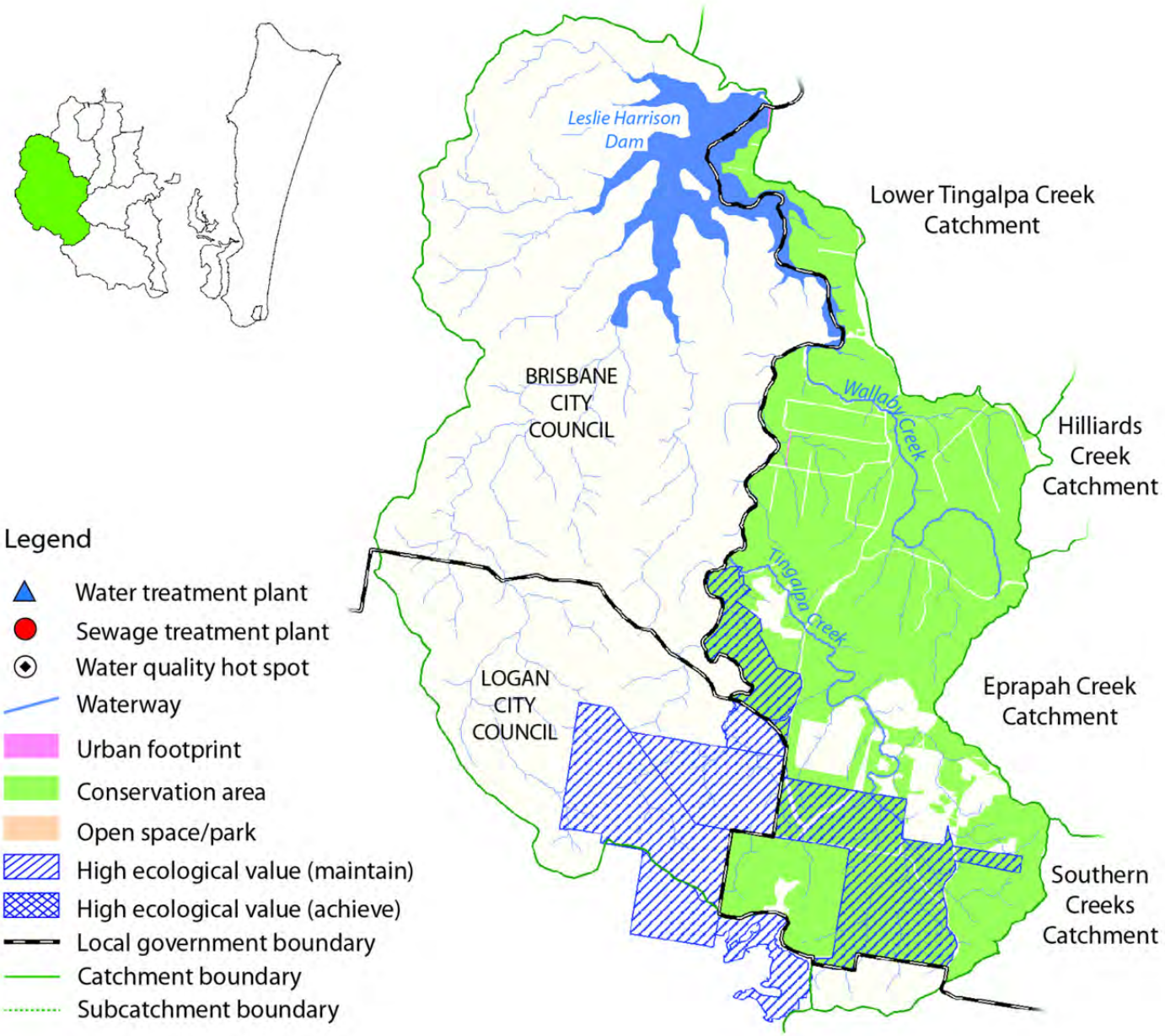
S6	Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	Redland Water input requried		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and		• Protect public health		2	2	**4**
S7	Sewerage upgrades to improve storage/conveyance of wet weather flows	Redland Water input requried		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		1	2	**3**
S8	Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	Redland Water input requried		• Avoided clean up cost of sewage overflows • Cost savings from reduced pipe sizes for smart sewers	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Community and developer capacity building opportunity for smart sewers	• Protect public health • Improve Council's reputation		1	2	**3**
S9	Wastewater infrastructure rates charged on mains water consumption basis	Redland Water input requried			• Potential financial incentive to reduce sewage generation • Primarily protection of receiving waters from nutrients from reduced effluent discharges	• Potential to improve waterway health	• Potential financial incentive to reduce water use		• Assist to educate community about cost of wastewater infrastructure	• Primarily funding mechanism for solutions that improve the performance of sewerage infrastructure		3	1	**4**
F	**Flooding & Storm tide**													
F1	Flood mitigation works implemented	• $1.4 Million road and culvert upgrades recommended in IWMP for Native Dog Creek catchment (EnGenY 2010)		• Avoided insurance claims • Avoided litigation costs • Avoided clean up costs				Reduced flood impacts to public and private assets		• Protect public health and safety		1	3	**4**
DC	**Development Control**													
DC1	Cap on population growth	• Low - planning policy. • Poential economic impacts		• Avoid costs associated with upgraded / new infrastructure	• Reduced pressures on water quality	• Reduced pressures on waterway health	• Reduced demand for water				Dependent on planned population growth	2	2	**4**
FS	**Funding to Implement Solutions**													
FS1	Develop business case for healthy waterways to support solutions	• $ 80,000 (regional, applies to all catchments)			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through justifying uptake of solutions	• Potential to save water through justifying uptake of solutions	• Potential to improve recreation and amenity values through justifying uptake of solutions	• Opportunity to educate community about the benefits of solutions and increase willingness to pay			3	3	**6**
FS2	Increase / re-prioritise funding to support TWCM solutions	No cost			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through funding uptake of solutions	• Potential to save water through funding uptake of solutions	• Potential to improve recreation and amenity values through funding		• Funding mechanism to support uptake of		2	3	**5**

