# Total Water Cycle Management Plan for Moreton Bay Regional Council

**Final Report June 2012**

# Total Water Cycle Management Plan for Moreton Bay Regional Council

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| Prepared For: | Moreton Bay Regional Council |
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| **BMT WBM Pty Ltd**<br>BMT WBM Pty Ltd<br>Level 8, 200 Creek Street<br>Brisbane 4000<br>Queensland Australia<br>PO Box 203 Spring Hill 4004<br><br>Tel: +61 7 3831 6744<br>Fax: + 61 7 3832 3627<br><br>ABN 54 010 830 421<br><br>www.wbmpl.com.au | ***Document :*** R.B18282.002.02.TWCMP.doc<br><br>***Project Manager :*** Nicole Ramilo<br><br>***Client :*** Moreton Bay Regional Council<br><br>***Client Contact:*** Lavanya Susarla<br><br>***Client Reference*** |
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| ***Title*** : | Total Water Cycle Management Plan for Moreton Bay Regional Council |
| ***Author :*** | Nicole Ramilo, Brad Grant |
| ***Synopsis :*** | This document presents the results of detailed planning investigations undertaken to develop a Total Water Cycle Management Plan for MBRC. It forms Phase 2 of the TWCM planning process, required by the *Environmental Protection (Water) Policy 2009*. Phase 1 involved the development of a TWCM Strategy, which forms the basis of the detailed planning investigations undertaken in this report. |

## REVISION/CHECKING HISTORY

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# ACRONYMS

**ADWF:** Average Dry Weather Flow

**ASR:** Aquifer Storage and Recovery

**AWTP:** Advanced Wastewater Treatment Plant

**BAU:** Business As Usual

**BMP:** Best Management Practice

**CAPEX:** Capital Expenditure

**CIGA:** Caboolture Identified Growth Area

**DCCEE:** Department of Climate Change and Energy Efficiency

**DERM:** Department of Environment and Resource Management

**DIP:** Department of Infrastructure and Planning

**E&SC:** Erosion and Sediment Control

**EHMP:** Ecosystem Health Monitoring Program

**EMC:** Event Mean Concentration

**EP:** Equivalent Person

**EPP Water:** Environmental Protection (Water) Policy 2009

**ET:** Equivalent Tenement

**GHG:** Greenhouse Gas

**IPR:** Indirect Potable Reuse

**LDAP:** Local Development Area Plan

**LGA:** Local Government Area

**MBRC:** Moreton Bay Regional Council

**MCA:** Multi Criteria Assessment

**MUSIC:** Model for Urban Stormwater Improvement Conceptualisation

**NGC:** Northern Growth Corridor

**NPV:** Net Present Value

**O&M:** Operation and Maintenance

**OPEX:** Operational expenditure

**PRW:** Purified Recycled Water

**QDC:** Queensland Development Code

**QWC:** Queensland Water Commission

**POS:** Public Open Space

**RO:** Reverse Osmosis

**ROC:** Reverse Osmosis Concentrate

**RWQM:** Receiving Water Quality Model

**SCAG:** Strategic Coordination Advisory Group

**SEQ:** South East Queensland

**SPA:** Sustainable Planning Act 2009

**SPP HW:** State Planning Policy for Healthy Waters

**STP:** Sewage Treatment Plant

**TBL:** Triple Bottom Line

**TN:** Total Nitrogen

**TOD:** Transit-Orientated Development

**TP:** Total Phosphorus

**TSS:** Total Suspended Solids

**TWCM:** Total Water Cycle Management

**UV:** Ultra Violet

**WQO:** Water Quality Objective

**WSUD:** Water Sensitive Urban Design

# EXECUTIVE SUMMARY

This Total Water Cycle Management (TWCM) Plan presents the findings from the detailed planning phase in a TWCM planning process for the Moreton Bay Regional Council (MBRC) area. It has been developed in accordance with *the TWCM Planning Guideline for South East Queensland* (WBD, 2010a) in order to satisfy requirements of the *Environmental Protection (Water) Policy (2009).*

This document builds on the initial phase of the process which was the development of a TWCM Strategy, prepared in 2010 (BMT WBM, 2010). The TWCM Plan represents the second phase in a four phase process, which is:

- **Phase 1: Preparation of a TWCM Strategy document.** This involved the identification of water cycle management drivers and issues in the MBRC region, development of solutions to address the identified issues, and preliminary assessment of these solutions resulting in a short list of solutions for further detailed analysis in Phase 2.
- **Phase 2: Preparation of the final TWCM Plan (this document).** This phase involves a detailed assessment of the costs and benefits of total water cycle management solutions developed in Phase 1. It identifies a preferred management scenario for each catchment to assist with Council's priority infrastructure planning.
- **Phase 3: Preparation of an Implementation Plan**. This plan will identify the implementation pathways for the preferred management scenarios identified in phase 2, including costs and benefits.
- **Phase 4: Preparation of a Monitoring and Review Plan**. This plan will include development of monitoring programs to measure the efficacy of the proposed management scenarios and inform the TWCM review process.

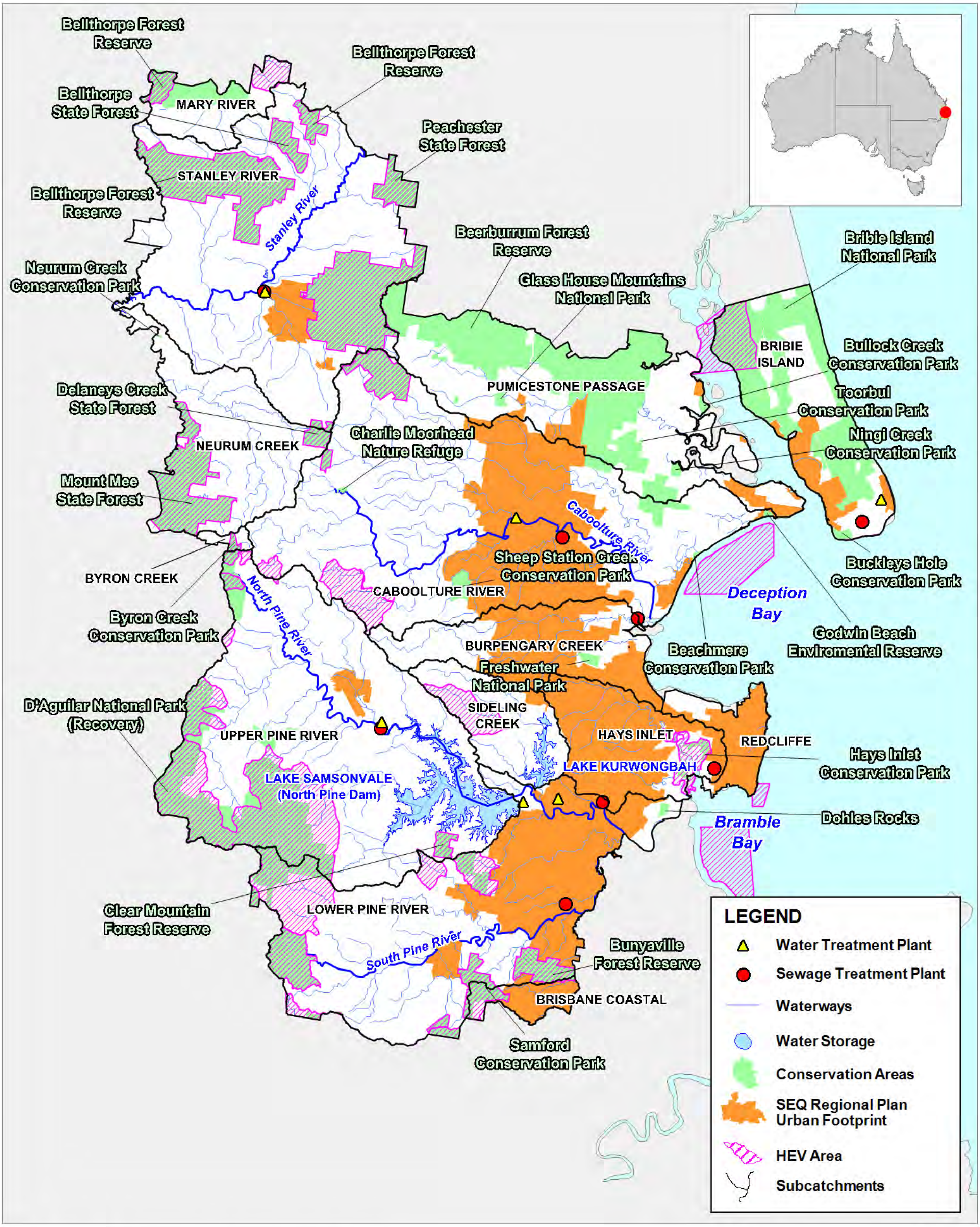
Some of the key findings of Phase 1 are outlined in this TWCM Plan to provide some background to the project, however the reader is referred to the Phase 1 Strategy report (BMT WBM, 2010) for detailed documentation.

The detailed planning study area and key catchment characteristics are summarised in Table E-1 and Figure E-1. It is noted that the Mary River, Byron Creek and Neurum Creek catchments are not included in the detailed planning area, as no key water management issues were identified for these catchments during Phase 1.

**Table E- 1 Key Characteristics of Detailed Planning Area**

| Catchment | Area (ha) | Residential Population[1] | | Land Use [2] | | Water Treatment Plant | Sewage Treatment Plant | Potable Water Storage |
|---|---|---|---|---|---|---|---|---|
| | | 2010 | 2031 | Urban | Rural[4] | | | |
| Bribie Island | 10,710[3] | 17,133 | 21,830 | 11% | 89% | Banksia Beach WTP | Bribie Island STP | Bribie Island Borefields |
| Pumicestone Passage | 18,480[3] | 11,415 | 12,183 | 9% | 91% | - | - | - |
| Redcliffe | 2,662 | 49,638 | 72,858 | 73% | 27% | - | - | - |
| Caboolture River [6] | 34,830 | 69,546 | 112,227 | 20% | 80% | Caboolture WTP | South Caboolture and Burpengary East STPs | Caboolture Weir |
| CIGA | 4,160 | 0 | 52,500 | 73% | 27% | - | New STP Required | - |
| Burpengary Creek | 8,435 | 42,766 | 64,396 | 33% | 67% | - | - | - |
| Hays Inlet | 7,599 | 63,613 | 111,641 | 56% | 44% | - | Redcliffe STP[5] | - |
| Brisbane Coastal | 1,530 | 22,601 | 24,058 | 39% | 61% | - | - | - |
| Sideling Creek | 5,267 | 1,397 | 2,609 | 11% | 89% | Petrie WTP | - | Lake Kurwongbah |
| Lower Pine River | 28,280 | 90,695 | 132,974 | 21% | 79% | - | Murrumba Downs and Brendale STPs | - |
| Upper Pine River | 34,890 | 2,014 | 3,223 | 3% | 97% | North Pine and Dayboro WTPs | Dayboro STP | North Pine Dam, Dayboro Borefields |
| Stanley River | 31,830 | 4,073 | 8,642 | 3% | 97% | Woodford WTP | Woodford STP | Woodford Weir |

Notes:
[1]Population sourced from Unitywater Demand Model (Residential EP)
[2] Land use based on 2031 mapping for medium growth scenario ('Scenario 3 Medium – Low Density')
[3] Does not include area outside of MBRC's jurisdiction
[4] This includes green space
[5]While the Redcliffe STP is physically located in Hays Catchment, Murrumba Downs STP treats the majority of wastewater generated in this catchment
[6] Future population figure does not include the Caboolture Investigation Growth Area (CIGA)




Title:
## Key Catchment Characteristics

Figure: E-1

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Solution Feasibility Assessment

The TWCM Strategy developed in Phase 1 identified the top ranking solutions (using Multi Criteria Analysis) for each catchment to address the key water cycle management issues identified in each catchment. These solutions were recommended for further investigation in the detailed planning phase of the project (this study).

To commence the detailed planning phase, solution feasibility assessment workshops were undertaken with key stakeholders (MBRC and Unitywater) to assist in screening and selecting refined solution sets (from those identified in Phase 1) for each catchment. During the workshops, shortlisted solutions for each catchment identified in Phase 1 were examined in more detail using the input, expertise and local knowledge of workshop participants to identify the benefits, constraints, risks and opportunities associated with all of the solutions in each catchment. The workshop assessment resulted in an improved understanding of the opportunities for solutions to be implemented in each catchment.

Selection of Management Scenarios

Management scenarios for each catchment were then developed consisting of a combination of individual solutions ('solutions sets') at targeted locations throughout the catchments using information gained through the feasibility assessment workshops.

Three incremental management scenarios were developed for each catchment, each one building upon the previous solution set (unless there were competing demands, in which case a solution may be replaced). This way the efficacy and value of incorporating additional management measures could be easily assessed using our modelling framework. The three management scenarios investigated for each catchment included:

1. **Low Intensity**: These management scenarios included those solutions deemed to reflect "business as usual", that is compliance with pollutant load reduction targets for new development under the State Planning Policy for Healthy Waters (SPP HW), and water saving targets required by the Queensland Development Code (QDC).

2. **Medium Intensity:** These management scenarios added those solutions identified in each catchment as 'easy to do' and most preferred (considered most cost effective opportunities, low risks) as a result of stakeholder feasibility assessment workshops.

3. **High Intensity:** These management scenarios will then add those solutions that may be considered to stretch the limits in terms of the expected costs and risks identified during the solution feasibility workshops.

A summary of the management scenarios developed for assessment in each catchment is detailed in Table E-2.

**Table E- 2 Solutions and Management Scenarios**

| Management Scenarios | Catchment | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stanley | Pumicestone | Bribie | Caboolture | CIGA | Burpengary | Upper Pine | Lower Pine | Sideling | Hays | Redcliffe | Brisbane Coastal |
| **Scenario 1: Low Intensity** | | | | | | | | | | | | |
| Future development meets 80/60/45% load reduction for TSS/TP/TN | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Future development meets QDC alternative water supply mandate | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| **Scenario 2: Medium Intensity** | | | | | | | | | | | | |
| Increased implementation / enforcement of E&SC management practices | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Waterway riparian revegetation of 3rd & 4th order streams | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| Rural BMP for grazing land - revegetation of 1st & 2nd order streams | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | | | |
| Rural BMP for horticultural land - implementation of filter/buffer strips | ✓ | ✓ | | ✓ | | | ✓ | ✓ | ✓ | | | |
| Education & /or capacity building and investment in incentive schemes | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Prevention of illegal stormwater inflow connections to sewer | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | |
| Recycled water supplied to land / agricultural users | ✓ | | | ✓ | | | | | | | | |
| Recycled water supplied to urban users | | | | | ✓ | | | ✓ | | ✓ | | |
| **Scenario 3: High Intensity** | | | | | | | | | | | | |
| WSUD retrofit to existing urban areas | | ✓ | ✓ | ✓ | | ✓ | | ✓ | | ✓ | ✓ | ✓ |
| Future greenfield development WSUD measures achieve 'no worsening' | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | |
| Recycled water supplied to urban users | | | | ✓ | | | | | | | | |
| Large-scale stormwater harvesting for non-potable use (greenfield sites) | ✓ | | | | ✓ | ✓ | | ✓ | | ✓ | ✓ | |
| Indirect potable reuse of Purified Recycled Water (PRW) | | | | | ✓ | | | ✓ | | | | |
| Rainwater tanks retrofitted to existing urban areas for non-potable use | | ✓ | ✓ | | | | | | | | ✓ | ✓ |

Development of Modelling Framework

To quantify the performance of individual solutions, and management scenarios in later sections, the development of an integrated water cycle, catchment and receiving water quality modelling framework was necessary. This modelling framework consisted of a suite of models including catchment models, receiving water quality models and smaller scale urban water balance and urban water quality models.

The catchment modelling software package applied is eWater's Source Catchments, and this model was used to determine flows and pollutant loads being delivered from the catchment, including diffuse loads (e.g. stormwater runoff) and point source loads (e.g. sewage treatment plants).

Flows and loads from the catchment model were used to force a receiving water quality model (version 2 of the HWP Receiving Water Quality Model (RWQM) (i.e. RWQM2)) to determine the behaviour and concentrations of pollutants in the study area estuary and Moreton Bay for comparisons with relevant WQO's.

Smaller scale catchment and urban water balance models were developed to assess each individual solution in terms of stormwater discharge reductions and the extent of potential water source substitution (e.g. yield from rainwater tanks, impacts of water recycling schemes, etc). The modelling software applied included eWater's MUSIC (Model for Urban Stormwater Improvement Conceptualisation) and Urban Developer, with these software packages being driven by locally appropriate hydrologic, water use and pollutant export parameterisations.

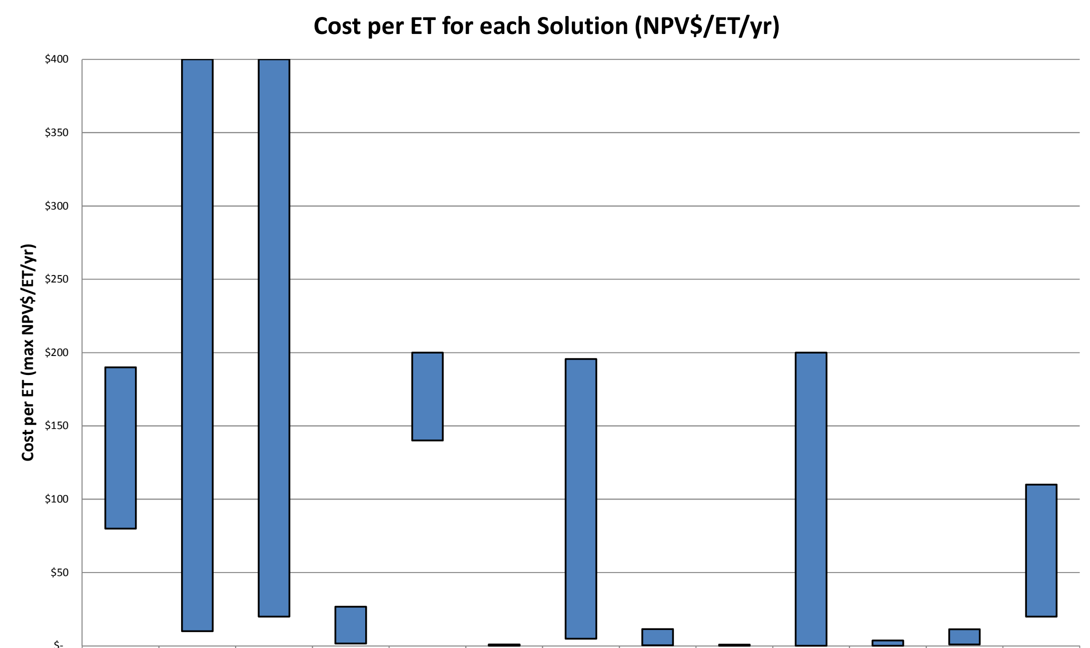
Assessment of Individual Solution Performance

The costs and benefits of individual solutions proposed for each catchment were assessed by quantifying the net present value, potable water savings, and pollutant treatment performance of each solution over the project's 20 year planning period (2011 to 2031). It is noted that other environmental and social assessment criteria are also used at a later stage during the MCA (once solutions are grouped) to better assess the performance of each management scenario.

Results of the individual solution assessment were used to calculate levelised costs for providing an alternative source of water (i.e. $/kL) or for treating pollutants (in $/kg of pollutant removed) so that the cost effectiveness of solutions could be easily compared. Only costs associated with the additional treatment and provision of recycled water were included in the cost analysis, i.e. the costs to upgrade STP capacity were not included. Pollutant (TSS, TN and TP) load reductions quantified during this assessment were also used to inform the MCA and receiving water quality modelling framework, which were used to evaluate the water quality outcomes from implementing the management scenarios in each catchment.

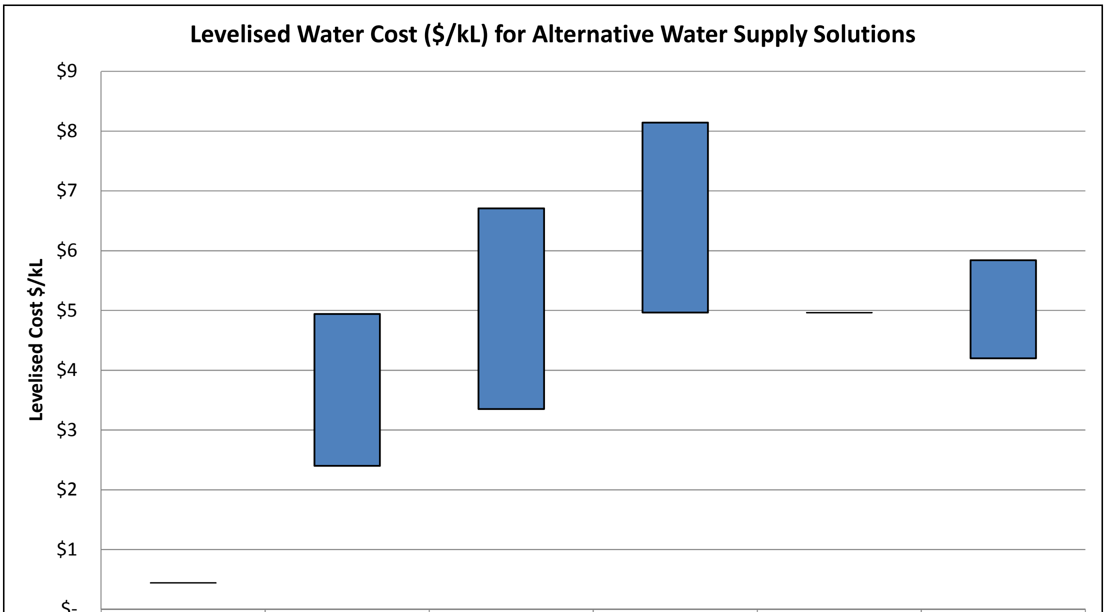
A summary of the each solution's performance amongst all catchments is provided in Figures E-2 to E-6. These figures show the performance range of each solution using bars to indicate the upper and lower extents of performance. It is noted that the costs do not include Project Support cost revisions, which were undertaken for concept designs of preferred recycled water schemes. Project support costs were significantly greater than estimated in the below figures.

The indicative cost range for implementing solutions across catchments, calculated as net present value (NPV)/ equivalent tenement (household) per year over the planning period (2011-2031), is shown in Figure E-2. Figure E-3 presents the levelised costs range of solutions for supply of an alternative water source over the 20 year planning period. Figure E-4 to Figure E-6 present the levelised cost range for treating TSS, TN and TP respectively. It should be noted that Figures E-4 to E-6 use a log scale, due to the large variation in costs between solutions.