Upper Tingalpa Creek Catchment



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		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
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W	**Waterway Rehabilitation**													
W1	Rehabilitation of waterways - Riparian buffer zones (private land)	• $450,000 ($10/m^2) • Further detailed investigation required	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate fair overall improvement, constitutes 2.4% of poor waterways in RCC, and 43% of poor waterways within local catchment	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	2	**4**
W2	Rehabilitation of waterways - Habitat restoration (Council land)	• $10/m^2 ($100,000/ha). • Note no poor - very poor waterways identified on Council/ state owned land	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading)	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	0	0	**0**
W3	Rehabilitation of waterways - Bank Stability Works	• Further detailed investigation required		• Avoided costs associated with flood remediation works	• TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health		• Improved community amenity & recreational benefits				2	2	**4**
W4	Rehabilitation of waterways - In-Stream Improvement works	• Further detailed investigation required		• Avoided costs associated with bank stabilisation and flood remediation works	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved in-stream habitat value		• Improved community amenity & recreational benefits				2	2	**4**
W5	Increased riparian protection for waterways (buffer/waterway corridor widths) e.g. through planning policy, voluntay Conservation Agreements	• Low cost to amend planning policy • Voluntary Conservation Agreements $18,500/yr for all catchments combined		• Avoided waterway rehabilitation and maintenance costs	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset		3	2	**5**
W6	Identify and prioritise waterway fish barrier locations	• $12,000 (Mick Holland to confirm)				• Potential for future improvement to fish passage and ecological health of waterways (if solutions to barriers are identified and implemented).					Note technology may not be available to implement solutions to identified fish barriers	1	1	**2**
W12	Monitoring to evaluate effectiveness of management solutions	• $1,000 per site (ambient monitoring), study specific		• Savings through identifying cost effective solutions	• Monitoring will assist to confirm the most effective solutions to improve water quality	• Monitoring will assist to confirm the most effective solutions to improve waterway health		• Improve community connectivity to waterways (through education)	• Results to educate community on waterway health (Waterway Recovery Report)			2	3	**5**
D	**Diffuse Pollution Management**													
D2	Rural BMP for grazing land - fencing off stock & revegetation around 1st & 2nd order streams	• $660,000 ($233 K per km of creek)	$340/ha	• Avoided costs associated with bank stabilisation and flood remediation works	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate significant improvement to water quality, constitutes 54% of poor waterways within local catchment	• Improved in-stream health • Improved habitat value		• Improved amenity and passive recreational values • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential flood mitigation benefits to downstream urban areas (through slowing and detaining flows)	• Literature values used. • Site specific investigations required to more accurately estimate • Requires support by private land owners	2	3	**5**
D3	Rural BMP for horticultural land - implementation of filter/buffer strips	• $69,000 ($1,600/ha)	• $17,000 ($390/ha)	• Avoided costs associated with waterway rehabilitation works	• 84% Removal TSS • 75% Removal of TP • 70% Removal TN • Landuse constitutes small proportion of catchment, expect localised improvements to water quality	• Improved in-stream health • Improved in-stream habitat value		• Improved connectivity to waterways	• Community planting and waterway health education opportunities		• Literature values used. • Site specific investigations required to more accurately estimate • Requires support by private land owners	2	1	**3**
D4	Integrate WSUD into government capital infrastructure works e.g. road/ park upgrades	• Unknown, dependent on amount of capital infrastructure works scheduled. • Will be more significantly more cost effective than retrofit, so should be integrated where possible.	$1-5/m2 (bioretention and swales)	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Depends on extent of capital upgrades in catchment • Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity	Effectiveness will depend on uptake through future works, which is unknown.	3	1	**4**
D5	Improved waterway health asset management system	• $10,000 to create asset register and maintenance schedule (Approx $100K for whole Redlands region)	$1-5/m2	• Avoided costs associated with waterway rehabilitation works	• Optimal treatment performance for well maintained bioretention systems: 85% TSS; 70% TP and 45% TN removal • If not well maintained, could act as a source of pollution • Only small areas of urban development, so minor potential to improve water quality	• Maintain in-stream health • Maintain in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values				3	1	**4**
D7	Naturalising land currently degraded by human activities (e.g. tree planting in rural areas void of vegetation)	• Revegetation cost $8/m^2. Further investigation required to identify areas. • Note: Rural Support and Waterways Extension programs Council carries out revegetation projects on individual and sometimes joint properties. Budget of both programs is $231,500	N/A (reveg. cost includes maintenance)	• Avoided costs associated with waterway rehabilitation works • Carbon credits	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction	• Improved in-stream health • Improved in-stream habitat value		• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Increased Bio-diversity • Carbon offset		1	2	**3**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
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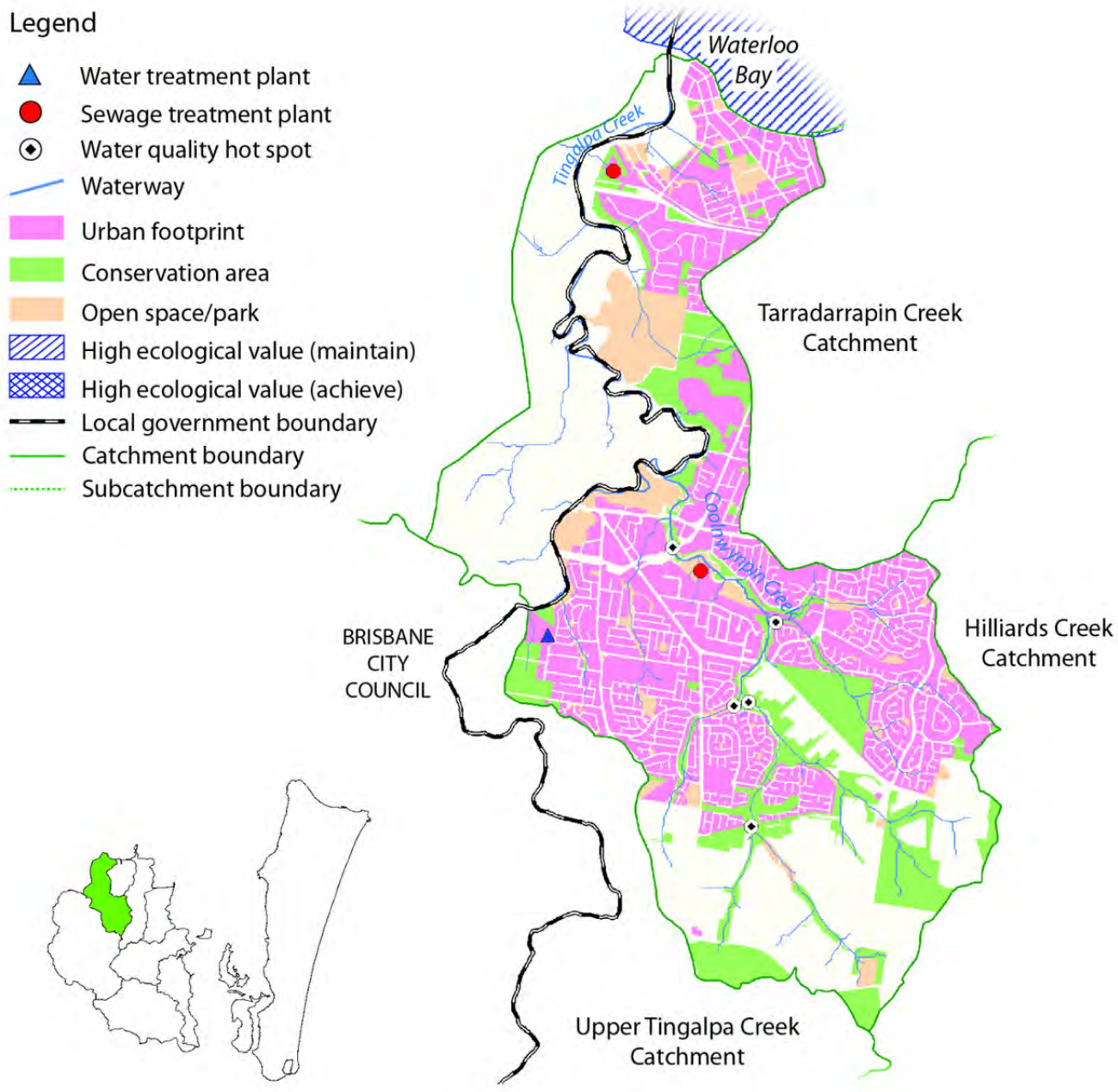
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate Good		1= 2 = 3 =
H	**Pollutant Hot Spot Management**													
H2	Rehabilitation of poorly performing water bodies (e.g. toxic dams/lakes)	• $65,000 to finalise management framework (all catchments) (2013/14) • Additional funding will be dependent on number and type of works required	• Dependent on works, however maintenance will be required	• Avoided costs associated with waterway rehabilitation works • Cost savings through nutrient trading scheme	• Note water bodies have been identified as a possible hot spot for pollutant load generation in catchment • A large proportion of Redlands' water bodies are in this catchment, hence benefits are likely to be high	• Improved in-stream health • Improved habitat value		• Improved amenity, active and passive recreational values • Improved connectivity to waterways • Increased land values	• Waterway health education opportunities on Council owned land (e.g. signage)		Firstly requires assessment and prioritisation of water bodies to rehabilitate	2	3	**5**
H4	Investigate sources of hot spot pollution & identify targeted treatment strategies	Minor initial expenditure associated with expanded program, but this is incorporated into annual/ ongoing costs.	• $100,000 for annual program (Assumes 60 sites for whole of Redlands, laboratory expenses comprise 50%)	• Avoided costs associated with waterway rehabilitation works	• No hot spots have been identified in this catchment, however further investigation required • Potential to improve water quality.	• Improved in-stream habitat value						3	2	**5**
H5	Nutrient Trading	Not known. Likely to be cost effective as targets least cost strategy to remove pollutants from catchment. e.g. funding of rural BMPs to address hot spots instead of upgrade to STP.	Not known	• Cost savings through targeting most cost effective management solutions	• Unknown however likely to be high water quality improvement benefits	• Improved in-stream health • Improved in-stream habitat value		• Potential to improve amenity and passive recreational values				3	1	**4**
E	**Education & Capacity Building**													
E1	Education & /or capacity building and investment in incentive schemes	• This will be dependent on the adopted solutions and how they can each be supported. Low anticipated costs. • Currently adopted Habitat Protection Programs may be used to support some solutions. These total $320K and include: • Waterways Extension • Land For Wildlife • Voluntary Conservation Agreement • Rural Support	Low	• Avoided costs associated with improved waterway outcomes	• Potential to improve water quality at low cost	• Potential to improve waterway health (e.g. reduced erosion, silt and weeds, improved riparian vegetation) at low cost	• Potential to save water at low cost	• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Education and capacity building to support other solutions	• Benefits to Council's reputation • Increased stewardship over land	This solution is generic and may be applied in support of other solutions e.g. waterway rehabilitation, WSUD retrofit etc.	3	3	**6**
E2	Active Extension Programs Idea: Rain gardens in backyards	• $15,000 for program development, may be more if rebates offered • Note could be added to current "Your Backyard Garden" extension program	Low	• Avoided costs associated with waterway rehabilitation works	• Potential to improve water quality at low cost • Typical water quality improvement for rain gardens/ bioretention systems 85% TSS; 70% TP and 45% TN removal • Small proportion of existing urban area, therefore minor potential for improvement	• Improved in-stream health • Improved in-stream habitat value	Potential landscape irrigation water savings		• Significant opportunity for community capacity building and waterway health education	• Benefits to Council's reputation • Increased stewardship over land		3	1	**4**
E3	Improved marketing around TWCM initiatives	• $5-20K - Basic marketing • $5-50K - Use of Healthy Waterways resources • $60+K - Waterways brand and marketing campaign • $20-$30K - Waterways Festival			• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Potential to improve community 'connectivity' to waterways	• Significant opportunity for community education and improved waterway health education • Increased awareness of Council initiatives improves Council's reputation	Benefits to Council's reputation		3	2	**5**
E4	Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	• $180,000 • Dependent on subsidy and number of houses without tanks that it could be applied to. Cost per lot (5kL tank internally plumbed) $3,560	• $1,000 ($20/ tank)	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• 70 kg/yr TSS • 10 kg/yr TN • 0.5 kg/yr TP	• Improved in-stream health • Improved in-stream habitat value	• 4 ML/yr water savings (70 kL/yr/tank).	• Potential to improve amenity during times when mains water restrictions are in place (i.e. access to rainwater)	• Water conservation educational opportunity	Benefits to Council's reputation	Estimate only, will be largely dependent on community uptake	1	2	**3**
E5	Improved connectivity to waterways through education & participation in waterway improvement projects	• Low, to be considered in support of other projects e.g. waterway rehabilitation • Note Waterway Extension Program (WEP) provides improved connectivity to waterways through education and onground improvements in hot spot catchments. The total budget for WEP is $141K (12/13).		• Labour costs for planting projects	• Potential to improve water quality at low cost	• Potential to improve waterway health at low cost		• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Opportunity to secure community support for funding solutions through education	Benefits to Council's reputation		3	2	**5**
DM	**Water Supply & Demand Management**													
DM1	Stormwater harvesting for POS	• $2.50 / kL • Further investigation of opportunities required	• $1.50/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• Improved water quality, through reduced catchment stormwater runoff	• Reduced volume and frequency of runoff	• Assumes use of 7ML/ha/yr (irrigation)	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity	Benefits to Council's reputation		2	2	**4**
DM9	Upgrade WTP process (i.e. trihalomethanes) at Capalaba Treatment Plant	Between $4M and $10M estimated (to allow for increased treatment of organics and micropollutants and to replace powdered activated for taste and odour and toxin treatment) …to allow the current capacity of 52 ML/d to be maintained. SEQ Water cost?		• Avoided litigation costs			• Potential savings if water is deemed to be unsafe (as will need to be sourced from elsewhere)			• Protects Council's reputation • Community Safety		2	2	**4**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate Good		1= 2 = 3 =
S	**Sewerage**													
S2	Inspections and improved management of on site wastewater systems	Minor initial expenditure associated with program, but this is incorporated into annual/ ongoing costs.	• $35,000	• Avoided costs for waterway health / groundwater quality remediation	• Protection of receiving waters from nutrients and pathogen contamination • Significant improvement to water quality expected	• Improve waterway health	• Potential to protect drinking water supplies (groundwater)	• Maintain current amenity and recreational values that may be detrimentally affected by poor sewage disposal practices	• Community capacity building on operation and maintenance of on site systems • Waterway health educational opportunity	• Protect public health		3	3	**6**
S5	Improve prevention of illegal stormwater inflow connections to sewer	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Potential education opportunity for reducing illegal connections	• Protect public health • Improve Council's reputation		2	2	**4**
S6	Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		2	2	**4**
S7	Sewerage upgrades to improve storage/conveyance of wet weather flows	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		1	2	**3**
S8	Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	Input from Redland Water required		• Avoided clean up cost of sewage overflows • Cost savings from reduced pipe sizes for smart sewers	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Community and developer capacity building opportunity for smart sewers	• Protect public health • Improve Council's reputation		1	2	**3**
S9	Wastewater infrastructure rates charged on mains water consumption basis	Input from Redland Water required			• Potential financial incentive to reduce sewage generation • Primarily protection of receiving waters from nutrients from reduced effluent discharges	• Potential to improve waterway health	• Potential financial incentive to reduce water use		• Assist to educate community about cost of wastewater infrastructure	• Primarily funding mechanism for solutions that improve the performance of sewerage infrastructure		3	1	**4**
FS	**Funding to implement Solutions**													
FS1	Develop business case for healthy waterways to support solutions	• $ 80,000 (regional, applies to all catchments)			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through justifying uptake of solutions	• Potential to save water through justifying uptake of solutions	• Potential to improve recreation and amenity values through justifying uptake of solutions	• Opportunity to educate community about the benefits of solutions and increase willingness to pay			3	3	**6**
FS2	Increase / re-prioritise funding to support TWCM solutions	No cost			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through funding uptake of solutions	• Potential to save water through funding uptake of solutions	• Potential to improve recreation and amenity values through funding uptake of solutions		• Funding mechanism to support uptake of solutions		2	3	**5**