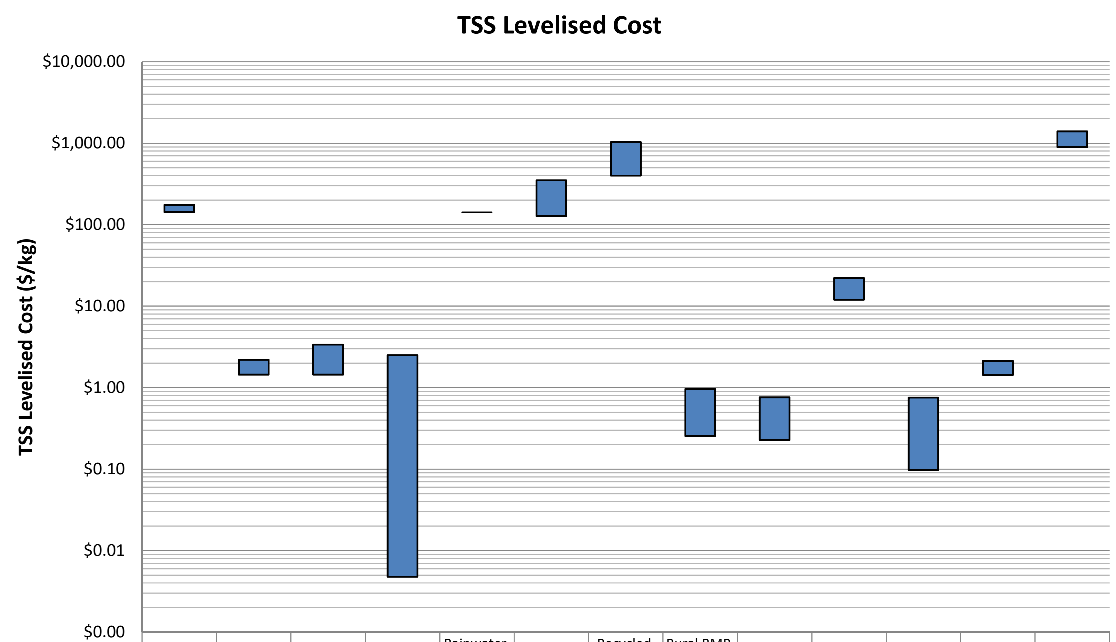

| | QDC Target | WSUD SPP HW | WSUD No Worsen. | Increased E&SC | Rainwater Tank Retrofit | Recycled Water Ag. | Recycled Water Urban | Rural BMP 1/2 streams | Rural BMP Hort. | S/W Harvest | W/W Reveg. | WSUD Retrofit | PRW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min | $80 | $10 | $20 | $1.62 | $140 | $- | $4.82 | $0.40 | $0.02 | $- | $0.08 | $1.00 | $20 |
| Max | $190 | $400 | $400 | $26.66 | $200 | $1.00 | $196 | $11.40 | $0.85 | $200 | $3.70 | $11.30 | $110 |

**Figure E- 2 Cost Range (NPV/ET/year) for Implementing Solutions**



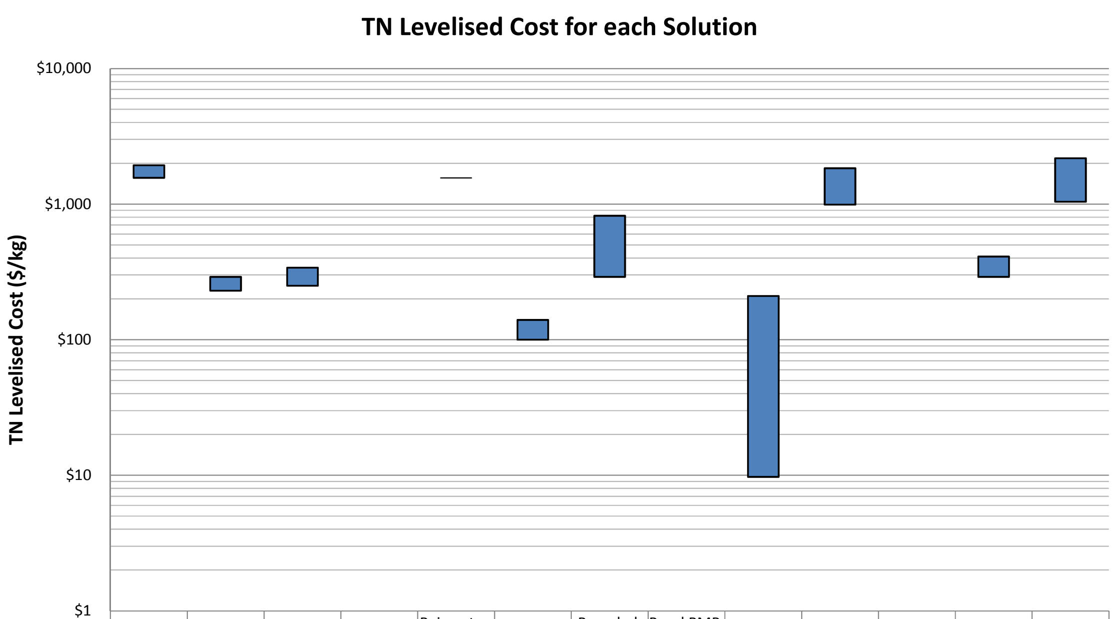

| | Recycled Water - Agriculture | Recycled Water - Urban | PRW | QDC Water Supply Target | Rainwater Tanks Retrofitted | Stormwater Harvesting |
|---|---|---|---|---|---|---|
| Min | $0.45 | $2.40 | $3.35 | $4.97 | $4.97 | $4.20 |
| Max | $0.45 | $4.94 | $6.71 | $8.14 | $4.97 | $5.84 |

**Figure E- 3 Cost Range ($/kL) for Alternative Water Supply Solutions**



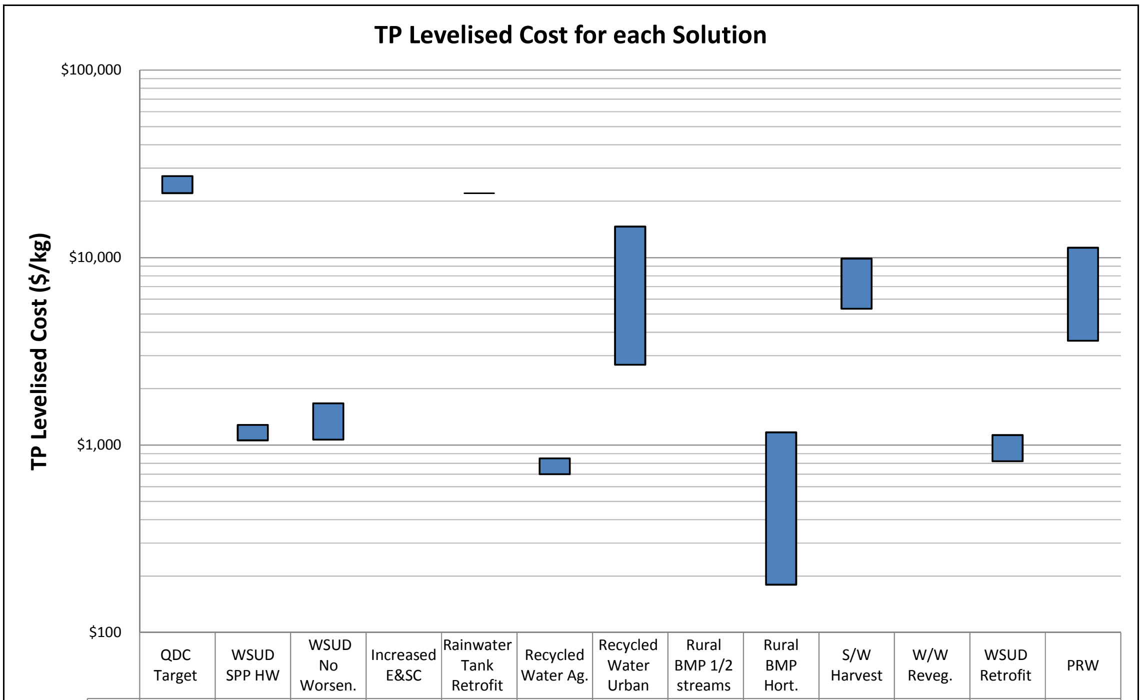

| | QDC Target | WSUD SPP HW | WSUD No Worsen. | Increased E&SC | Rainwater Tank Retrofit | Recycled Water Ag. | Recycled Water Urban | Rural BMP 1/2 streams | Rural BMP Hort. | S/W Harvest | W/W Reveg. | WSUD Retrofit | PRW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min | $142 | $1.45 | $1.45 | $0.00 | $142 | $128 | $402 | $0.26 | $0.23 | $12 | $0.10 | $1.43 | $900 |
| Max | $175 | $2.20 | $3.37 | $2.50 | $142 | $351 | $1,031 | $0.96 | $0.76 | $22 | $0.75 | $2.14 | $1,400 |

**Figure E- 4 Cost Range ($/kL) for Treatment of Total Suspended Solids**




| | QDC Target | WSUD SPP HW | WSUD No Worsen. | Increased E&SC | Rainwater Tank Retrofit | Recycled Water Ag. | Recycled Water Urban | Rural BMP 1/2 streams | Rural BMP Hort. | S/W Harvest | W/W Reveg. | WSUD Retrofit | PRW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min | $1,560 | $230 | $250 | N/A | $1,560 | $100 | $290 | N/A | $10 | $990 | N/A | $290 | $1,040 |
| Max | $1,930 | $290 | $340 | N/A | $1,560 | $140 | $820 | N/A | $210 | $1,840 | N/A | $410 | $2,180 |

**Figure E- 5 Cost Range ($/kL) for Treatment of Total Nitrogen**




| | QDC Target | WSUD SPP HW | WSUD No Worsen. | Increased E&SC | Rainwater Tank Retrofit | Recycled Water Ag. | Recycled Water Urban | Rural BMP 1/2 streams | Rural BMP Hort. | S/W Harvest | W/W Reveg. | WSUD Retrofit | PRW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min | $22,080 | $1,060 | $1,070 | N/A | $22,080 | $700 | $2,680 | N/A | $180 | $5,340 | N/A | $820 | $3,600 |
| Max | $27,200 | $1,280 | $1,670 | N/A | $22,080 | $850 | $14,630 | N/A | $1,170 | $9,880 | N/A | $1,130 | $11,300 |

**Figure E- 6 Cost Range ($/kL) for Treatment of Total Phosphorus**

Assessment of Management Scenarios

Using results of the individual solution performance and the catchment and RWQM, solution sets contained within the three management scenarios for each catchment were assessed to quantify outcomes in terms of environmental, economic and social performance. Results from the management scenario assessment were then used to determine the preferred scenario for implementation in each catchment, using a multi criteria assessment (MCA) process. This MCA process takes into account environmental, social and economic factors when determining the preferred scenario.

*Sustainable Load Targets*

In order to assess the effectiveness of management scenarios, sustainable load targets for receiving waters were investigated. Sustainable load targets provide an indication of the capacity of receiving waters to assimilate pollutant loads without adversely impacting on aquatic ecosystems. The target refers to the quantity (tonnes/yr) of catchment pollutant loads (TN, TP, TSS) able to discharge into receiving waters without causing concentrations of those pollutants to exceed water quality objectives (WQOs).

To determine the sustainable load target for each catchment, the catchment modelling software package (i.e. Source Catchments) was utilised in conjunction with the receiving water quality modelling software package (i.e. RWQM2). Existing catchment loads were used as inputs into the RWQM2 modelling software package which provided an indication of the pollutant concentrations in receiving waters under existing conditions.

The catchment loads were then incrementally reduced (in RWQM2) until the point where water quality objectives were achieved in receiving waters. To test whether this sustainable load target was actually achievable in the catchment, a 'Green Space' scenario was modelled in Source Catchments to represent the catchment condition prior to European settlement. This was modelled as an entirely forested catchment, and was deemed to represent the best achievable catchment pollutant loads.

Interestingly, for the majority of catchments, it was found that the sustainable load target was less than the Green Space scenario. This means that even if these catchments reverted back to natural condition (i.e. totally forested), the water quality objectives in receiving waters would still be exceeded. Therefore, the sustainable load targets for these catchments were set to be the quantity of pollutants in the receiving waterway, assuming a totally forested upstream catchment. The exception to this was Pumicestone Passage and Bribie Island Catchments. Modelling of these catchments showed that WQOs in receiving waters (Pumicestone Passage south) would be met in the future, even without additional management measures (modelled as 'business as usual'). This is thought to be due to well mixed receiving waters, and does not necessarily reflect the ecological health of waters on the mainland. A summary of the sustainable load targets adopted for each catchment is presented in Table E-3.

**Table E- 3 Sustainable Load Targets**

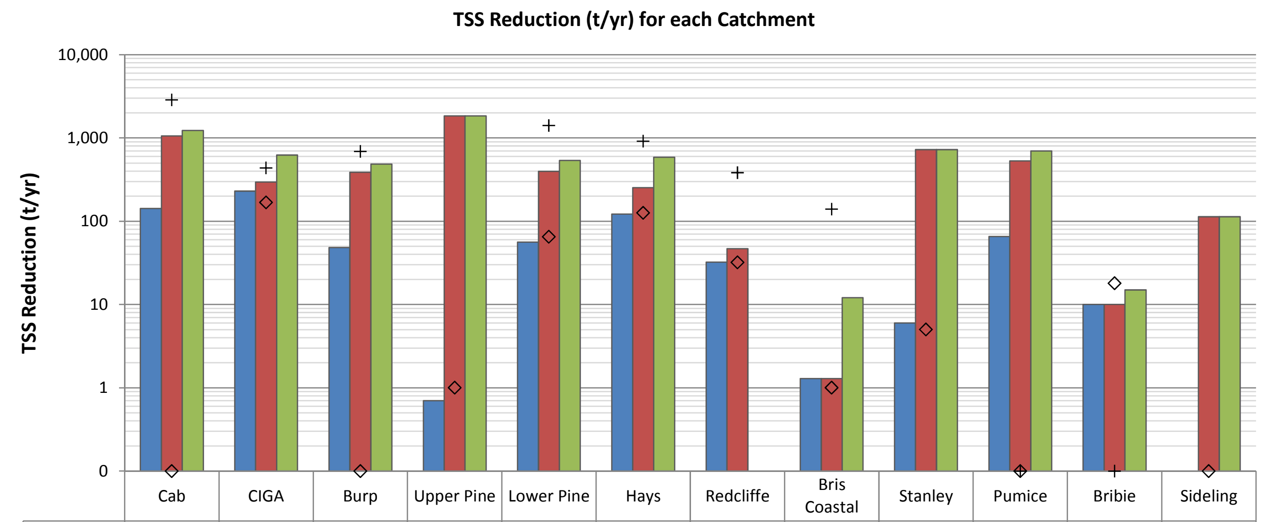
| Catchment | Sustainable Load Targets | | | Sustainable Load Modelling Condition | Receiving Waters |
|---|---|---|---|---|---|
| | TSS (t/yr) | TN (t/yr) | TP (t/yr) | | |
| Bribie | 246 | 13.3 | 1.27 | Future BAU | Pumicestone Passage |
| Brisbane Coastal | 11 | 0.7 | 0.04 | Green Space | Bramble Bay |
| Burpengary | 140 | 11.1 | 0.52 | Sustainable load (TSS), Green Space (TN,TP) | Deception Bay |
| Caboolture | 786 | 55.3 | 2.61 | Green Space | Caboolture River Estuary |
| CIGA | 94 | 6.6 | 0.31 | Green Space | Caboolture River Estuary |
| Hays | 53 | 3.7 | 0.18 | Green Space | Bramble Bay |
| Lower Pine | 123 | 8.6 | 0.41 | Green Space | Pine River Estuary |
| Pumicestone | 1,261 | 38.2 | 3.12 | Future BAU | Pumicestone Passage |
| Redcliffe | 16 | 1.1 | 0.06 | Green Space | Deception Bay / Bramble Bay |

*Environmental Performance*

The environmental performance of management scenarios was quantified through assessing pollutant load reduction and generation of greenhouse gases.

Source Catchments was used to quantify pollutant load reductions from management scenarios in each catchment. Figures E-7 to E-9 show anticipated TSS, TN and TP load reductions for management scenarios modelled in each catchment.

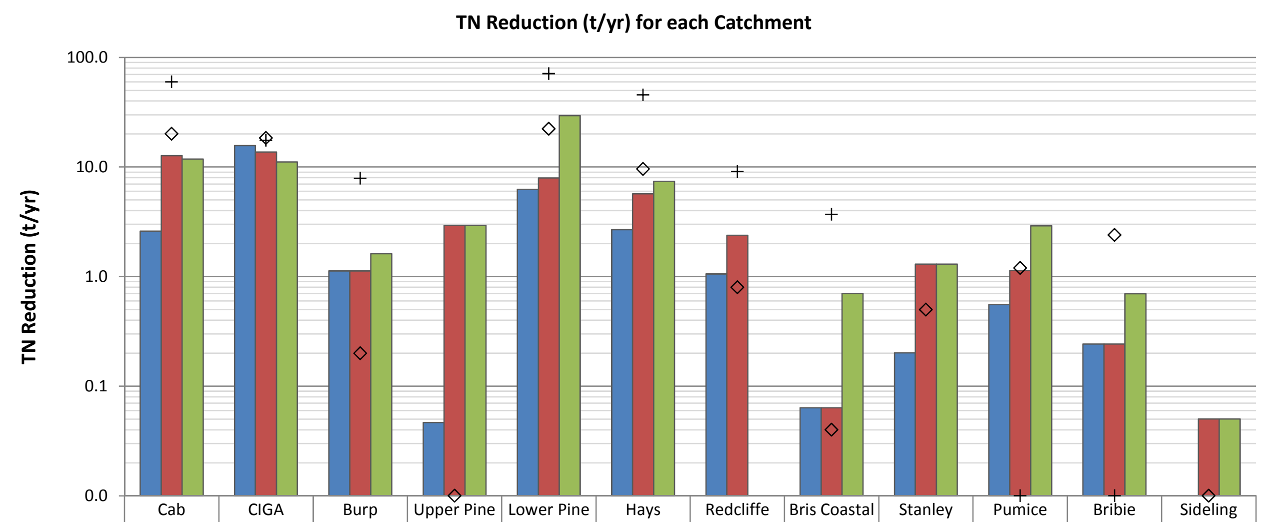
Water quality modelling of the management scenarios indicated that the sustainable load targets were not met for any of the catchment management scenarios, apart from Bribie and Pumicestone. This is because in most cases the sustainable load target essentially reflects Green Space conditions (forested catchments). The management scenarios were therefore modelled and compared with 'no worsening' targets, that is target load reductions to ensure 'no worsening' from existing conditions. Results showed that management scenarios could achieve 'no worsening' targets for TSS in all catchments, apart from Scenario 1 (low intensity) in some instances. Results for TN, however, indicated that even Scenario 3 (high intensity) could not meet 'no worsening' targets in Caboolture, CIGA, Lower Pine, Hays or Bribie Island catchments. This is attributed to the increased loads from Sewage Treatment Plants. Results for TP indicate that although 'no worsening' targets are not met for some scenarios, in most instances it can be achieved through Scenario 3.




| | Cab | CIGA | Burp | Upper Pine | Lower Pine | Hays | Redcliffe | Bris Coastal | Stanley | Pumice | Bribie | Sideling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario 1 | 142 | 230 | 48 | 0.7 | 56 | 122 | 32 | 1.3 | 6 | 65 | 10 | - |
| Scenario 2 | 1,058 | 296 | 387 | 1,839 | 398 | 253 | 47 | 1 | 723 | 529 | 10 | 113 |
| Scenario 3 | 1,227 | 621 | 484 | 1,839 | 536 | 587 | - | 12 | 723 | 696 | 15 | 113 |
| + Sus Load | 2,845 | 435 | 687 | N/A | 1,408 | 914 | 381 | 139 | N/A | 0 | 0 | N/A |
| ◇ No Worse | 0 | 168 | 0 | 1.0 | 65 | 126 | 32 | 1.0 | 5 | 0 | 18 | 0 |

Catchment

**Figure E- 7 TSS Reduction (t/yr) for Each Catchment and Scenario**




| | Cab | CIGA | Burp | Upper Pine | Lower Pine | Hays | Redcliffe | Bris Coastal | Stanley | Pumice | Bribie | Sideling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario 1 | 2.6 | 15.6 | 1.1 | 0.0 | 6.3 | 2.7 | 1.1 | 0.1 | 0.2 | 0.6 | 0.2 | - |
| Scenario 2 | 12.7 | 13.7 | 1.1 | 2.9 | 7.9 | 5.7 | 2.4 | 0.1 | 1.3 | 1.1 | 0.2 | 0.1 |
| Scenario 3 | 11.8 | 11.1 | 1.6 | 2.9 | 29.4 | 7.4 | - | 0.7 | 1.3 | 2.9 | 0.7 | 0.1 |
| + Sus Load | 59.8 | 17.5 | 7.9 | N/A | 71.2 | 45.4 | 9.1 | 3.7 | N/A | 0 | 0 | N/A |
| ◇ No Worse | 20.1 | 18.4 | 0.2 | 0 | 22.3 | 9.6 | 0.8 | 0.04 | 0.5 | 1.2 | 2.4 | 0 |

Catchment

**Figure E- 8 TN Reduction (t/yr) for Each Catchment and Scenario**

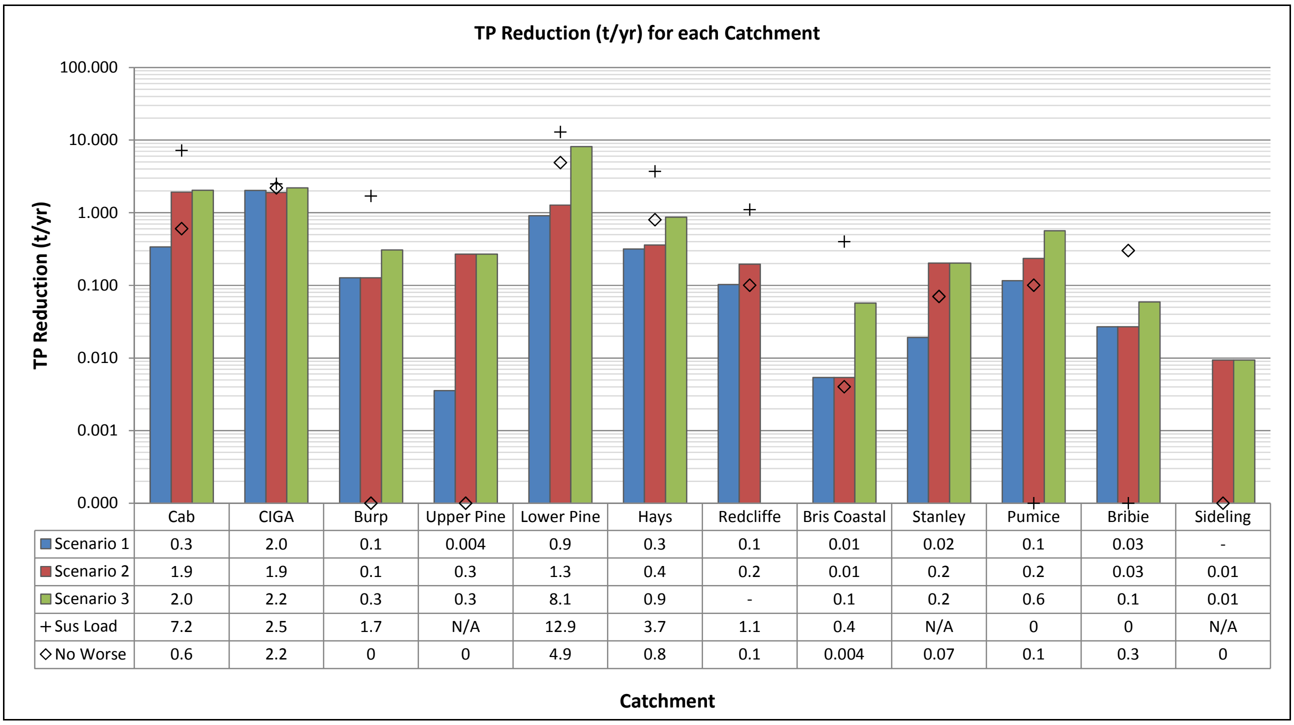



**Figure E- 9 TP Reduction (t/yr) for Each Catchment and Scenario**

Predicted pollutant load reductions in each management scenario were used to estimate how implementing each management scenario may affect EHMP grades of receiving waters. Table E-4 and Figure E-10 present the estimated EHMP grades for each management scenario.