Lower Tingalpa Creek Catchment



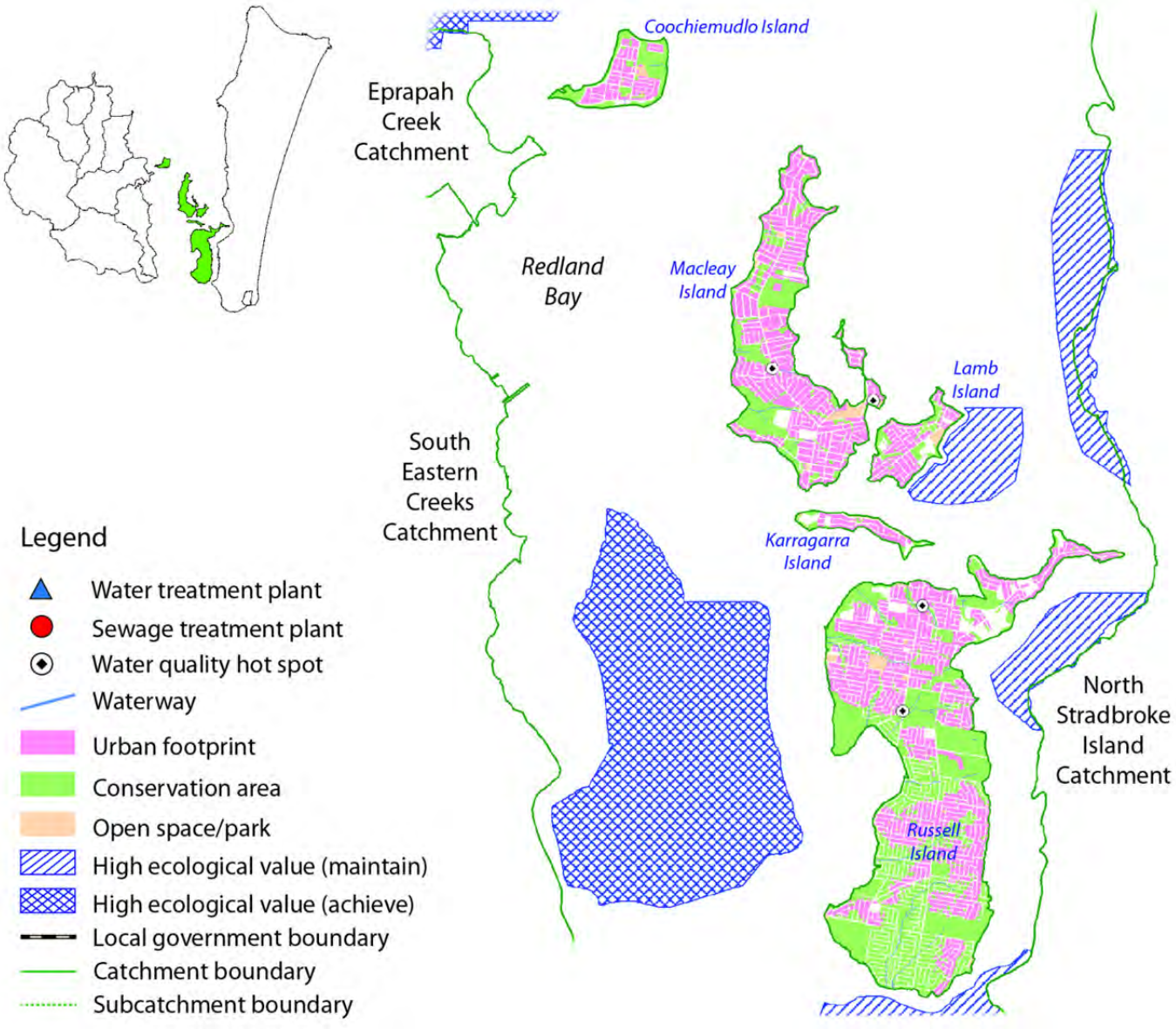
	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate = Good		1= 2 = 3
W	**Waterway Rehabilitation**													
W1	Rehabilitation of waterways - Riparian buffer zones (private land)	• $10/m^2 ($100,000/ha). • $410,000 for poor - very poor condition waterways on private land • Further investigation required	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate fair overall improvement, constitutes 2.2% of poor waterways in RCC, and 58% of poor waterways within local catchment	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	2	**4**
W2	Rehabilitation of waterways - Habitat restoration (Council land)	• $10/m^2 ($100,000/ha). • $300,000 for poor - very poor condition waterways on RCC/State land • Further investigation required	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate fair overall improvement, constitutes 1.6% of poor waterways in RCC, and 42% of poor waterways within local catchment	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	**2**	**2**	**4**
W3	Rehabilitation of waterways - Bank Stability Works	• Further detailed investigation required		• Avoided costs associated with flood remediation works	• TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health		• Improved community amenity & recreational benefits				**2**	**2**	**4**
W4	Rehabilitation of waterways - In-Stream Improvement works	• Further detailed investigation required		• Avoided costs associated with bank stabilisation and flood remediation works	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved in-stream habitat value		• Improved community amenity & recreational benefits				**2**	**2**	**4**
W5	Increased riparian protection for waterways (buffer/waterway corridor widths) e.g. through planning policy, voluntay Conservation Agreements	• Low cost to amend planning policy • Voluntary Conservation Agreements $18,500/yr for all catchments combined		• Avoided waterway rehabilitation and maintenance costs	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset		**3**	**1**	**4**
W6	Identify and prioritise waterway fish barrier locations	• $12,000 (Mick Holland to confirm)				• Potential for future improvement to fish passage and ecological health of waterways (if solutions to barriers are identified and implemented).					Note technology may not be available to implement solutions to identified fish barriers	1	1	**2**
W12	Monitoring to evaluate effectiveness of management solutions	• $1,000 per site (ambient monitoring), study specific		• Savings through identifying cost effective solutions	• Monitoring will assist to confirm the most effective solutions to improve water quality	• Monitoring will assist to confirm the most effective solutions to improve waterway health		• Improve community connectivity to waterways (through education)	• Results to educate community on waterway health (Waterway Recovery Report)			2	3	**5**
D	**Diffuse Pollution Management**													
D1	Increased implementation / enforcement of E&SC management practices and capacity building through education	• $500	• $5,000 ($100,000 for all catchments)	• Avoided waterway rehabilitation and maintenance / monitoring costs • Avoided loss of profits to tourism industry (from decline in waterway health)	• Significant coarse sediment removal • TSS removal performance 40% • Nutrient removal assumed minor	• Improved habitat value through decreasing water turbidity and protecting sea-grass habitat from being smothered		• Maintain community amenity, recreational and tourism benefits, particularly in receiving waters (Moreton Bay) • Improved connectivity to waterways	• Capacity building and education for council, land developers and contractors			3	1	**4**
D2	Rural BMP for grazing land - fencing off stock & revegetation around 1st & 2nd order streams	• $240,000 ($233 K per km of creek) • No grazing land use identified in Lower Tingalpa Catchment (SEQ landuse mapping)	$340/ha	• Avoided costs associated with bank stabilisation and flood remediation works	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate marginal overall improvement, constitutes 1% of poor waterways in RCC, and 9% of poor waterways within local catchment • Potential to stabilise alluvial soils with high nutrient content	• Improved in-stream health • Improved habitat value		• Improved amenity and passive recreational values • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential flood mitigation benefits to downstream urban areas (through slowing and detaining flows)	• Literature values used. • Site specific investigations required to more accurately estimate • Requires support by private land owners	0	0	**0**
D3	Rural BMP for horticultural land - implementation of filter/buffer strips	• $33,000 ($1,600/ha)	• $8,000 ($390/ha)	• Avoided costs associated with waterway rehabilitation works	• 84% Removal TSS • 75% Removal of TP • 70% Removal TN • Landuse constitutes 1% of catchment, expect localised improvements to water quality	• Improved in-stream health • Improved in-stream habitat value		• Improved connectivity to waterways	• Community planting and waterway health education opportunities		• Literature values used. • Site specific investigations required to more accurately estimate • Requires support by private land owners	2	1	**3**
D4	Integrate WSUD into government capital infrastructure works e.g. road/ park upgrades	• Unknown, dependent on amount of capital infrastructure works scheduled. • Will be more significantly more cost effective than retrofit, so should be integrated where possible.	$1-5/m2 (bioretention and swales)	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Depends on extent of capital upgrades in catchment • Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity	Effectiveness will depend on uptake through future works, which is unknown.	3	2	**5**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate = Good		1= 2 = 3
D5	Improved waterway health asset management system	• $10,000 to create asset register and maintenance schedule (Approx $100K for whole Redlands region)	$1-5/m2	• $230,000 avoided asset rectification • Avoided costs associated with waterway rehabilitation works	• Optimal treatment performance for well maintained bioretention systems: 85% TSS; 70% TP and 45% TN removal • If not well maintained, could act as a source of pollution • Potential to ensure to significant water quality improvement	• Maintain in-stream health • Maintain in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values			Costing based on bioretention area estimate	3	3	**6**
D6	Future development to achieve better than SPP Water requirements (for WSUD)	• $800,000	• $8,000	• Avoided costs associated with waterway rehabilitation works	• Achieve no future worsening in catchment pollutant loads i.e. maintain or improve on existing loads generated • Small amount of future development hence improvements expected to be minor	• Maintain / improve in-stream health • Maintain / improve in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values	• Community planting and waterway health education opportunities		This solution will be more applicable to catchments with sensitive receiving environments, as it's not as cost effective as traditional WSUD	1	1	**2**
D7	Naturalising land currently degraded by human activities (e.g. tree planting in rural areas void of vegetation)	• Revegetation cost $8/m^2. Further investigation required to identify areas. • Note: Rural Support and Waterways Extension programs Council carries out revegetation projects on individual and sometimes joint properties. Budget of both programs is $231,500	N/A (reveg. cost includes maintenance)	• Avoided costs associated with waterway rehabilitation works • Carbon credits	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction	• Improved in-stream health • Improved in-stream habitat value		• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Increased Bio-diversity • Carbon offset		1	2	**3**
D8	Water Sensitive Urban Design Retrofit (beyond capital infrastructure works)	• $3.4 Million	• $34,000	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal, however difficult to achieve in retrofit scenarios • Potential to significantly improve water quality	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity		1	3	**4**
H	**Pollutant Hot Spot Management**													
H1	BMP for poultry farms - EMP review	• $6,000 ($3,000 / farm)		• Avoided costs associated with waterway rehabilitation works	• Note poultry farms have been identified as a possible hot spot for pollutant load generation in catchment • Only 2 poultry farms identified in catchment, so expect benefits to be localised and minor	• Improved in-stream health • Improved in-stream habitat value						3	1	**4**
H2	Rehabilitation of poorly performing water bodies (e.g. toxic dams/lakes)	• $65,000 to finalise management framework (all catchments) (2013/14) • Additional funding will be dependent on number and type of works required	• Dependent on works, however maintenance will be required	• Avoided costs associated with waterway rehabilitation works • Cost savings through nutrient trading scheme	• Note water bodies have been identified as a possible hot spot for pollutant load generation in catchment • A fair proportion of Redlands' water bodies are in this catchment, hence benefits are likely to be moderate	• Improved in-stream health • Improved habitat value		• Improved amenity, active and passive recreational values • Improved connectivity to waterways • Increased land values	• Waterway health education opportunities on Council owned land (e.g. signage)		Firstly requires assessment and prioritisation of water bodies to rehabilitate	2	2	**4**
H3	Improved landfill capping /leachate management & treatment systems	• Estimated at $4-7 Million with an approx split of 15%ops 85% capital and 20% contingency	• Current annual trucking operations - $700k to $1.2M	• Avoided costs associated with waterway rehabilitation works	• Note landfills have been identified as a possible hot spot for pollutant load generation in catchment • Potential to greatly improve water quality and reduce landfill contaminants from entering waterways	• Improved in-stream health • Improved habitat value		• Potential to improve amenity and passive recreational values through use of treatment wetlands	• Waterway health education opportunities (e.g. signage)			2	3	**5**
H4	Investigate sources of hot spot pollution & identify targeted treatment strategies	Minor initial expenditure associated with expanded program, but this is incorporated into annual/ ongoing costs.	• $100,000 for annual program (Assumes 60 sites for whole of Redlands, laboratory expenses comprise 50%)	• Avoided costs associated with waterway rehabilitation works	• Note 5 hot spots have been identified as key pollutant generation sources in the catchment • Significant potential to improve water quality.	• Improved in-stream habitat value						3	3	**6**
E	**Education & Capacity Building**													