**Table E- 4 Estimated EHMP Grades for Catchment Management Scenarios**

| Catchment | Estimated EHMP Grade | | | | Receiving Waters |
|---|---|---|---|---|---|
| | 2010 | | 2031 Scenario 2 | 2031 Scenario 3 | |
| Bribie | D+ | D+ | D+ | D+ | Pumicestone Passage |
| Brisbane Coastal | D+ | D+ | D+ | C- | Bramble Bay |
| Burpengary | D+ | D | C | C+ | Deception Bay |
| Caboolture | D | D- | D+ | D+ | Caboolture River Estuary |
| CIGA | C+ | C | C- | C+ | Caboolture River (Freshwater) |
| Hays | D+ | D | D+ | C- | Bramble Bay |
| Lower Pine | C- | D | D+ | C+ | Pine River Estuary |
| Pumicestone | D+ | D+ | C- | C | Pumicestone Passage |
| Redcliffe | D+ | D+ | C- | N/A | Deception/Bramble Bay |
| Sideling | C- | N/A | C | N/A | Pine River (Freshwater) |
| Stanley | B- | B- | B | N/A | Stanley River |
| Upper Pine | C- | C- | C+ | C+ | Pine River (Freshwater) |

N/A – Scenario not applicable to catchment


BMT WBM

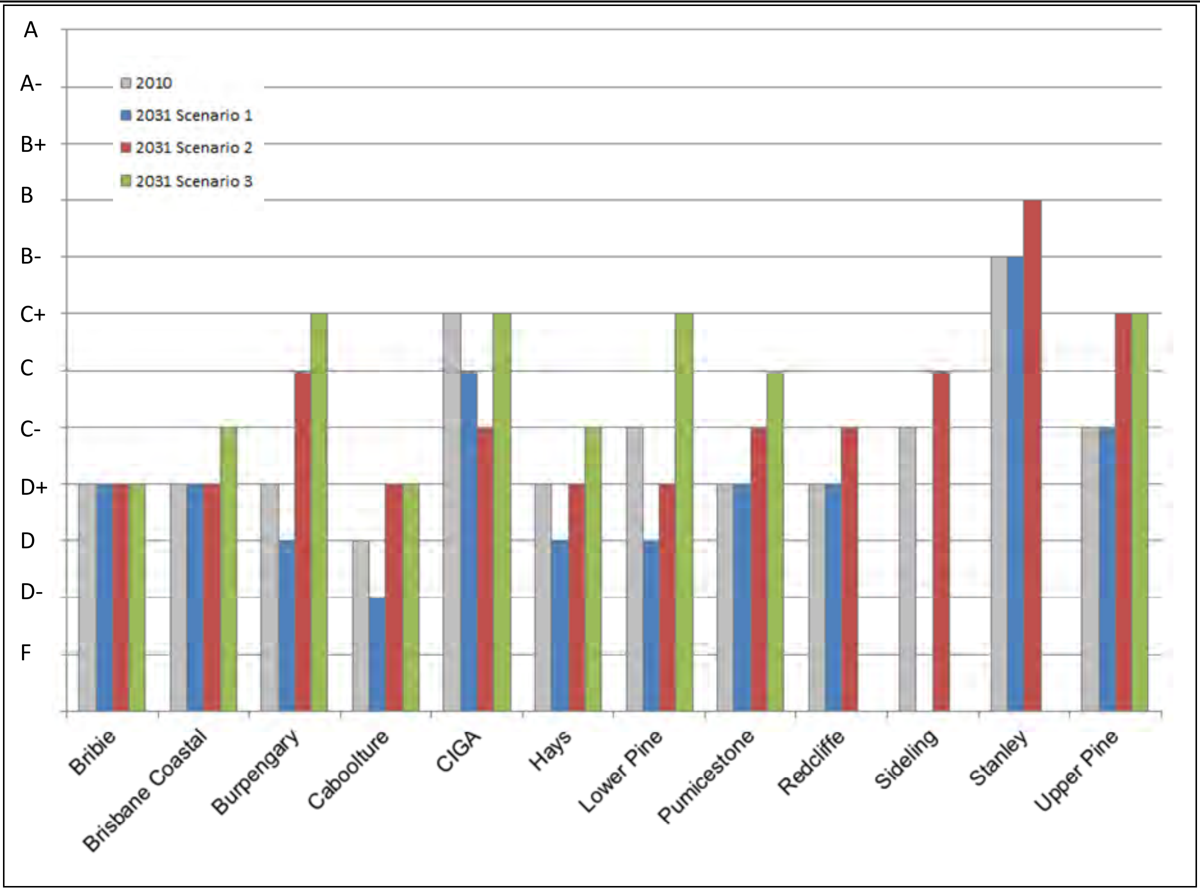
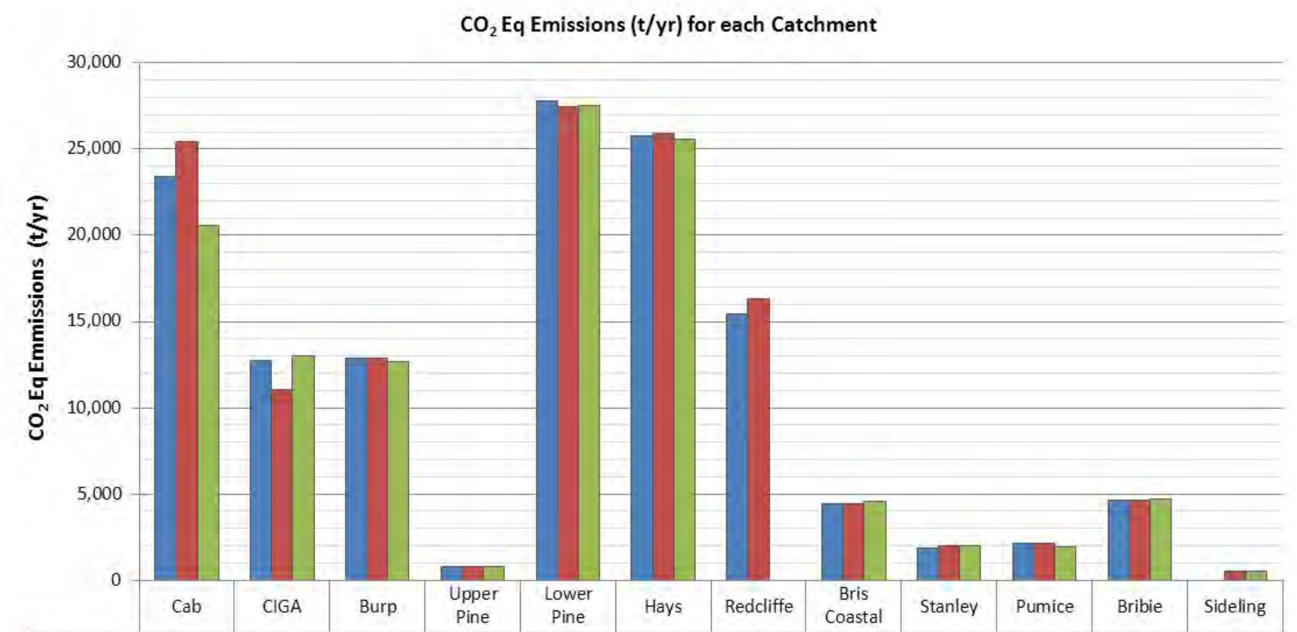



**Figure E- 10 Estimated EHMP Grades for Catchment Management Scenarios**

A high level assessment was undertaken of the generation of greenhouse gases in each scenario. Greenhouse gas (GHG) emissions were quantified using energy use assumptions for water production only, based on information from Hall et al. (2009) and DCCEE (2011). It is noted that Unitywater is expected to complete their Climate Change Strategy in June 2012, which will assist to better quantify GHG emissions for transporting and treating sewage, and will be used when optimising the solution sets presented in this TWCM Plan. Subsequent reviews of TWCMP may include GHG quantifications for other solutions based on the research knowledge available.

A summary of the greenhouse gases emitted by each management scenario in each catchment is shown in Figure E-11.




| | Cab | CIGA | Burp | Upper Pine | Lower Pine | Hays | Redcliffe | Bris Coastal | Stanley | Pumice | Bribie | Sideling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario 1 | 23,417 | 12,748 | 12,861 | 783 | 27,779 | 25,793 | 15,422 | 4,451 | 1,891 | 2,160 | 4,612 | - |
| Scenario 2 | 25,461 | 11,075 | 12,861 | 783 | 27,446 | 25,942 | 16,344 | 4,451 | 1,993 | 2,160 | 4,612 | 540 |
| Scenario 3 | 20,575 | 13,041 | 12,676 | 783 | 27,515 | 25,548 | - | 4,587 | 1,993 | 1,915 | 4,715 | 540 |

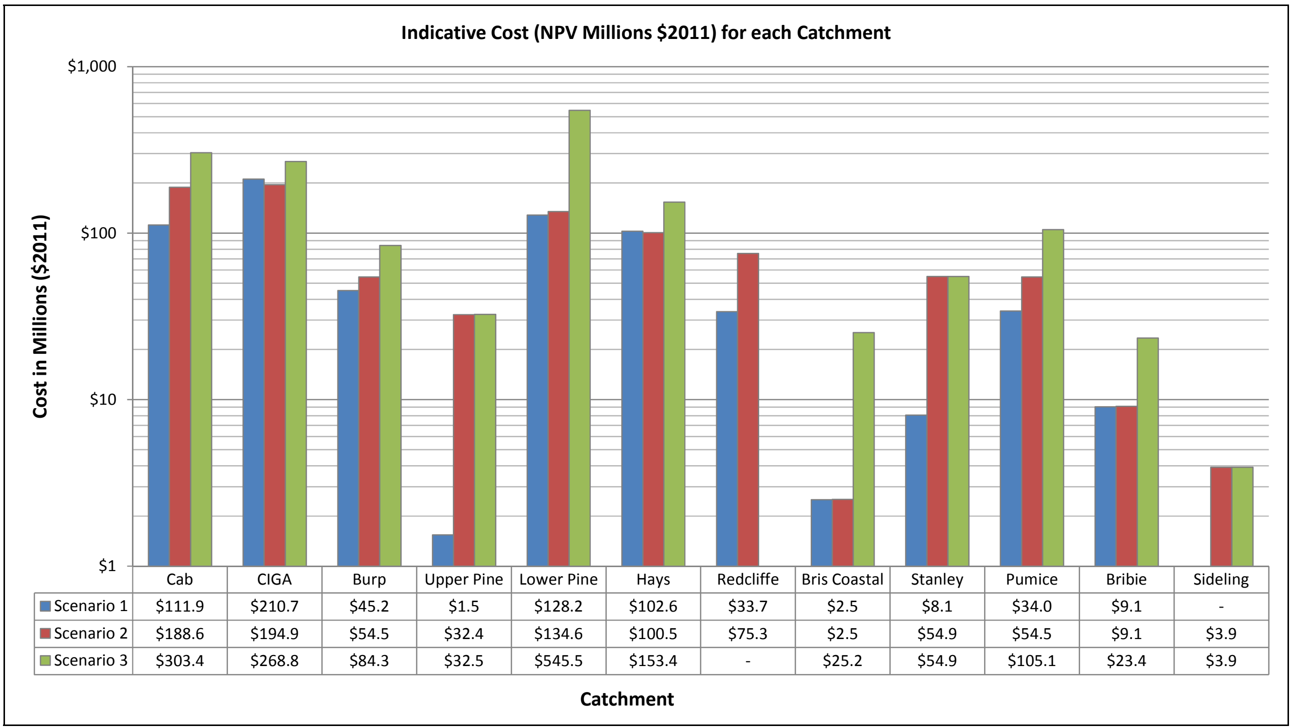
**Figure E- 11 Greenhouse Gas Emissions from Water Supply for Each Catchment and Scenario**

As illustrated in Figure E-11, greenhouse gas emissions are seen to differ between catchments, generally to be commensurate with catchment size and water use. It should be noted that scenario 1 is the Business as Usual case, so if compliance with current legislation was achieved, these are the quantities of emissions likely, the other scenarios can then be compared to this to identify whether going for a medium or high intensity scenario will improve or worsen greenhouse gas contributions. Scenario 3 is seen to produce the least emissions as a result of stormwater harvesting replacing rainwater tanks in scenario 3 in Caboolture, Burpengary, Pumicestone and Hays catchments. The high emissions from Scenario 3 in the CIGA are due to the PRW solution, and the energy required to pump water to NPD.