E1	Education & /or capacity building and investment in incentive schemes	• This will be dependent on the adopted solutions and how they can each be supported. Low anticipated costs. • Currently adopted Habitat Protection Programs may be used to support some solutions. These total $320K and include: • Waterways Extension • Land For Wildlife • Voluntary Conservation Agreement • Rural Support	Low	• Avoided costs associated with improved waterway outcomes	• Potential to improve water quality at low cost	• Potential to improve waterway health (e.g. reduced erosion, silt and weeds, improved riparian vegetation) at low cost	• Potential to save water at low cost	• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Education and capacity building to support other solutions	• Benefits to Council's reputation • Increased stewardship over land	This solution is generic and may be applied in support of other solutions e.g. waterway rehabilitation, WSUD retrofit etc.	3	3	**6**
E2	Active Extension Programs Idea: Rain gardens in backyards	• $15,000 for program development, may be more if rebates offered • Note could be added to current "Your Backyard Garden" extension program	Low	• Avoided costs associated with waterway rehabilitation works	• Potential to improve water quality at low cost • Typical water quality improvement for rain gardens/ bioretention systems 85% TSS; 70% TP and 45% TN removal • High proportion of existing urban area, therefore high potential for improvement (dependent on uptake)	• Improved in-stream health • Improved in-stream habitat value	Potential landscape irrigation water savings		• Significant opportunity for community capacity building and waterway health education	• Benefits to Council's reputation • Increased stewardship over land		3	3	**6**
E3	Improved marketing around TWCM initiatives	• $5-20K - Basic marketing • $5-50K - Use of Healthy Waterways resources • $60+K - Waterways brand and marketing campaign • $20-$30K - Waterways Festival			• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Potential to improve community 'connectivity' to waterways	• Significant opportunity for community education and improved waterway health education • Increased awareness of Council initiatives improves Council's reputation	Benefits to Council's reputation		3	2	**5**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate = Good		1= 2 = 3
E4	Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	• $3.27 Million • Dependent on subsidy and number of houses without tanks that it could be applied to. Cost per lot (5kL tank internally plumbed) $3,560	• $18,000 ($20/ tank)	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• 1,280 kg/yr TSS • 120 kg/yr TN • 8.3 kg/yr TP	• Improved in-stream health • Improved in-stream habitat value	• 64 ML/yr water savings (70 kL/yr/tank).	• Potential to improve amenity during times when mains water restrictions are in place (i.e. access to rainwater)	• Water conservation educational opportunity	Benefits to Council's reputation	Estimate only, will be largely dependent on community uptake	1	3	**4**
E5	Improved connectivity to waterways through education & participation in waterway improvement projects	• Low, to be considered in support of other projects e.g. waterway rehabilitation • Note Waterway Extension Program (WEP) provides improved connectivity to waterways through education and onground improvements in hot spot catchments. The total budget for WEP is $141K (12/13).		• Labour costs for planting projects	• Potential to improve water quality at low cost	• Potential to improve waterway health at low cost		• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Opportunity to secure community support for funding solutions through education	Benefits to Council's reputation		3	2	**5**
E6	Education campaign to address flooding and storm tide issues - Mapping made available to public	• Low $5,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	2	**5**
E7	Education campaign to address flooding and storm tide issues - Include notes on rates	• Low $5,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community	• Benefits to Council's		3	2	**5**
E8	Education campaign to address flooding and storm tide issues - Install historical flood marks/signs	• Low $10,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	3	**6**
DM	**Water Supply & Demand Management**													
DM1	Stormwater harvesting for POS	• $2.50/kL • Further investigation of opportunities required	• $1.50/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• Improved water quality, through reduced catchment stormwater runoff • 150 kg TSS per ML reuse • 2 kg TN per ML reuse • 0.3 kg TP per ML reuse	• Reduced volume and frequency of runoff	• Up to 7ML/ha/yr (irrigation)	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity	Benefits to Council's reputation		2	2	**4**
DM4	Recycled water supplied to large industrial/commercial users • Opportunities to include in Capalaba Master Plan • Note few large industrial users identified. Key users cement plants and food processing plants. Food processing plants not deemed viable due to the high potential for adverse publicity (KBR 2006)		$2.50/kL	• Potential avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades for water supply	• Improved water quality, through reduced effluent discharge: • 3-15 kg TSS per ML reuse • 1.6-5 kg TN per ML reuse • 0.7-2 kg TP per ML reuse	• Improved in-stream health • Improved in-stream habitat value	• Potential potable water savings, further studies required					2	1	**3**
DM5	Recycled water supplied to urban users (public open space and commercial) • Costing and demand based on Capalaba STP scheme investigated in Redland Recycled Water Planning report (KBR 2006) • Note Capalaba STP recently upgraded to provide 240 kL/day A+ recycled water	• $10-17/kL • 7.1 - 11 Million	• $300,000 - $500,000	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades for water supply	• Improved water quality, through reduced effluent discharge: • 3-15 kg TSS per ML reuse • 1.6-5 kg TN per ML reuse • 0.7-2 kg TP per ML reuse	• Improved in-stream health • Improved in-stream habitat value	• 49 - 60 ML/yr	• Potential to improve amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)				2	2	**4**
DM6	Recycled water disposed to land or irrigated to woodlots (note limited feasible due to koala habitat & land shortage)	• Further investigation of opportunities required	Existing RCC studies	• Potential avoided costs associated with waterway rehabilitation works	• Improved water quality, through reduced effluent discharge: • 3-15 kg TSS per ML reuse • 1.6-5 kg TN per ML reuse • 0.7-2 kg TP per ML reuse	• Improved in-stream health • Improved in-stream habitat value	N/A	• Potential to improve visual amenity through woodlot planting	• Potential waterway health education opportunity for woodlot reuse	• Carbon offset benefits for woodlots • Increased biodiversity for woodlots • Potential to Improve habitat connectivity for woodlots		2	1	**3**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key Poor Moderate = Good		1= 2 = 3
S	**Sewerage**													
S2	Inspections and improved management of on site wastewater systems	Minor initial expenditure associated with program, but this is incorporated into annual/ ongoing costs.	• $35,000	• Avoided costs for waterway health / groundwater quality remediation	• Protection of receiving waters from nutrients and pathogen contamination • Signficant improvement to water quality expected	• Improve waterway health		• Maintain current amenity and recreational values that may be detrimentally affected by poor sewage disposal practices	• Community capacity building on operation and maintenance of on site systems • Waterway health educational opportunity	• Protect public health		3	1	**4**
S3	Improved nutrient treatment processes of Capalaba and Thorneside STP	Input from Redland Water required		• Avoided costs associated with waterway rehabilitation works (e.g. lyngbya clean up costs). • Avoided loss of profits to tourism industry (from decline in waterway health)	• Nutrient removal benefits	• Improve waterway health		• Maintain amenity and recreational values (e.g. through reduced lyngbya outbreaks)		• Protect public health through reduced lyngbya outbreaks		1	1	**2**
S5	Improve prevention of illegal stormwater inflow connections to sewer	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Potential education opportunity for reducing illegal connections	• Protect public health • Improve Council's reputation		2	2	**4**
S6	Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		2	2	**4**
S7	Sewerage upgrades to improve storage/conveyance of wet weather flows	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		1	2	**3**
S8	Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	Input from Redland Water required		• Avoided clean up cost of sewage overflows • Cost savings from reduced pipe sizes for smart sewers	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Community and developer capacity building opportunity for smart sewers	• Protect public health • Improve Council's reputation		1	2	**3**
S9	Wastewater infrastructure rates charged on mains water consumption basis	Input from Redland Water required			• Potential financial incentive to reduce sewage generation • Primarily protection of receiving waters from nutrients from reduced effluent discharges	• Potential to improve waterway health	• Potential financial incentive to reduce water use		• Assist to educate community about cost of wastewater infrastructure	• Primarily funding mechanism for solutions that improve the performance of sewerage infrastructure		3	1	**4**
F	**Flooding & Storm tide**													
F1	Flood mitigation investigation/works implemented	• $20,000 Detailed hydraulic investigation Firtree St • $880,000 to implement recommended flood mitigation works (Worley Parson 2010)		• Avoided insurance claims • Avoided litigation costs • Avoided clean up costs				Reduced flood impacts to public and private assets		• Protect public health and safety		2	3	**5**
DC	**Development Control**													
DC1	Cap on population growth	• Low - planning policy. • Poential economic impacts		• Avoid costs associated with upgraded / new infrastructure	• Reduced pressures on water quality	• Reduced pressures on waterway health	• Reduced demand for water				Dependent on planned population growth	2	3	**5**
FS	**Funding to Implement Solutions**													
FS1	Develop business case for healthy waterways to support solutions	• $ 80,000 (regional, applies to all catchments)			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through justifying uptake of solutions	• Potential to save water through justifying uptake of solutions	• Potential to improve recreation and amenity values through justifying uptake of solutions	• Opportunity to educate community about the benefits of solutions and increase willingness to pay			3	3	**6**
FS2	Increase / re-prioritise funding to support TWCM solutions	No cost			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through funding uptake of solutions	• Potential to save water through funding uptake of solutions	• Potential to improve recreation and amenity values through funding uptake of solutions		• Funding mechanism to support uptake of solutions		2	3	**5**

Coochiemudlo & SMBIs Catchment



	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key 1= Poor 2 = Moderate 3 = Good		
W	**Waterway Rehabilitation**													
W1	Rehabilitation of waterways - Riparian buffer zones	• Further investigation required to identify need - creek funtional mapping study • $10/m^2 ($100,000/ha).		• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading)	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	2	**4**
W2	Rehabilitation of waterways - Habitat restoration (Council land)	• Further detailed investigation required		• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• TSS treatment benefits • Minor nutrient removal benefits • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen control (shading)	• Improved habitat value • Improved in-stream health		• Improved community amenity & recreational benefits • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset		2	1	**3**
W3	Rehabilitation of waterways - Bank Stability Works	• Further detailed investigation required		• Avoided costs associated with flood remediation works	• TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health		• Improved community amenity & recreational benefits				2	2	**4**
W4	Rehabilitation of waterways - In-Stream Improvement works	• Further detailed investigation required		• Avoided costs associated with bank stabilisation and flood remediation works	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved in-stream habitat value		• Improved community amenity & recreational benefits				2	2	**4**
W5	Increased riparian protection for waterways (buffer/waterway corridor widths) e.g. through planning policy, voluntay Conservation Agreements	• Low cost to amend planning policy • Voluntary Conservation Agreements $18,500/yr for all catchments combined		• Avoided waterway rehabilitation and maintenance costs	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset		3	3	**6**
W6	Identify and prioritise waterway fish barrier locations	• $12,000 (Mick Holland to confirm)				• Potential for future improvement to fish passage and ecological health of waterways (if solutions to barriers are identified and implemented).					Note technology may not be available to implement solutions to identified fish barriers	2	1	**3**
W11	Investigations/monitoring to better define waterway health	$30,000 for ambient monitoring of 30 sites on a quarterly basis ($1K per site)		• Avoided cost for unnecessary works	• Assist to identify targeted water quality improvement strategies	• Assist to identify targeted waterway health improvement strategies		• Improve community connectivity to waterways (through education)	• Results to educate community on waterway health (Waterway Recovery Report)			2	3	**5**
W12	Monitoring to evaluate effectiveness of management solutions	• $1,000 per site (ambient monitoring), study specific		• Savings through identifying cost effective solutions	• Monitoring will assist to confirm the most effective solutions to improve water quality	• Monitoring will assist to confirm the most effective solutions to improve waterway health		• Improve community connectivity to waterways (through education)	• Results to educate community on waterway health (Waterway Recovery Report)			2	3	**5**
D	**Diffuse Pollution Management**													
D1	Increased implementation / enforcement of E&SC management practices and capacity building through education	• $2,400	• $24,000 ($100,000 for all catchments)	• Avoided waterway rehabilitation and maintenance / monitoring costs • Avoided loss of profits to tourism industry (from decline in waterway health)	• Significant coarse sediment removal • TSS removal performance 40% • Nutrient removal assumed minor • Significant development pressures in this catchment hence significant water quality benefits expected	• Improved habitat value through decreasing water turbidity and protecting sea-grass habitat from being smothered		• Maintain community amenity, recreational and tourism benefits, particularly in receiving waters (Moreton Bay) • Improved connectivity to waterways	• Capacity building and education for council, land developers and contractors			3	3	**6**
D4	Integrate WSUD into government capital infrastructure works e.g. road/ park upgrades	• Unknown, dependent on amount of capital infrastructure works scheduled. • Will be more significantly more cost effective than retrofit, so should be integrated where possible.	$1-5/m2 (bioretention and swales)	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Depends on extent of capital upgrades in catchment • Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity	Effectiveness will depend on uptake through future works, which is unknown.	3	2	**5**
D5	Improved waterway health asset management system	• $10,000 to create asset register and maintenance schedule (Approx $100K for whole Redlands region)	$1-5/m2	• $1.03 Million avoided asset rectification • Avoided costs associated with waterway rehabilitation works	• Optimal treatment performance for well maintained bioretention systems: 85% TSS; 70% TP and 45% TN removal • If not well maintained, could act as a source of pollution • Potential to ensure to significant water quality improvement	• Maintain in-stream health • Maintain in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values			Costing based on bioretention area estimate	3	3	**6**
D6	Future development to achieve better than SPP Water requirements (for WSUD)	• $3.8 Million	• $38,000	• Avoided costs associated with waterway rehabilitation works	• Achieve no future worsening in catchment pollutant loads i.e. maintain or improve on existing loads generated • Large amount of future development hence improvements expected to be large	• Maintain / improve in-stream health • Maintain / improve in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values	• Community planting and waterway health education opportunities		This solution will be more applicable to catchments with sensitive receiving environments, as it's not as cost effective as traditional WSUD	1	3	**4**
D7	Naturalising land currently degraded by human activities (e.g. tree planting in rural areas void of vegetation)	• Revegetation cost $8/m^2. Further investigation required to identify areas. • Note: Rural Support and Waterways Extension programs Council carries out revegetation projects on individual and sometimes joint properties. Budget of both programs is $231,500	N/A (reveg. cost includes maintenance)	• Avoided costs associated with waterway rehabilitation works • Carbon credits	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction	• Improved in-stream health • Improved in-stream habitat value		• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Increased Bio-diversity • Carbon offset		1	2	**3**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key 1= Poor 2 = Moderate 3 = Good		
H	**Pollutant Hot Spot Management**													
H2	Rehabilitation of poorly performing water bodies (e.g. toxic dams/lakes) • Need further investigations to identify waterways and water bodies	• $65,000 to finalise management framework (all catchments) (2013/14) • Additional funding will be dependent on number and type of works required	• Dependent on works, however maintenance will be required	• Avoided costs associated with waterway rehabilitation works • Cost savings through nutrient trading scheme	• Note water bodies have been identified as a possible hot spot for pollutant load generation in other catchments • If poorly performing waterbodies are identified, remediation may significantly improve water quality	• Improved in-stream health • Improved habitat value		• Improved amenity, active and passive recreational values • Improved connectivity to waterways • Increased land values	• Waterway health education opportunities on Council owned land (e.g. signage)		Firstly requires assessment and prioritisation of water bodies to rehabilitate	2	2	**4**
H4	Investigate sources of hot spot pollution & identify targeted treatment strategies	Minor initial expenditure associated with expanded program, but this is incorporated into annual/ ongoing costs.	• $100,000 for annual program (Assumes 60 sites for whole of Redlands, laboratory expenses comprise 50%)	• Avoided costs associated with waterway rehabilitation works	• Note 4 hot spots have been identified as key pollutant generation sources in the catchment • Potential to significantly improve water quality.	• Improved in-stream habitat value						3	3	**6**
H6	Improved management of unsealed roads	• Swale cost $21/m^2	• Swale maintenance costs $2.50/m^2 (grass, less for vegetated)	• Avoided costs associated with waterway rehabilitation works	• Typical water quality improvement for swale systems: 90% TSS; 62% TP and 13% TN removal • Identified as possibly contributing to high pollutant loads	• Improved in-stream health • Improved in-stream habitat value		• Potential to improve amenity and passive recreational values				2	3	**5**
E	**Education & Capacity Building**													
E1	Education & /or capacity building and investment in incentive schemes	• This will be dependent on the adopted solutions and how they can each be supported. Low anticipated costs. • Currently adopted Habitat Protection Programs may be used to support some solutions. These total $320K and include: • Waterways Extension • Land For Wildlife • Voluntary Conservation Agreement • Rural Support	Low	• Avoided costs associated with improved waterway outcomes	• Potential to improve water quality at low cost	• Potential to improve waterway health (e.g. reduced erosion, silt and weeds, improved riparian vegetation) at low cost	• Potential to save water at low cost	• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Education and capacity building to support other solutions	• Benefits to Council's reputation • Increased stewardship over land	This solution is generic and may be applied in support of other solutions e.g. waterway rehabilitation, WSUD retrofit etc.	3	3	**6**
E2	Active Extension Programs Idea: Rain gardens in backyards	• $15,000 for program development, may be more if rebates offered • Note could be added to current "Your Backyard Garden" extension program	Low	• Avoided costs associated with waterway rehabilitation works	• Potential to improve water quality at low cost • Typical water quality improvement for rain gardens/ bioretention systems 85% TSS; 70% TP and 45% TN removal • Fair proportion of existing urban area, therefore moderate potential for improvement (dependent on uptake)	• Improved in-stream health • Improved in-stream habitat value	Potential landscape irrigation water savings		• Significant opportunity for community capacity building and waterway health education	• Benefits to Council's reputation • Increased stewardship over land		3	2	**5**
E3	Improved marketing around TWCM initiatives	• $5-20K - Basic marketing • $5-50K - Use of Healthy Waterways resources • $60+K - Waterways brand and marketing campaign • $20-$30K - Waterways Festival			• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Potential to improve community 'connectivity' to waterways	• Significant opportunity for community education and improved waterway health education • Increased awareness of Council initiatives improves Council's reputation	Benefits to Council's reputation		3	2	**5**
E4	Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	• $1.61 Million • Dependent on subsidy and number of houses without tanks that it could be applied to. Cost per lot (5kL tank internally plumbed) $3,560	• $9,000 ($20/ tank)	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• 630 kg/yr TSS • 60 kg/yr TN • 4.1 kg/yr TP	• Improved in-stream health • Improved in-stream habitat value	• 32 ML/yr water savings (70 kL/yr/tank).	• Potential to improve amenity during times when mains water restrictions are in place (i.e. access to rainwater)	• Water conservation educational opportunity	Benefits to Council's reputation	Estimate only, will be largely dependent on community uptake	1	3	**4**
E5	Improved connectivity to waterways through education & participation in waterway improvement projects	• Low, to be considered in support of other projects e.g. waterway rehabilitation • Note Waterway Extension Program (WEP) provides improved connectivity to waterways through education and onground improvements in hot spot catchments. The total budget for WEP is $141K (12/13).		• Labour costs for planting projects	• Potential to improve water quality at low cost	• Potential to improve waterway health at low cost		• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Opportunity to secure community support for funding solutions through education	Benefits to Council's reputation		3	2	**5**
E6	Education campaign to address flooding and storm tide issues - Mapping made available to public	• Low $5,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	2	**5**
E7	Education campaign to address flooding and storm tide issues - Include notes on rates	• Low $5,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	2	**5**
E8	Education campaign to address flooding and storm tide issues - Install historical flood marks/signs	• Low $10,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	3	**6**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key 1= Poor 2 = Moderate 3 = Good		
DM	**Water Supply & Demand Management**													
DM1	Stormwater harvesting for POS	• $2.50/kL • Further investigation of opportunities required	• $1.50/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• Improved water quality, through reduced catchment stormwater runoff • 150 kg TSS per ML reuse • 2 kg TN per ML reuse • 0.3 kg TP per ML reuse	• Reduced volume and frequency of runoff	• Up to 7ML/ha/yr (irrigation)	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity	Benefits to Council's reputation		2	2	**4**
DM2	Stormwater harvesting for dual reticulation (greenfield)	• $4.50/kL • Further investigation of opportunities required	• $3/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades • Avoided cost for individual household tanks	• Improved water quality, through reduced catchment stormwater runoff • 150 kg TSS per ML reuse • 2 kg TN per ML reuse • 0.3 kg TP per ML reuse	• Reduced volume and frequency of runoff	• Potential water savings, further investigations required	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity			1	2	**3**
DM3	Rainwater harvesting communal tanks (greenfield)	• $10/kL • Further investigation of opportunities required	$3.30/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades • Avoided cost for individual household tanks	• Improved water quality, through reduced catchment stormwater runoff • 20 kg TSS per ML reuse • 2 kg TN per ML reuse • 0.1 kg TP per ML reuse	• Reduced volume and frequency of runoff	• Potential water savings, further investigations required	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity		Further detailed studies required to quantify water savings and water quality benefits	1	2	**3**
DM4	Recycled water supplied to large industrial users	• $3.50/kL • Further investigation of opportunities required as part of sewerage infrastructure investigation, however limited demand anticipated	$2.50/kL	• Potential avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades for water supply	• Improved water quality, through reduced effluent discharge (Victoria Point STP): • 3-10 kg TSS per ML reuse • 1.3-3 kg TN per ML reuse • 3-5 kg TP per ML reuse	• Improved in-stream health • Improved in-stream habitat value	• Potential water savings, further investigations required					1	1	**2**
DM5	Recycled water supplied to urban users (public open space)	• Further investigation of opportunities required as part of sewerage infrastructure investigation	Existing RCC studies	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades for water supply	• Improved water quality, through reduced effluent discharge (Victoria Point STP): • 3-10 kg TSS per ML reuse • 1.3-3 kg TN per ML reuse • 3-5 kg TP per ML reuse	• Improved in-stream health • Improved in-stream habitat value	• Potential water savings, further investigations required	• Potential to improve amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)				1	1	**2**
DM8	Recycled water supplied to urban users (dual reticulation)	• Further investigation of opportunities required as part of sewerage infrastructure investigation	Existing RCC studies	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades for water supply	• Improved water quality, through reduced effluent discharge (Victoria Point STP): • 3-10 kg TSS per ML reuse • 1.3-3 kg TN per ML reuse • 3-5 kg TP per ML reuse	• Improved in-stream health • Improved in-stream habitat value	• Potential water savings, further investigations required	• Potential to improve amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity			1	2	**3**
S	**Sewerage**													
S1	Provide sewerage infrastructure for unsewered areas	•$27.1 Million ($7,900/ET)	•$860,000 ($250/ET)	• Avoided costs for waterway health / groundwater quality remediation	• Protection of receiving waters from nutrients and pathogen contamination • Significant improvement to water quality expected	• Improve waterway health		• Maintain current amenity and recreational values that may be detrimentally affected by poor sewage disposal practices		• Protect public health		1	3	**4**
S2	Inspections and improved management of on site wastewater systems	Minor initial expenditure associated with program, but this is incorporated into annual/ ongoing costs.	• $35,000	• Avoided costs for waterway health / groundwater quality remediation	• Protection of receiving waters from nutrients and pathogen contamination • Signficant improvement to water quality expected	• Improve waterway health		• Maintain current amenity and recreational values that may be detrimentally affected by poor sewage disposal practices	• Community capacity building on operation and maintenance of on site systems • Waterway health educational opportunity	• Protect public health		3	3	**6**
S5	Improve prevention of illegal stormwater inflow connections to sewer	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Potential education opportunity for reducing illegal connections	• Protect public health • Improve Council's reputation		2	2	**4**
S6	Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		2	2	**4**
S7	Sewerage upgrades to improve storage/conveyance of wet weather flows	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		1	2	**3**
S8	Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	Input from Redland Water required		• Avoided clean up cost of sewage overflows • Cost savings from reduced pipe sizes for smart sewers	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Community and developer capacity building opportunity for smart sewers	• Protect public health • Improve Council's reputation		1	2	**3**
S9	Wastewater infrastructure rates charged on mains water consumption basis	Input from Redland Water required			• Potential financial incentive to reduce sewage generation • Primarily protection of receiving waters from nutrients from reduced effluent discharges	• Potential to improve waterway health	• Potential financial incentive to reduce water use		• Assist to educate community about cost of wastewater infrastructure	• Primarily funding mechanism for solutions that improve the performance of sewerage infrastructure		3	1	**4**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
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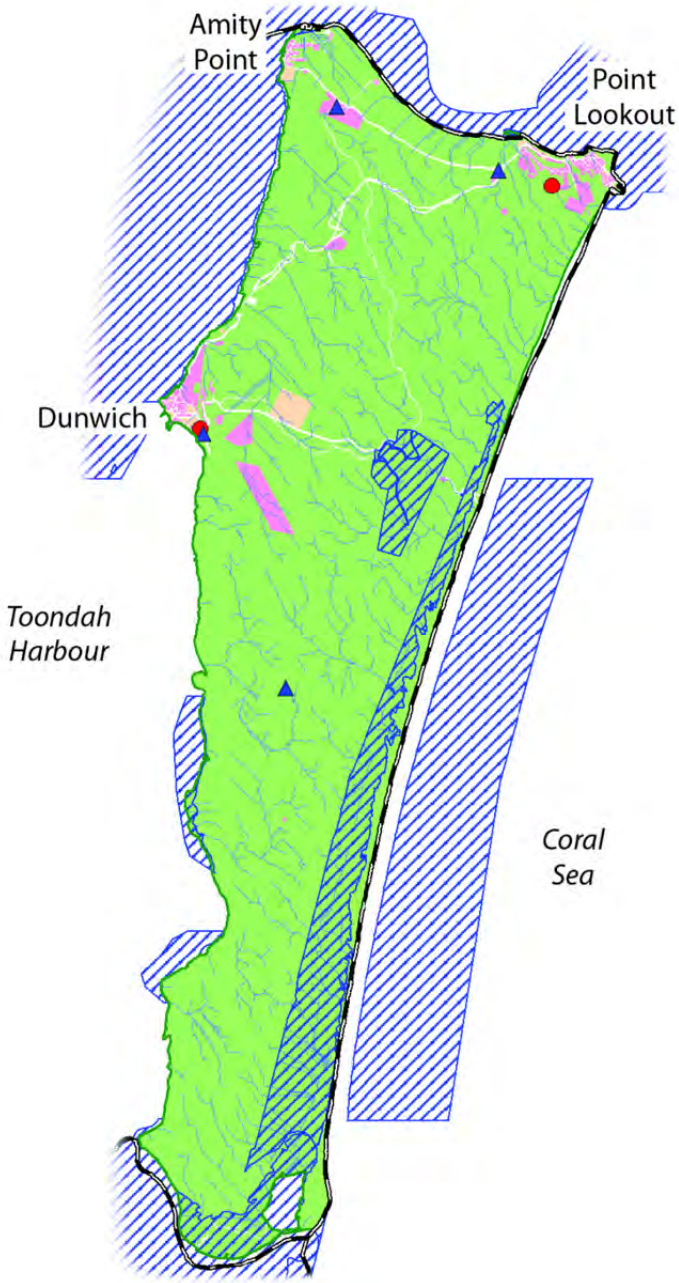
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key 1= Poor 2 = Moderate 3 = Good		
F	**Flooding & Storm tide**													
F1	Flood mitigation investigation/works implemented	• Investigate flood mitigation options $40,000		• Avoided insurance claims • Avoided litigation costs • Avoided clean up costs				Reduced flood impacts to public and private assets		• Protect public health and safety		1	3	**4**
F2	Constraints on future land development to address flooding and storm tide issues	Low, implement through planning scheme		• Avoided insurance claims • Avoided litigation costs • Avoided clean up costs				Reduced flood impacts to public and private assets		• Protect public health and safety		3	3	**6**
F3	Acquisition of land inundated by flooding/storm tide	SMBI land exchange program expenditure for 12/13FY = $1,129,000		• Avoided insurance claims • Avoided litigation costs • Avoided clean up costs				Reduced flood impacts to public and private assets		• Protect public health and safety		2	2	**4**
DC	**Development Control**													
DC1	Cap on population growth	• Low - planning policy. • Poential economic impacts		• Avoid costs associated with upgraded / new infrastructure	• Reduced pressures on water quality	• Reduced pressures on waterway health	• Reduced demand for water				Dependent on planned population growth	2	3	**5**
DC2	Increased restrictions on development extent and intensity for proposed development areas	• Low - planning policy. • Poential economic impacts			• Reduced pressures on water quality	• Reduced pressures on waterway health	• Reduced demand for water	• Increase land area for amenity and recreation			Dependent on planned development	2	3	**5**
DC3	Investigations to more accurately define population growth for future planning purposes	• $100,000 (whole Redlands region)		• More accurate forward planning can result in cost savings from deferred infrastructure upgrades								3	3	**6**
FS	**Funding to Implement Solutions**													
FS1	Develop business case for healthy waterways to support solutions	• $ 80,000 (regional, applies to all catchments)			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through justifying uptake of solutions	• Potential to save water through justifying uptake of solutions	• Potential to improve recreation and amenity values through justifying uptake of solutions	• Opportunity to educate community about the benefits of solutions and increase willingness to pay			3	3	**6**
FS2	Increase / re-prioritise funding to support TWCM solutions	No cost			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through funding uptake of solutions	• Potential to save water through funding uptake of solutions	• Potential to improve recreation and amenity values through funding uptake of solutions		• Funding mechanism to support uptake of solutions		2	3	**5**