*Economic Performance*

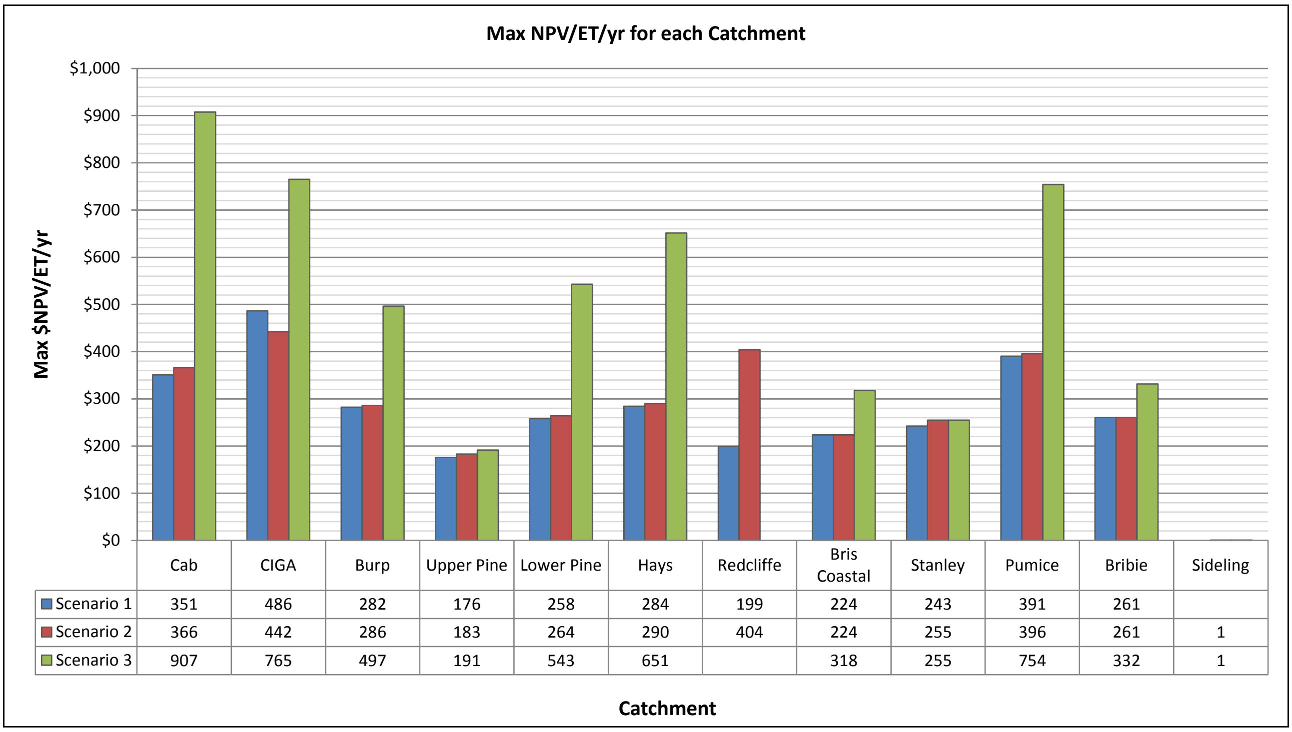
Indicative costs were quantified to assist in assessing the economic performance of each management scenario. This simply entailed summing the individual cost of the solutions (quantified in Section 5) in each management scenario. Two indicators of cost were used, the NPV cost of the management scenario, as well as the maximum NPV cost per ET of the management scenario.

Figure E-12 shows the indicative NPV of each management scenario over the planning period (2011-2031). It can be seen that in, most catchments, Scenario 3 has the highest capital costs, due to the added outlay to reach stretched performance targets. Of all the catchments, Scenario 3 in the Lower Pine catchment has the highest NPV over the planning period. This is due to the large PRW scheme proposed in this scenario. Figure E-13 presents the indicative maximum annual cost of each management scenario per ET (i.e. household). It is noted that only costs associated with the additional treatment and provision of recycled water were included in the cost analysis, i.e. not the costs to upgrade STP capacity. Furthermore, additional costing by project support of select recycled water solutions indicated significantly higher costs that are not included below.




| | Cab | CIGA | Burp | Upper Pine | Lower Pine | Hays | Redcliffe | Bris Coastal | Stanley | Pumice | Bribie | Sideling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario 1 | $111.9 | $210.7 | $45.2 | $1.5 | $128.2 | $102.6 | $33.7 | $2.5 | $8.1 | $34.0 | $9.1 | - |
| Scenario 2 | $188.6 | $194.9 | $54.5 | $32.4 | $134.6 | $100.5 | $75.3 | $2.5 | $54.9 | $54.5 | $9.1 | $3.9 |
| Scenario 3 | $303.4 | $268.8 | $84.3 | $32.5 | $545.5 | $153.4 | - | $25.2 | $54.9 | $105.1 | $23.4 | $3.9 |

**Figure E- 12 Indicative Cost (NPV Millions $2011) for Each Catchment and Scenario**



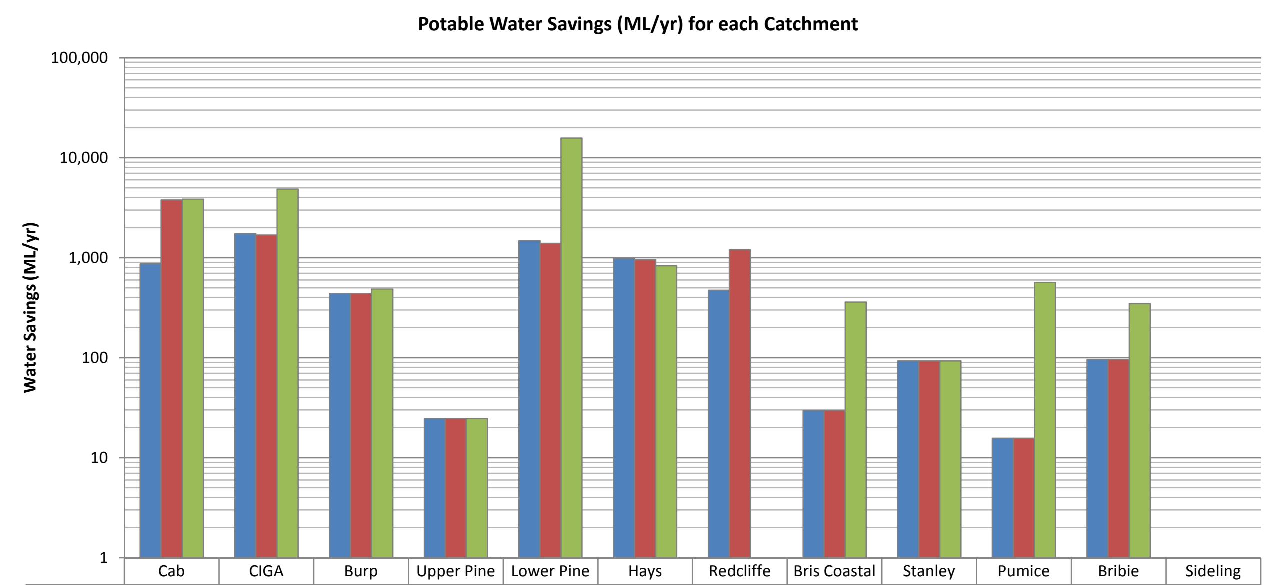

| | Cab | CIGA | Burp | Upper Pine | Lower Pine | Hays | Redcliffe | Bris Coastal | Stanley | Pumice | Bribie | Sideling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario 1 | 351 | 486 | 282 | 176 | 258 | 284 | 199 | 224 | 243 | 391 | 261 | |
| Scenario 2 | 366 | 442 | 286 | 183 | 264 | 290 | 404 | 224 | 255 | 396 | 261 | 1 |
| Scenario 3 | 907 | 765 | 497 | 191 | 543 | 651 | | 318 | 255 | 754 | 332 | 1 |

**Figure E- 13 Indicative Annual Cost (NPV $2011) per ET for Each Catchment and Scenario**

*Social Performance*

For each management scenario, the potential potable water savings were quantified to use as a key performance indicator reflecting the 'social' criteria category in the MCA. This assessment entailed summing the potable water savings quantified for each individual solution, to determine the total potable water savings for each management scenario.

The results are presented in Figure E-14, which generally shows that for scenarios 1 and 2, the potential water savings are similar. As expected, scenario 3 records the greatest potential water savings due to the stretched performance targets of this scenario. In particular, scenario 3 in the Lower Pine catchment has the potential to provide approximately 16,000 ML/year potable water savings with the inclusion of a PRW scheme (which would supply approximately 15,000 ML/year to North Pine Dam). Another PRW scheme for Scenario 3 in the CIGA catchment accounts for the high potable water savings. In Brisbane Coastal and Bribie Island catchments, the additional water savings from Scenario 3 are due to the retrofit of rainwater tanks to existing properties. Increased water savings in the Pumicestone Catchment from Scenario 3 are due to potential stormwater harvesting schemes in greenfield developments.




| | Cab | CIGA | Burp | Upper Pine | Lower Pine | Hays | Redcliffe | Bris Coastal | Stanley | Pumice | Bribie | Sideling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario 1 | 869 | 1,735 | 440 | 25 | 1,480 | 977 | 472 | 30 | 93 | 16 | 96 | - |
| Scenario 2 | 3,789 | 1,688 | 440 | 25 | 1,393 | 952 | 1,200 | 30 | 93 | 16 | 96 | - |
| Scenario 3 | 3,863 | 4,858 | 485 | 25 | 15,714 | 830 | - | 361 | 93 | 567 | 347 | - |

**Figure E- 14 Potable Water Savings (ML/yr) for Each Catchment and Scenario**

*Multi Criteria Analysis*

To assist in the selection of the preferred management scenario, Multi Criteria Assessment (MCA) was used.

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 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).

It is noted that an initial MCA was undertaken during the Strategy development phase of this project (BMT WBM, 2010), with involvement of key stakeholders and Councillors. Scoring during the initial MCA was undertaken using a qualitative assessment of each solutions performance. During the detailed planning phase, the multi-criteria analysis undertaken during the strategy development phase was refined to include a quantitative assessment of a management scenarios environmental, social and economic performance where possible.

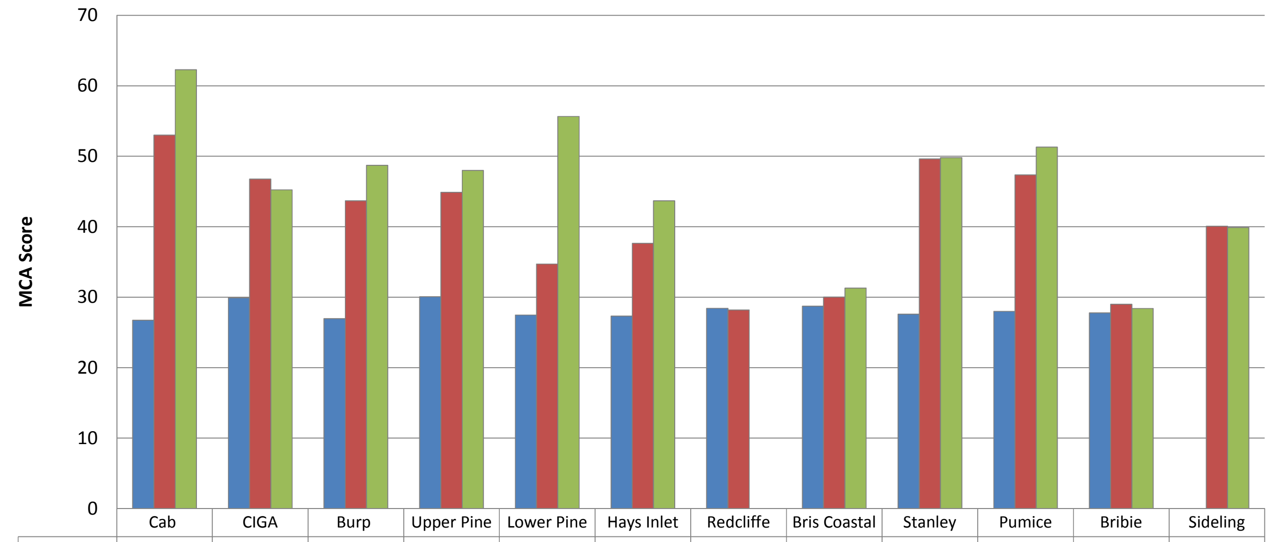
The criteria and criteria weighting originally developed were also slightly amended (with consensus from stakeholders) to better reflect the information available. The final adopted criteria and criteria weighting is shown in Table E-5.

**Table E- 5 MCA Criteria and Weighting**

| Criteria Category & Weighting | Criteria | Criteria Weighting |
|---|---|---|
| Environmental<br>Weighting = 33.3% | Changes in water quality in inland water systems, as well as changes to biodiversity, and bed and bank integrity[1] | 10% |
| | Changes in hydrology | 10% |
| | Changes to water quality and biodiversity in estuaries and Moreton Bay[1] | 30% |
| | Changes in water quality and flow and biodiversity of groundwater systems | 5% |
| | Changes in emissions of greenhouse gases[1] | 15% |
| | Impact on environmentally sensitive values[1] | 30% |
| | *Total Environmental Criteria Weighting* | *100%* |
| Social<br>Weighting = 33.3% | Impacts on water supply[1] | 25% |
| | Impacts on human health | 25% |
| | Impacts on public amenity/recreation | 20% |
| | Level of community understanding, engagement and ownership | 10% |
| | Public acceptability | 20% |
| | *Total Social Criteria Weighting* | *100%* |
| Economic<br>Weighting = 33.3% | Financial impacts on MBRC – Outlays, capital and operating expenditure and revenue[1] | 35% |
| | Financial impacts including costs and cost savings on consumers (e.g. infrastructure charges) and other organisations[1] | 35% |
| | Impacts on local industries that rely on the environment (Fisheries, tourism) | 15% |
| | Employment plus local economic sustainability | 15% |
| | *Total Economic Criteria Weighting* | *100%* |

[1] Quantitative assessment undertaken to score criteria

Results of the MCA undertaken for the three management scenarios in each catchment are shown in Figure E-15. A sensitivity analysis was also undertaken, by assigning different weightings to environmental, social and economic criteria categories. Results of the sensitivity analysis showed that despite overall scores changing, the preferred scenarios generally remained the same. Hence discussion with Council indicated that an equal weighting for environmental, social and economic criteria categories should be adopted when determining the preferred scenario. The preferred management scenario for each catchment was selected in consultation with Council and Unitywater.




| | Cab | CIGA | Burp | Upper Pine | Lower Pine | Hays Inlet | Redcliffe | Bris Coastal | Stanley | Pumice | Bribie | Sideling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario 1 | 27 | 30 | 27 | 30 | 27 | 27 | 28 | 29 | 28 | 28 | 28 | 0 |
| Scenario 2 | 53 | 47 | 44 | 45 | 35 | 38 | 28 | 30 | 50 | 47 | 29 | 40 |
| Scenario 3 | 62 | 45 | 49 | 48 | 56 | 44 | 0 | 31 | 50 | 51 | 28 | 40 |

**Figure E- 15 MCA Scores for Management Scenarios in Each Catchment (equal TBL weighting)**

Preferred Management Scenarios

The preferred management scenarios were initially selected based on the results of the Multi Criteria Analysis. Concept designs were prepared for the preferred scenarios, so that detailed costings could be undertaken of proposed recycled water schemes. In some instances, the detailed costings substantially differed to those used during the MCA, reducing the economic viability of the preferred management scenario. In these instances, and where significant implementation issues have been identified, alternative management scenarios have been selected and recommended in consultation with key stakeholders. These management scenarios will require further detailed investigations to ensure that they satisfy environmental requirements and are economically feasible. A summary of the preferred management scenarios initially selected from the MCA (and the final recommended TWCM Planning scenarios for adoption) is shown in Table E-6.

Table E-7 identifies the estimated costs associated with the scenarios outlined in Table E-6. Preferred scenarios from the MCA that have been replaced with recommended alternatives for the TWCM Plan are shaded in red for ease of reference.

It is noted that Net Present Value (NPV) costs include capital and operating costs over a 20 year period, discounted to reflect the real life cycle value in $2011 dollars. The costs will be distributed amongst Council, Unitywater, developers and landowners. Estimates of total capital and annual operating costs for each scenario are also shown in Table E-7. Further detail on the cost distribution is presented in the report.

**Table E- 6 Recommended TWCM Planning Scenarios**

| Catchment | Assessment | | Recommended TWCM Plan Scenario | Comments |
|---|---|---|---|---|
| | Multi Criteria Analysis | Additional Financial & Implementation Criteria | | |
| Bribie Island | 2 | 2 | 2 | |
| Burpengary Creek | 3 | 3 | 3 | |
| Brisbane Coastal | 2 | 2 | 2 | |
| Caboolture River | 3 | 2 | 2 | Scenario 3 is not economically viable. Scenario 2 was selected as an acceptable compromise as it provides similar water quality outcomes at significantly reduced costs. |
| Caboolture Identified Growth Area (CIGA) | 2 | 1 | 1 | Scenario 2 is not economically viable. Scenario 1 was selected as an acceptable compromise because it provides slightly improved water quality outcomes and is a more affordable option. As all scenarios required zero discharge of effluent, a key difference will be additional land required by the developer for Scenario 1 (for wastewater disposal). |
| Hays Inlet | 3 | 3 | 3 | |
| Lower Pine River | 3 | 2 | 2 | Scenario 3 was identified to have significant implementation barriers, including:<br>i) Political/public palatability<br>ii) Current government policy re Indirect Potable Reuse<br>iii) SEQ Water Strategy preference for desalinisation (over IPR)<br>Scenario 2 was considered the next best alternative if the barriers to Scenario 3 prohibit implementation. However additional measures will be required to meet water quality targets. |
| Pumicestone Passage | 2 | 2 | 2 | |
| Redcliffe | 1 | 1 | 1 | |
| Stanley River | 2 | 2 | 2 | |
| Sideling Creek | 2 | 2 | 2 | |
| Upper Pine River | 3 | 3 | 3 | |

Conceptual designs and plan layouts for solutions in the preferred management scenarios as identified from the MCA have also been prepared as a part of this study, and are included in Appendix F. It should be noted that near to the completion of this project, a number of greenfield sites originally identified as viable for stormwater harvesting, were identified to have been granted Development Approval, and hence were no longer deemed as viable options for stormwater harvesting. The concept designs outline the updated location of viable stormwater harvesting sites, however the performance of this solution will differ slightly from the results presented in this study. Revised estimates of the cost and performance of these stormwater harvesting schemes is included in Appendix F.

Similarly, detailed costing of the marginal capital costs of recycled water schemes in the preferred management scenarios (identified during the MCA) has been undertaken by Project Support. These costings are included in Appendix G. As previously noted, these costs are in some instances substantially different to those estimated prior to concept design during the MCA, and have impacted on the viability of recycled water schemes and the chosen management scenarios. It is recommended that further detailed investigations of the costing and feasibility of recycled water schemes be undertaken prior to any adoption of these schemes.

To assist with the development of an Implementation Plan, details of the cost, primary responsibility and actions for implementing the preferred management scenario in each catchment are also presented as part of this study.

**Table E- 7 Cost Summary of Recommended Management Scenarios for all Catchments**

| Catchment | Management Scenario Description | Net Present Value ($2011) | Capital Cost (CAPEX)[1] | Annual Operating Cost (OPEX)[1] |
|---|---|---|---|---|
| Bribie Island | 2 | $9,111,000 | $8,406,731 | $62,715 |
| Burpengary Creek | 3 | $84,331,000 | $80,789,522 | $913,934 |
| Brisbane Coastal | 2 | $2,514,900 | $2,320,251 | $17,377 |
| Caboolture River[1] | 3 | $460,597,000 | $384,988,732 | $6,737,336 |
| Caboolture River | 2 | $223,969,000 | $199,198,517 | $2,436,340 |
| Caboolture Identified Growth Area (CIGA)[1] | 2 | $342,617,000 | $339,251,415 | $6,627,635 |
| Caboolture Identified Growth Area (CIGA) | 1 | $210,735,000 | $273,175,068 | $4,603,181 |
| Hays Inlet[1] | 3 | $153,441,000 | $127,034,673 | $2,353,670 |
| Lower Pine River[1] | 3 | $545,544,000 | $337,448,212 | $24,051,601 |
| Lower Pine River | 2 | $134,616,000 | $88,123,439 | $4,059,098 |
| Pumicestone Passage | 2 | $54,483,300 | $51,249,538 | $277,804 |
| Redcliffe | 1 | $33,702,000 | $31,279,711 | $211,165 |
| Stanley River | 2 | $54,925,000 | $52,333,965 | $250,958 |
| Sideling Creek | 2 | $3,924,000 | $3,816,141 | $8,559 |
| Upper Pine River | 3 | $32,508,500 | $29,495,920 | $242,904 |

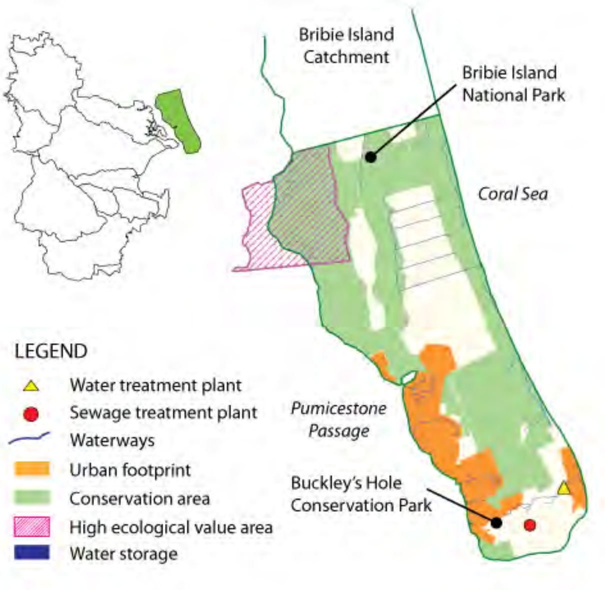
1 Includes detailed costing of recycled water projects by Project Support

Notes:

1. Costs represent the total costs to be distributed between Council, Unitywater, developers and ratepayers. Cost distributions are further detailed in Section 7.
2. Scenarios shaded in red represent those scenarios that have been replaced with alternative recommendations following additional economic/feasibility assessment.

A summary of the recommended management scenario for each catchment is provided below. In instances that the recommended management scenario differs from the preferred scenario based on results of the MCA, the performance of both have been documented.

***Bribie Island Catchment***




Solutions in the preferred and recommended management scenario for Bribie Island include:

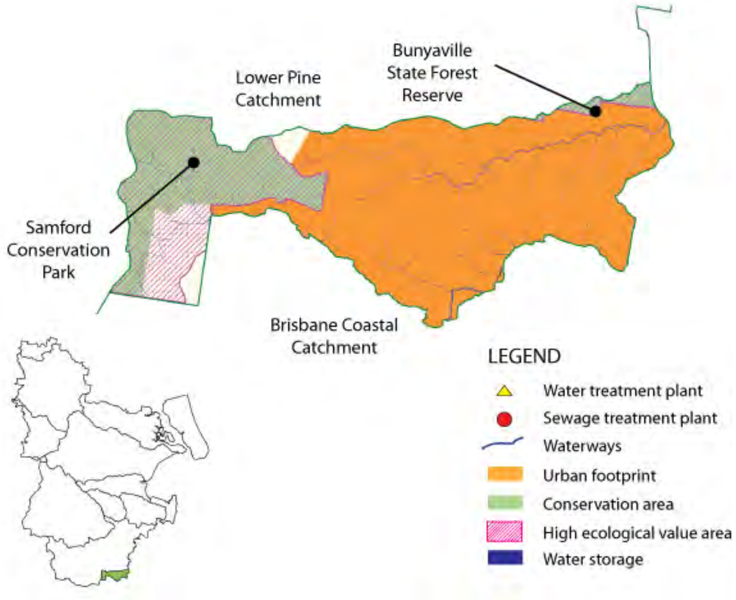
- Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN
- Future development meets QDC alternative water supply target
- Increased implementation/ enforcement of erosion and sediment control (E&SC) on development sites
- Education and capacity building to support implementation of solutions

A summary of the overall performance of this management scenario is detailed in Table E-8.

**Table E- 8 Bribie Island Management Scenario Performance Summary**

| Indicator | Performance | Notes |
|---|---|---|
| Maximum Total CAPEX/EP | $1,611 | |
| Maximum Total Annual OPEX/EP | $8.20 | |
| Potable Water Saving (ML/year) | 96 | |
| Land Take (ha) | 1.21 | 0.001% of catchment |
| EHMP Grade 2010 | D+ | Pumicestone Passage |
| Predicted EHMP Grade 2031 | D+ | Meets sustainable load objectives. Catchment has minor contribution to EHMP score |

***Brisbane Coastal Catchment***




Solutions in the preferred and recommended management scenario for Brisbane Coastal include:

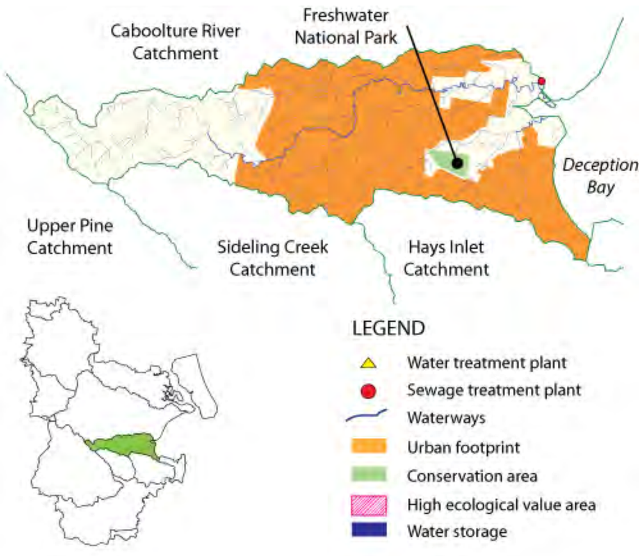
- Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN
- Future development meets QDC alternative water supply target
- Increased implementation/ enforcement of erosion and sediment control (E&SC) on development sites
- Education and capacity building to support implementation of solutions

A summary of the overall performance of this management scenario is detailed in Table E-9.