North Stradbroke Island Catchment



Legend

- Water treatment plant
- Sewage treatment plant
- Water quality hot spot
- Waterway
- Urban footprint
- Conservation area
- Open space/park
- High ecological value (maintain)
- High ecological value (achieve)
- Local government boundary
- Catchment boundary
- Subcatchment boundary

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key 1= Poor 2 = Moderate 3 = Good		
W	**Waterway Rehabilitation**													
W1	Rehabilitation of waterways - Riparian buffer zones	• Further investigation required to identify need - creek funtional mapping study • $10/m^2 ($100,000/ha).	First 6 months included in rate	• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading)	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset	Literature values used. Site specific investigations required to more accurately estimate	2	2	**4**
W2	Rehabilitation of waterways - Habitat restoration (Council land)	• Further detailed investigation required		• Avoided costs associated with bank stabilisation and flood remediation works • Operational cost savings through volunteer support to manage sites (Community Bushcare Program)	• TSS treatment benefits • Minor nutrient removal benefits • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen control (shading)	• Improved habitat value • Improved in-stream health		• Improved community amenity & recreational benefits • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset		2	1	**3**
W3	Rehabilitation of waterways - Bank Stability Works	• Further detailed investigation required		• Avoided costs associated with flood remediation works	• TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health		• Improved community amenity & recreational benefits				2	2	**4**
W4	Rehabilitation of waterways - In-Stream Improvement works	• Further detailed investigation required		• Avoided costs associated with bank stabilisation and flood remediation works	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved in-stream habitat value		• Improved community amenity & recreational benefits				2	2	**4**
W5	Increased riparian protection for waterways (buffer/waterway corridor widths) e.g. through planning policy, voluntay Conservation Agreements	• Low cost to amend planning policy • Voluntary Conservation Agreements $18,500/yr for all catchments combined		• Avoided waterway rehabilitation and maintenance costs	• Primarily TSS treatment benefits • Minor nutrient removal benefits	• Improved in-stream health • Improved habitat value		• Improved community amenity & recreational benefits, particularly on Council owned land • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity • Potential carbon offset		3	2	**5**
W6	Identify and prioritise waterway fish barrier locations	• $12,000 (Mick Holland to confirm)				• Potential for future improvement to fish passage and ecological health of waterways (if solutions to barriers are identified and implemented).					Note technology may not be available to implement solutions to identified fish barriers	1	1	**2**
W10	Investigations to better define sustainable groundwater yields	• $80,000				Environmental flow & ecological health benefits (for groundwater dependent ecosystems)	Potential for increased availability of water supply	Protection of amenity /recreational values associated with groundwater dependent ecosystems	Will assist to educate all stakeholders by establishing sustainable yields			2	3	**5**
W11	Investigations/monitoring to better define waterway health	$30,000 for ambient monitoring of 30 sites on a quarterly basis ($1K per site)		• Avoided cost for unnecessary works	• Assist to identify targeted water quality improvement strategies	• Assist to identify targeted waterway health improvement strategies		• Improve community connectivity to waterways (through education)	• Results to educate community on waterway health (Waterway Recovery Report)			2	3	**5**
W12	Monitoring to evaluate effectiveness of management solutions	• $1,000 per site (ambient monitoring), study specific		• Savings through identifying cost effective solutions	• Monitoring will assist to confirm the most effective solutions to improve water quality	• Monitoring will assist to confirm the most effective solutions to improve waterway health		• Improve community connectivity to waterways (through education)	• Results to educate community on waterway health (Waterway Recovery Report)			2	3	**5**
D	**Diffuse Pollution Management**													**0**
D1	Increased implementation / enforcement of E&SC management practices and capacity building through education	• $600	• $6,000 ($100,000 for all catchments)	• Avoided waterway rehabilitation and maintenance / monitoring costs • Avoided loss of profits to tourism industry (from decline in waterway health)	• Significant coarse sediment removal • TSS removal performance 40% • Nutrient removal assumed minor • Significant development pressures in this catchment hence significant water quality benefits expected	• Improved habitat value through decreasing water turbidity and protecting sea-grass habitat from being smothered		• Maintain community amenity, recreational and tourism benefits, particularly in receiving waters (Moreton Bay) • Improved connectivity to waterways	• Capacity building and education for council, land developers and contractors			3	3	**6**
D2	Rural BMP for grazing land - fencing off stock & revegetation around 1st & 2nd order streams	• $240,000 ($233 K per km of creek) • Assumed no grazing land in catchment	$340/ha	• Avoided costs associated with bank stabilisation and flood remediation works	• 95% TSS Reduction • 53% TP reduction • Minor TN reduction • Temperature regulation (shading) • Waterweed reduction and dissolved oxygen regulation (due to shading) • Anticipate marginal overall improvement, constitutes 1% of poor waterways in RCC, and 9% of poor waterways within local catchment • Potential to stabilise alluvial soils with high nutrient content	• Improved in-stream health • Improved habitat value		• Improved amenity and passive recreational values • Improved connectivity to waterways • Increased land values	• Community planting and waterway health education opportunities	• Potential flood mitigation benefits to downstream urban areas (through slowing and detaining flows)	• Literature values used. • Site specific investigations required to more accurately estimate • Requires support by private land owners	0	0	**0**
D3	Rural BMP for horticultural land - implementation of filter/buffer strips	• $1,600/ha • Assumed no / minimal horticultura land in catchment	• $390/ha	• Avoided costs associated with waterway rehabilitation works	• 84% Removal TSS • 75% Removal of TP • 70% Removal TN	• Improved in-stream health • Improved in-stream habitat value		• Improved connectivity to waterways	• Community planting and waterway health education opportunities		• Literature values used. • Site specific investigations required to more accurately estimate • Requires support by private land owners	0	0	**0**
D4	Integrate WSUD into government capital infrastructure works e.g. road/ park upgrades	• Unknown, dependent on amount of capital infrastructure works scheduled. • Will be more significantly more cost effective than retrofit, so should be integrated where possible.	$1-5/m2 (bioretention and swales)	• Avoided costs associated with waterway rehabilitation works • Avoided costs to irrigate landscaped areas, as systems self watering	• Depends on extent of capital upgrades in catchment • Typical removal for bioretention systems: 85% TSS; 70% TP and 45% TN removal	• Improved in-stream health • Improved in-stream habitat value	• Potential landscape irrigation water savings	• Improved visual amenity and passive recreational values • Increased land values	• Community planting and waterway health education opportunities	• Potential increased bio-diversity	Effectiveness will depend on uptake through future works, which is unknown.	3	1	**4**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key 1= Poor 2 = Moderate 3 = Good		
D5	Improved waterway health asset management system	• $10,000 to create asset register and maintenance schedule (Approx $100K for whole Redlands region)	$1-5/m2	• $270,000 avoided asset rectification • Avoided costs associated with waterway rehabilitation works	• Optimal treatment performance for well maintained bioretention systems: 85% TSS; 70% TP and 45% TN removal • If not well maintained, could act as a source of pollution • Potential to ensure to moderate level of water quality improvement	• Maintain in-stream health • Maintain in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values			Costing based on bioretention area estimate	3	2	5
D6	Future development to achieve better than SPP Water requirements (for WSUD)	• $1 million	• $10,000	• Avoided costs associated with waterway rehabilitation works	• Achieve no future worsening in catchment pollutant loads i.e. maintain or improve on existing loads generated • High amount of future development hence improvements expected to be significant	• Maintain / improve in-stream health • Maintain / improve in-stream habitat value		• Maintain visual amenity and passive recreational values • Maintain land values	• Community planting and waterway health education opportunities		This solution will be more applicable to catchments with sensitive receiving environments, as it's not as cost effective as traditional WSUD	1	2	3
H	**Pollutant Hot Spot Management**													**0**
H2	Rehabilitation of poorly performing water bodies (e.g. toxic dams/lakes)	• $65,000 to finalise management framework (all catchments) (2013/14) • Additional funding will be dependent on number and type of works required • Identification and mapping of water bodies needs to be undertaken within this catchment,potentially through creek functional mapping investigation	• Dependent on works, however maintenance will be required	• Avoided costs associated with waterway rehabilitation works • Cost savings through nutrient trading scheme	• Note water bodies have been identified as a possible hot spot for pollutant load generation in other catchments • If poorly performing waterbodies are identified, remediation may significantly improve water quality	• Improved in-stream health • Improved habitat value		• Improved amenity, active and passive recreational values • Improved connectivity to waterways • Increased land values	• Waterway health education opportunities on Council owned land (e.g. signage)		Firstly requires assessment and prioritisation of water bodies to rehabilitate	2	2	4
H3	Improved landfill capping /leachate management & treatment systems	• Estimated at $4-7 Million with an approx split of 15%ops 85% capital and 20% contingency	• Current annual trucking operations - $700k to $1.2M	• Avoided costs associated with waterway rehabilitation works	• Note landfills have been identified as a possible hot spot for pollutant load generation in catchment • Potential to greatly improve water quality and reduce landfill contaminants from entering waterways	• Improved in-stream health • Improved habitat value		• Potential to improve amenity and passive recreational values through use of treatment wetlands	• Waterway health education opportunities (e.g. signage)			2	3	5
H4	Investigate sources of hot spot pollution & identify targeted treatment strategies	Minor initial expenditure associated with expanded program, but this is incorporated into annual/ ongoing costs.	• $100,000 for annual program (Assumes 60 sites for whole of Redlands, laboratory expenses comprise 50%)	• Avoided costs associated with waterway rehabilitation works	• No hot spots have been identified as key pollutant generation sources in the catchment, however limited sampling undertaken • Potential to improve water quality.	• Improved in-stream habitat value						3	3	6
H6	Improved management of unsealed roads	• Swale cost $21/m^2	• Swale maintenance costs $2.50/m^2 (grass, less for vegetated)	• Avoided costs associated with waterway rehabilitation works	• Typical water quality improvement for swale systems: 90% TSS; 62% TP and 13% TN removal • Identified as possibly contributing to high pollutant loads	• Improved in-stream health • Improved in-stream habitat value		• Potential to improve amenity and passive recreational values				2	3	5
E	**Education & Capacity Building**													**0**
E1	Education & /or capacity building and investment in incentive schemes	• This will be dependent on the adopted solutions and how they can each be supported. Low anticipated costs. • Currently adopted Habitat Protection Programs may be used to support some solutions. These total $320K and include: • Waterways Extension • Land For Wildlife • Voluntary Conservation Agreement • Rural Support	Low	• Avoided costs associated with improved waterway outcomes	• Potential to improve water quality at low cost	• Potential to improve waterway health (e.g. reduced erosion, silt and weeds, improved riparian vegetation) at low cost	• Potential to save water at low cost	• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Education and capacity building to support other solutions	• Benefits to Council's reputation • Increased stewardship over land	This solution is generic and may be applied in support of other solutions e.g. waterway rehabilitation, WSUD retrofit etc.	3	3	6
E2	Active Extension Programs Idea: Rain gardens in backyards	• $15,000 for program development, may be more if rebates offered • Note could be added to current "Your Backyard Garden" extension program	Low	• Avoided costs associated with waterway rehabilitation works	• Potential to improve water quality at low cost • Typical water quality improvement for rain gardens/ bioretention systems 85% TSS; 70% TP and 45% TN removal • Minor proportion of existing urban area, therefore low potential for improvement	• Improved in-stream health • Improved in-stream habitat value	Potential landscape irrigation water savings		• Significant opportunity for community capacity building and waterway health education	• Benefits to Council's reputation • Increased stewardship over land		2	2	4
E3	Improved marketing around TWCM initiatives	• $5-20K - Basic marketing • $5-50K - Use of Healthy Waterways resources • $60+K - Waterways brand and marketing campaign • $20-$30K - Waterways Festival			• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Encouraging community support of solutions and willingness to pay	• Potential to improve community 'connectivity' to waterways	• Significant opportunity for community education and improved waterway health education • Increased awareness of Council initiatives improves Council's reputation	Benefits to Council's reputation		3	2	5
E4	Encourage the use of Rainwater tanks in existing developed areas for non-potable uses	• $680,000 • Dependent on subsidy and number of houses without tanks that it could be applied to. Cost per lot (5kL tank internally plumbed) $3,560	• $4,000 ($20/ tank)	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• 270 kg/yr TSS • 20 kg/yr TN • 1.7 kg/yr TP	• Improved in-stream health • Improved in-stream habitat value	• 13 ML/yr water savings (70 kL/yr/tank).	• Potential to improve amenity during times when mains water restrictions are in place (i.e. access to rainwater)	• Water conservation educational opportunity	Benefits to Council's reputation	Estimate only, will be largely dependent on community uptake	1	2	3
E5	Improved connectivity to waterways through education & participation in waterway improvement projects	• Low, to be considered in support of other projects e.g. waterway rehabilitation • Note Waterway Extension Program (WEP) provides improved connectivity to waterways through education and onground improvements in hot spot catchments. The total budget for WEP is $141K (12/13).		• Labour costs for planting projects	• Potential to improve water quality at low cost	• Potential to improve waterway health at low cost		• Potential to contribute towards improved amenity and recreation opportunities, and improve community 'connectivity' to waterways	• Opportunity to secure community support for funding solutions through education	Benefits to Council's reputation		3	2	5

	Solution	Costs		Benefits						Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key 1= Poor 2 = Moderate 3 = Good		
E6	Education campaign to address flooding and storm tide issues - Mapping made available to public	• Low $5,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	2	**5**
E7	Education campaign to address flooding and storm tide issues - Include notes on rates	• Low $5,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community	• Benefits to Council's		3	2	**5**
E8	Education campaign to address flooding and storm tide issues - Install historical flood marks/signs	• Low $10,000 (all catchments)		• Cost savings from avoided flood damages					• Opportunity to educate community about properties in danger of flood & storm tide inundation	• Benefits to Council's reputation • Community Safety		3	3	**6**
DM	**Water Supply & Demand Management**													**0**
DM1	Stormwater harvesting for POS	• $2.50/kL • Further investigation of opportunities required	• $1.50/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades	• Improved water quality, through reduced catchment stormwater runoff • 150 kg TSS per ML reuse • 2 kg TN per ML reuse • 0.3 kg TP per ML reuse	• Reduced volume and frequency of runoff	• Up to 7ML/ha/yr (irrigation)	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity	Benefits to Council's reputation		2	2	**4**
DM2	Stormwater harvesting for dual reticulation (greenfield)	• $4.50/kL • Further investigation of opportunities required	• $3/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades • Avoided cost for individual household tanks	• Improved water quality, through reduced catchment stormwater runoff • 150 kg TSS per ML reuse • 2 kg TN per ML reuse • 0.3 kg TP per ML reuse	• Reduced volume and frequency of runoff	• Potential water savings, further investigations required	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity			1	2	**3**
DM3	Rainwater harvesting communal tanks (greenfield)	• $10/kL • Further investigation of opportunities required	$3.30/kL	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades • Avoided cost for individual household tanks	• Improved water quality, through reduced catchment stormwater runoff • 20 kg TSS per ML reuse • 2 kg TN per ML reuse • 0.1 kg TP per ML reuse	• Reduced volume and frequency of runoff	• Potential water savings, further investigations required	• Improved amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity		Further detailed studies required to quantify water savings and water quality benefits	1	2	**3**
DM4	Recycled water supplied to large agricultural/ industrial users	• $3.50/kL • Further investigation of opportunities required however limited demand anticipated	$2.50/kL	• Potential avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades for water supply	• Improved water quality, through reduced effluent discharge: • 3-30 kg TSS per ML reuse • 2.6-12.5 kg TN per ML reuse • 0.8-6 kg TP per ML reuse	• Improved in-stream health • Improved in-stream habitat value	• Potential water savings, further investigations required					2	1	**3**
DM5	Recycled water supplied to urban users (public open space)	• Further investigation of opportunities required	Existing RCC studies	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades for water supply	• Improved water quality, through reduced effluent discharge: • 3-30 kg TSS per ML reuse • 2.6-12.5 kg TN per ML reuse • 0.8-6 kg TP per ML reuse	• Improved in-stream health • Improved in-stream habitat value	• Potential water savings, further investigations required	• Potential to improve amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)				1	2	**3**
DM6	Recycled water disposed to land or irrigated to woodlots (note limited feasible due to koala habitat & land shortage)	• Further investigation of opportunities required	Existing RCC studies	• Potential avoided costs associated with waterway rehabilitation works	• Improved water quality, through reduced effluent discharge: • 3-30 kg TSS per ML reuse • 2.6-12.5 kg TN per ML reuse • 0.8-6 kg TP per ML reuse	• Improved in-stream health • Improved in-stream habitat value	N/A	• Potential to improve visual amenity through woodlot planting	• Potential waterway health education opportunity for woodlot reuse	• Carbon offset benefits for woodlots • Increased biodiversity for woodlots • Potential to Improve habitat connectivity for woodlots		2	1	**3**
DM8	Recycled water supplied to urban users (dual reticulation)	• Further investigation of opportunities required	Existing RCC studies	• Avoided costs associated with waterway rehabilitation works, potable water savings and delayed regional infrastructure upgrades for water supply	• Improved water quality, through reduced effluent discharge: • 3-30 kg TSS per ML reuse • 2.6-12.5 kg TN per ML reuse • 0.8-6 kg TP per ML reuse	• Improved in-stream health • Improved in-stream habitat value	• Potential water savings, further investigations required	• Potential to improve amenity and recreational values during times when mains water restrictions are in place (i.e. access to alternative supply source)	• Water conservation educational opportunity			1	2	**3**
DM10	Investigate and reduce leakage 'losses' from potable water infrastructure	• Current annual operational budget that funds flow & pressure monitors is $130K. • On top of that budget need to do the analysis which would be an internal wage cost (relatively minimal). • Also leak sweep the identified problem area – approx $200/km of watermain. • Repairs additional cost dependent on issue		• Avoided cost of water losses. Likely to be small.			• Water savings. Likely to be low (as leakage currently low)		• Water conservation educational opportunity	• Benefits to Council's reputation		2	3	**5**
DM11	Desalination plant for water supply	• $2.00 - $3.50/kL			• Potential negative impact on water quality from saline discharge	• Negative impact on waterway health from saline discharge	• No water savings, however provides security of supply	• Potential to improve amenity and recreational values through security of supply during times of drought	• Water treatment technology educational opportunity	• Negative impact from high carbon generation		1	3	**4**
DM12	New/ upgraded water supply infrastructure (e.g. dams, weirs, pipeline, bores)	Dependent on source - unknown	Dependent on source - unknown			• Potential to have a negative impact on waterway health (e.g. dams)	• No water savings, new supply source	• Potential to maintain amenity and recreational values through security of supply				1	3	**4**

	Solution	Costs		Benefits							Notes/ Comment	Prioritisation		
		Capital	Annual O&M	Potential Cost Savings	Environmental		Social			Other		Cost	Benefits	Score
					Water Quality	Waterway Health	Water savings	Amenity and Recreation	Education			Performance Key 1= Poor 2 = Moderate 3 = Good		
S	**Sewerage**													**0**
S2	Inspections and improved management of on site wastewater systems	Council cost estimate per household x number on site systems (Brad Taylor?)	Brad Taylor?	• Avoided costs for waterway health / groundwater quality remediation	• Protection of receiving waters from nutrients and pathogen contamination • Moderate improvement to water quality expected	• Improve waterway health	• Potential to protect drinking water supplies (groundwater)	• Maintain current amenity and recreational values that may be detrimentally affected by poor sewage disposal practices	• Community capacity building on operation and maintenance of on site systems • Waterway health educational opportunity	• Protect public health		3	3	**6**
S3	Improved nutrient treatment processes of STPs (Dunwich and Point Lookout)	Minor initial expenditure associated with program, but this is incorporated into annual/ ongoing costs.	• $35,000	• Avoided costs associated with waterway rehabilitation works (e.g. lyngbya clean up costs). • Avoided loss of profits to tourism industry (from decline in waterway health)	• Nutrient removal benefits	• Improve waterway health		• Maintain amenity and recreational values (e.g. through reduced lyngbya outbreaks)		• Protect public health through reduced lyngbya outbreaks		1	3	**4**
S5	Improve prevention of illegal stormwater inflow connections to sewer	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and	• Potential education opportunity for	• Protect public health		2	2	**4**
S6	Pump station EMPs / upgrades to reduce likelihood of wet weather overflow	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		2	2	**4**
S7	Sewerage upgrades to improve storage/conveyance of wet weather flows	Input from Redland Water required		• Avoided clean up cost of sewage overflows	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows		• Protect public health • Improve Council's reputation		1	2	**3**
S8	Reduction of wet weather infiltration to sewerage infrastructure (through rehabilitation/smart sewers)	Input from Redland Water required		• Avoided clean up cost of sewage overflows • Cost savings from reduced pipe sizes for smart sewers	• Primarily protection of receiving waters from nutrients and faecal contamination	• Potential to improve waterway health		• Potential to improve current amenity and recreational values by decreasing incidence of sewage overflows	• Community and developer capacity building opportunity for smart sewers	• Protect public health • Improve Council's reputation		1	2	**3**
S9	Wastewater infrastructure rates charged on mains water consumption basis	Input from Redland Water required			• Potential financial incentive to reduce sewage generation • Primarily protection of receiving waters from nutrients from reduced effluent discharges	• Potential to improve waterway health	• Potential financial incentive to reduce water use		• Assist to educate community about cost of wastewater infrastructure	• Primarily funding mechanism for solutions that improve the performance of sewerage infrastructure		3	1	**4**
S10	Further investigate sustainable wastewater treatment options for new development	Input from Redland Water required		• Savings from investigating the least cost solution	• Primarily protection of receiving waters from nutrients	• Potential to improve waterway health		• Potential to maintain current amenity and recreational values that may be detrimentally affected by poor sewage disposal practices				1	3	**4**
F	**Flooding & Storm tide**													**0**
F1	Flood mitigation investigation/works implemented	• Investigate storm tide mitigation options $40,000		• Avoided insurance claims • Avoided litigation costs • Avoided clean up costs				Reduced flood impacts to public and private assets		• Protect public health and safety		1	3	**4**
F2	Constraints on future land development to address flooding and storm tide issues	Low, implement through planning scheme		• Avoided insurance claims • Avoided litigation costs • Avoided clean up costs				Reduced flood impacts to public and private assets		• Protect public health and safety		3	3	**6**
F3	Acquisition of land inundated by flooding/storm tide	• $1 Million land aquisition / substitution program		• Avoided insurance claims • Avoided litigation costs • Avoided clean up costs				Reduced flood impacts to public and private assets		• Protect public health and safety		1	3	**4**
DC	**Development Control**													**0**
DC1	Cap on population growth	• Low - planning policy. • Poential economic impacts		• Avoid costs associated with upgraded / new infrastructure	• Reduced pressures on water quality	• Reduced pressures on waterway health	• Reduced demand for water				Dependent on planned population growth	2	3	**5**
DC2	Increased restrictions on development extent and intensity for proposed development areas	• Low - planning policy. • Poential economic impacts			• Reduced pressures on water quality	• Reduced pressures on waterway health	• Reduced demand for water	• Increase land area for amenity and recreation			Dependent on planned development	2	2	**4**
DC3	Investigations to more accurately define population growth for future planning purposes	• $100,000 (whole Redlands region)		• More accurate forward planning can result in cost savings from deferred infrastructure upgrades								3	3	**6**
FS	**Funding to Implement Solutions**													**0**
FS1	Develop business case for healthy waterways to support solutions	• $ 80,000 (regional, applies to all catchments)			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through justifying uptake of solutions	• Potential to save water through justifying uptake of solutions	• Potential to improve recreation and amenity values through justifying uptake of solutions	• Opportunity to educate community about the benefits of solutions and increase willingness to pay			3	3	**6**
FS2	Increase / re-prioritise funding to support TWCM solutions	No cost			• Potential to improve water quality through funding uptake of solutions	• Potential to improve waterway health through funding uptake of solutions	• Potential to save water through funding uptake of solutions	• Potential to improve recreation and amenity values through funding uptake of solutions		• Funding mechanism to support uptake of solutions		2	3	**5**

Appendix G

Detailed Planning Assessment Options & Criteria

APPENDIX G: DETAILED PLANNING ASSESSMENT OPTIONS AND CRITERIA

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Dear Tim

RE: OPTIONS FOR ASSESSING SOLUTIONS - DETAILED PLANNING

The following provides an outline of two key options available to Council for assessing preferred solutions during the detailed Total Water Cycle Management (TWCM) planning stage. This has been prepared in accordance with our proposal for developing a TWCM Plan for Redland City Council (BMT WBM, 2011).

Option 1 - Multi Criteria Analysis

Multi Criteria Analysis (MCA) is a management tool that allows the incorporation of monetary and non-monetary data of various options by assigning scores and weights to criteria used to assess the various options. The MCA framework uses the multiple criteria to assess sustainability impacts, rather than using economic evaluation methods.

The weights express the importance of each criteria effect to the decision-maker or stakeholders. A key feature of MCA is the emphasis on the judgment of the decision-making team. This judgment needs to be exercised in establishing objectives and criteria, estimating the relative importance (weights) of criteria and in judging the contribution of each option to each performance criterion (scoring).

The MCA process should be undertaken through workshops with key stakeholders and experts.

The key steps undertaken in the MCA process include:

1. Develop and agree on the list of criteria for evaluating the solutions;

2. Determine the relative importance and weighting of the assessment criteria;
3. Score the impact of the solutions with respect to each criteria;
4. Combine the scores for each criteria with the criteria weighting to provide an overall score for each solution; and
5. Select the preferred solution set for each catchment.

These steps are discussed in more detail below.

Step 1 Develop Criteria for Evaluating the Solutions

The criteria should be developed to reflect the TWCM objectives that Redland City Council have developed. As part of the TWCM planning process, we have developed draft criteria that may be used for assessing the solutions (refer to Attachment 1). Criteria with which to assess the performance of each solution were developed around quadruple bottom line principles and include the following four criteria categories, in line with Council's quadruple' bottom line sustainability principles:

- Environment;
- Social;
- Economic; and
- Governance

Step 2 Weighting the Criteria

The relative importance and weighting of each criteria category (environmental, social and economic) and the individual criteria within each criteria category should be assigned through a workshop with key stakeholders and experts. The sum of the criteria categories should be 100% (e.g. equal weighting would be 25% for Environment, Social, Economic and Governance) and the sum of the individual criteria (within each category) should also equal 100%. An example of the criteria category and individual criteria weighting is shown in Table 1. Table 1 shows equal weighting applied to each criteria category and individual criteria as an example only.

Table 1 Example of MCA Criteria Weighting

Criteria Category & Weighting	Criteria	Individual Criteria Weighting
Environmental Weighting = 25%	*Environmental Criteria 1*	50%
	Environmental Criteria 2	50%
	Total Environmental Criteria Weighting	*100%*
Social Weighting = 25%	*Social Criteria 1*	50%
	Social Criteria 2	50%
	Total Social Criteria Weighting	*100%*
Economic Weighting = 25%	*Economic Criteria 1*	50%
	Economic Criteria 2	50%
	Total Economic Criteria Weighting	*100%*
Governance Weighting = 25%	*Governance Criteria 1*	50%
	Governance Criteria 2	50%
	Total Governance Criteria Weighting	*100%*

Sensitivity tests should be undertaken when evaluating options to assess how changing the weighting for criteria categories affects the preferred options.

Step 3 Scoring the Options

To score options, a criteria performance matrix will first need to be developed from collected or derived data for each option (through detailed planning studies). The criteria performance may be documented using quantitative data, where the performance can be measured, and qualitative data where the performance is not easily quantified.

Where the scoring is qualitative, clear performance descriptions should be developed to help minimise subjectivity in assessment. It is recommended the qualitative scoring of solutions should be undertaken through workshops with key stakeholders and experts using a consensus method. That is, each solution is discussed and debated in terms of how it satisfies the criteria, and is scored by the workshop facilitator with the consensus of workshop participants.

The performance results for each criterion will need to be normalised before any criteria weighting factors are applied. This process converts the criteria performance results into uniform, dimensionless numbers or 'scores' for further analysis. Some approaches for scoring the criteria are described in Table 2 (from the TWCM Planning Guidelines developed by DERM, 2010). The selected method of converting performance results into scores may depend on the availability of data.

Table 2: Approaches to convert performance results into scores (DERM, 2010)

Approach	Description
Min-Max approach	The best indicator result gets the highest score of 100, while the worst indicator result scores lowest (i.e. 0). All indicator results in between are scaled in a linear manner.
Ranges approach	For each indicator, minimum and maximum boundaries might be defined if more sophisticated information is available (from similar previous projects) on what is technically achievable. For example, options under consideration may perform better than worst case, but they may be inferior to the best available technology. In this case the option would be scored higher than 0 but less than 100 when applying the value function.
Distance-to-target approach	The distance-to-target weighting method ranks criteria performance as being more important the further away it is from achieving aspirational targets. This approach can be applied when unambiguous aspirational targets are defined.

Step 4 Calculation of Overall Weighted Scores

Once the initial scoring is completed (Step 3), the weighted score is then calculated for each criteria score. The weighted score adjusts the scoring for each criteria based on the relative importance of the individual criteria and the criteria category:

Weighted Criteria Score = Original Score x Criteria Category Weighting x Individual Criteria Weighting

The overall weighted score of each option is then estimated by applying the following calculation:

Overall Weighted Score of Option X = Sum of the Weighted Scores of Criteria 1 to Criteria n of Option X

Step 5 Selection of Preferred Options

The highest scoring option for each catchment would then be selected as the preferred management option, taking into consideration results of the sensitivity analysis.

Option 2 - Extended cost effectiveness analysis

The principles of extended cost effectiveness analysis are outlined in the National Water Commission's *Integrated resource planning for urban water —resource papers* (NWC, 2011). The key characteristic of the extended cost effectiveness framework is that it is used for comparing alternative options for meeting the same objective.

Extended cost effectiveness analysis differs from MCA in that it uses economic evaluation methods for assessing sustainability impacts (as 'externalities') using the single criterion of dollars. By doing this, the least-cost set of options to meet the required goal can be selected. The key difficulty in using this method is due to constraints on measuring and costing externalities such as the impact to biodiversity, recreational and amenity values.

For an economic valuation of externalities, NWC (2011) first recommends identifying the sustainability impacts through mapping how an option's attributes might cause changes to environmental or biophysical conditions, and then how those changes would affect various stakeholder groups. The next step is to determine the physical magnitude of the sustainability impact so that it can then be valued.

As part of an investigation for the Urban Water Security Research Alliance (UWSRA), Hall et al (draft 2012) provides a case study (using data from the Moreton Bay Regional Council TWCM planning study) which demonstrates how pollution costs may be used in extended cost effectiveness analysis for TWCM planning. The study considers pollutant abatement costs for greenhouse gases, nutrients and sediments. Equation 1 expresses the extended cost effectiveness calculation proposed:

Equation 1.

$$Y = C_p + O_p + \sum_{j}^{m} P_j . W_j$$

Where
Y = extended cost effectiveness
C_p = capital cost of a project
O_p = operating cost of a project over the period of analysis
P_j = pollution emitted by the project
W_j = value of pollution for a defined pollution reduction target
j = first pollutant considered
m = last pollutant considered

Pollutant costs were developed using pollutant targets and marginal abatement cost curves developed by Hall in another UWSRA study that is currently in press. Further guidance on this approach will become available once this study is published.

As outlined above, extended cost effectiveness analysis assists with options evaluation by assigning costs to externalities (such as water quality pollutants) to assist in choosing the least cost option for total water cycle management planning.

Attached: Draft Criteria for MCA

Criteria Category	Criteria	Criteria Description
Environmental	Changes in water quality in inland water systems, as well as changes to biodiversity, and bed and bank integrity	What impact does the solution have on: • The water quality of receiving waterways (suspended solids & nutrients) • Ecological health (riparian and in stream) • Environmental values in freshwater systems • Water quality in drinking water catchments
	Changes in hydrology	What impact does the solution have on: • natural flow regimes (surface water & groundwater), including changes to baseflow in waterways (which is maintained through gradual inflows from groundwater) • changes to mean annual flow volume (e.g. from stormwater harvesting, STP discharges, surface water extraction) • changes to flow frequency, peak flows and flow velocities
	Changes to water quality and biodiversity in estuaries and Moreton Bay	What impact does the solution have on: • Environmental Values and water quality in estuaries and Moreton Bay • Critical habitats, marine species and key ecological processes • Urban and non-urban diffuse and point source pollution entering Moreton Bay
	Changes in emissions of greenhouse gases	Are there any increases/decreases in greenhouse gas emissions as a result of changes in potable water production, wastewater and stormwater treatment (e.g. treatment infrastructure energy requirements)? Consider the amount of embodied energy (e.g. energy to produce, maintain and decommission infrastructure) associated with the solution.
	Impact on environmentally sensitive values	What impact does the solution have on environmentally sensitive values (e.g. protected and/or threatened species and High Environmental Value ecosystems)?
Social	Impacts on water supply	Does the solution have an impact on the ability to maintain a sufficient and reliable water supply to support a comfortable, sustainable and prosperous lifestyle, while meeting urban, rural and environmental needs?
	Impacts on human health	What impact does the solution have on: • The day-to-day continuity of a safe, quality water supply • Community wellbeing (e.g. displacement and/or other disturbance such as algae bloom) • Environmental health (e.g. air, noise, light nuisances) Also, what risk does the solution pose to human health from alternate sources of water (e.g. such as stormwater harvesting)
	Impacts on flooding/storm tide hazard	What impact does the solution have on communities from increased flooding hazard as a result of: • urbanisation • changes to flow paths • changes in waterway geomorphology
	Level of community understanding, engagement and ownership	Does the solution provide an opportunity for community involvement and education?
	Public acceptability	What is the general level of public acceptability for the solution – in terms of the perceived environmental, social and economic impacts (i.e. is it affordable to the public)? Consideration should be given to those directly, indirectly and not affected by the solution.

Financial	Financial impacts on RCC – Outlays, capital and operating expenditure and revenue	What financial impacts does the solution have on MBRC/Unitywater, including: • Capital costs in constructing/installing infrastructure? • Operating and maintenance costs over the lifetime of the infrastructure? • Potential revenue for MBRC from community use of the infrastructure? • Cost savings to MBRC through deferment or avoidance of infrastructure upgrades and/or construction?
	Financial impacts including costs and cost savings on consumers (e.g. infrastructure charges) and other organisations	What financial impacts does the solution have on the community, in terms of: • Increased rates? • Increased infrastructure charges? • Housing affordability? • Cost savings to the community from implementation of the solution (e.g. avoidance of increased rates
	Impacts on local industries that rely on the environment (Fisheries, tourism)	Due to changes in water quality and quantity in waterways and Moreton Bay, what financial impacts does the solution have on local industries such as fisheries or tourism which rely on the environment for income?
	Employment	What financial impacts does the solution have on: • employment in the region (e.g. jobs creation through creation of new industry, or job losses from loss of an industry)?
Governance	Engaging communities	Does the solution: • Provide accessible information (through different media) to let residents know about local issues and how to get involved in programs? • Engage with community to seek their views about plans and decisions affecting them?

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