**Table E- 9 Brisbane Coastal Management Scenario Performance Summary**

| Indicator | Performance | Notes |
|---|---|---|
| Maximum Total CAPEX/EP | $1,341 | |
| Maximum Total Annual OPEX/EP | $7.40 | |
| Potable Water Saving (ML/year) | 30 | |
| Land Take (ha) | 0.27 | 0.02 % of catchment |
| EHMP Grade 2010 | D+ | Receiving Waters Bramble Bay |
| Predicted EHMP Grade 2031 | D+ | Meets ‘no worsening’ objectives |

***Burpengary Creek Catchment***




Solutions in the preferred and recommended management scenario for Burpengary Creek catchment include:

- Future development meets QDC alternative water supply target
- Waterway riparian revegetation (3$^{rd}$ & 4$^{th}$ order streams)
- Rural BMP for grazing – fencing and revegetation of 1$^{st}$ & 2$^{nd}$ order streams
- Increased implementation/ enforcement of E&SC on development sites
- Greenfield WSUD achieves 'No Worsening'
- Stormwater harvesting for non-potable use (Public open space irrigation and dual reticulation for toilet flushing and outdoor use)
- WSUD retrofit to existing urban areas
- Education and capacity building to support implementation of solutions

Stormwater harvesting was nominated in this catchment as part of the stretched management scenario for Greenfield development areas that recycled water schemes were not initially proposed for. Stormwater harvesting will also assist in meeting hydrological objectives for the catchment.

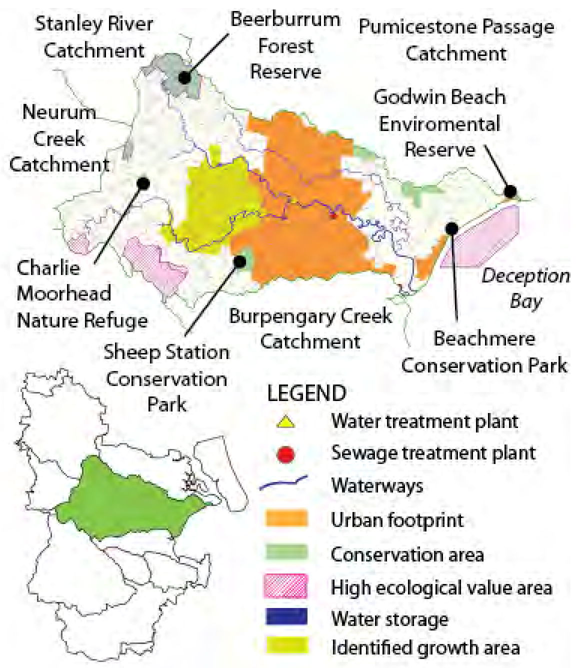
It is noted that extending the dual reticulation recycled water scheme proposed for the Caboolture River Catchment (from the Caboolture STP) may be another alternative to stormwater harvesting in this catchment, particularly if the Wamuran irrigation scheme does not proceed. Further assessment of the best option will be required pending the outcomes of the Wamuran irrigation scheme.

A summary of the overall performance of this management scenario is detailed in Table E-10.

**Table E- 10 Burpengary Creek Management Scenario Performance Summary**

| Indicator | Performance | Notes |
|---|---|---|
| Maximum Total CAPEX/EP | $2,333 | |
| Maximum Total Annual OPEX/EP | $12.52 | |
| Potable Water Saving (ML/year) | 485 | |
| Land Take (ha) | 116 | 1.4% of catchment |
| EHMP Grade 2010 | D+ | Receiving waters Deception Bay |
| Predicted EHMP Grade 2031 | C+ | Meets 'no worsening' objectives |

***Caboolture River Catchment***




Solutions in the preferred management scenario for Caboolture River catchment (Scenario 3) that were initially selected from the MCA include:

- Future development meets QDC alternative water supply target
- Waterway riparian revegetation (3rd & 4th order streams)
- Rural BMP for grazing – fencing and revegetation of 1st & 2nd order streams
- Rural BMP for horticulture – filter strips
- Increased implementation/ enforcement of E&SC on development sites
- WSUD retrofit to existing urban areas
- Greenfield WSUD achieves 'No Worsening'

- Recycled water supplied to urban users for dual reticulation and Public Open Space (POS) irrigation
- Stormwater harvesting for non-potable use (POS irrigation and dual reticulation for toilet flushing and outdoor use)
- Prevention of illegal stormwater inflow connections to sewer
- Education and capacity building to support implementation of solutions
- Upgrade STP Capacity

A summary of the overall performance of this management scenario is detailed in Table E-11.

**Table E- 11 Caboolture River Management Scenario 3 Performance Summary**

| Indicator | Performance | Notes |
|---|---|---|
| Maximum Total CAPEX/EP | $6,771 | |
| Maximum Total Annual OPEX/EP | $100 | |
| Potable Water Saving (ML/year) | 2,914 | |
| Land Take (ha) | 410 | 1.2% of catchment |
| EHMP Grade 2010 | D | Receiving Waters Caboolture River Estuary |
| Predicted EHMP Grade 2031 | D+ | Meets 'no worsening' objectives for TSS & TP, not TN |

Additional economic assessment of Scenario 3 indicated that it was cost prohibitive to implement, and Scenario 2 was identified as the recommended alternative. Scenario 2 was selected due to significant cost savings with only marginally less water quality benefits. Solutions contained in Scenario 2 (the recommended management scenario for Caboolture River catchment) include:

- Future development meets QDC alternative water supply target
- Greenfield WSUD meets SPP Healthy Waters target
- Waterway riparian revegetation (3rd & 4th order streams)
- Rural BMP for grazing – fencing and revegetation of 1st & 2nd order streams
- Rural BMP for horticulture – filter strips
- Increased implementation/ enforcement of E&SC on development sites
- Recycled water supplied to agricultural users
- Prevention of illegal stormwater inflow connections to sewer
- Education and capacity building to support implementation of solutions
- Upgrade STP Capacity

A summary of the overall performance of this recommended management scenario is detailed in Table E-12.

**Table E- 12 Caboolture River Management Scenario 2 (Recommended) Performance Summary**

| Indicator | Performance | Notes |
|---|---|---|
| Maximum Total CAPEX/EP | $3,202 | |
| Maximum Total Annual OPEX/EP | $44 | |
| Potable Water Saving (ML/year) | 869 | |
| Land Take (ha) | 375 | 1.1% of catchment |
| EHMP Grade 2010 | D | Receiving Waters Caboolture River Estuary |
| Predicted EHMP Grade 2031 | D+ | Meets 'no worsening' objectives for TSS & TP, not TN |

As the recommended management scenario does not meet 'no worsening' requirements for TN, it is recommended that additional treatment measures be investigated to progressively work towards meeting this target:

- WSUD retrofit at a streetscape scale, particularly as opportunities arise through urban renewal and road upgrade projects, as well as implementation of end of pipe opportunities identified for Scenario 3 (refer to Appendix F)
- Stormwater harvesting in greenfield developments (as identified in Scenario 3).
- Upgrade of effluent nitrogen treatment process at Burpengary and Caboolture South STPs
- Potential cap on population growth.

Furthermore, if the proposed agricultural reuse scheme does not proceed, other opportunities to use recycled water (such as those identified in Scenario 3) should be considered.

***CIGA (within Caboolture River Catchment)***

Solutions in the preferred management scenario for CIGA catchment (Scenario 2) that was initially selected from the MCA include:

- Future development meets SPP Healthy Waters target
- Waterway riparian revegetation (3rd & 4th order streams)
- Increased implementation/ enforcement of E&SC on development sites
- Recycled water for dual reticulation & public open space irrigation, with remainder discharged to land
- Prevention of illegal stormwater inflow connections to sewer
- Education and capacity building to support implementation of solutions
- New STP

A summary of the overall performance of this management scenario is detailed in Table E-13.

**Table E- 13 CIGA Management Scenario 2 Performance Summary**

| Indicator | Performance | Notes |
|---|---|---|
| Maximum Total CAPEX/EP | $6,130 | |
| Maximum Total Annual OPEX/EP | $120 | |
| Potable Water Saving (ML/year) | 1,688 | |
| Land Take (ha) | 295 | 7.1% of catchment |
| EHMP Grade 2010 | C+ | Receiving Waters Caboolture River (freshwaters) |
| Predicted EHMP Grade 2031 | C- | Meets 'no worsening' objectives for TSS, not TN or TP |

Additional economic assessment of Scenario 2 indicated that it was cost prohibitive to implement, and Scenario 1 was identified as the recommended alternative. Scenario 1 was selected due to significant cost savings and slightly improved water quality benefits for nutrient removal. Solutions contained in Scenario 1, the recommended management scenario for CIGA catchment include:

- Future development meets SPP Healthy Waters target
- Future development meets QDC alternative water supply target (using rainwater tanks)
- Recycled water for public open space irrigation, with remainder discharged to land
- New STP

A summary of the overall performance of this recommended management scenario is detailed in Table E-14.

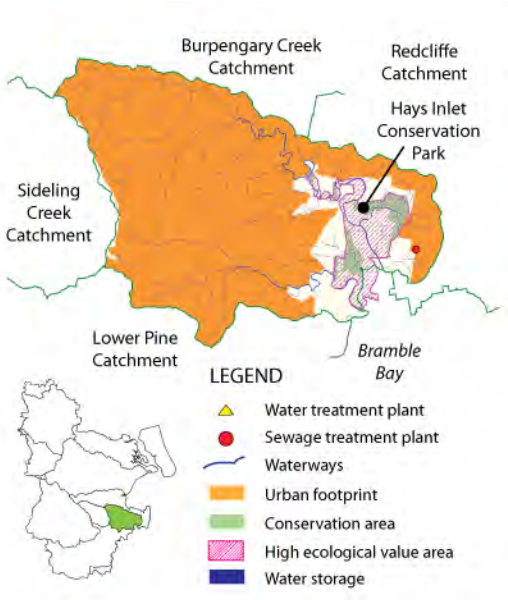
**Table E- 14 CIGA Management Scenario 1 Performance Summary**

| Indicator | Performance | Notes |
|---|---|---|
| Maximum Total CAPEX/EP | $4,991 | |
| Maximum Total Annual OPEX/EP | $84 | |
| Potable Water Saving (ML/year) | 1,735 | |
| Land Take (ha) | 411 | 9.9% of catchment |
| EHMP Grade 2010 | C+ | Receiving Waters Caboolture River (freshwaters) |
| Predicted EHMP Grade 2031 | C | Meets 'no worsening' objectives for TSS, not TN or TP |

As the recommended management scenario does not meet 'no worsening' requirements for TN or TP, it is recommended that additional management measures targeted at nutrient removal be further investigated as follows:

- Implementation of WSUD to achieve 'no worsening' in catchment pollutant loads
- Potential cap on population growth.

***Hays Inlet Catchment***




Solutions in the preferred and recommended management scenario for Hays Inlet catchment include:

- Future development meets QDC alternative water supply target
- Waterway riparian revegetation (3rd & 4th order streams)
- Increased implementation/ enforcement of E&SC on development sites
- Recycled water supplied to urban users (Redcliffe STP)
- Greenfield WSUD achieves 'No Worsening'
- Stormwater harvesting for non-potable use (dual reticulation for toilet flushing and outdoor use)
- WSUD retrofit to existing urban areas
- Prevention of illegal stormwater inflow connections to sewer
- Education and capacity building to support implementation of solutions
- Upgrade STP design capacity

A summary of the overall performance of this management scenario is detailed in Table E-15.

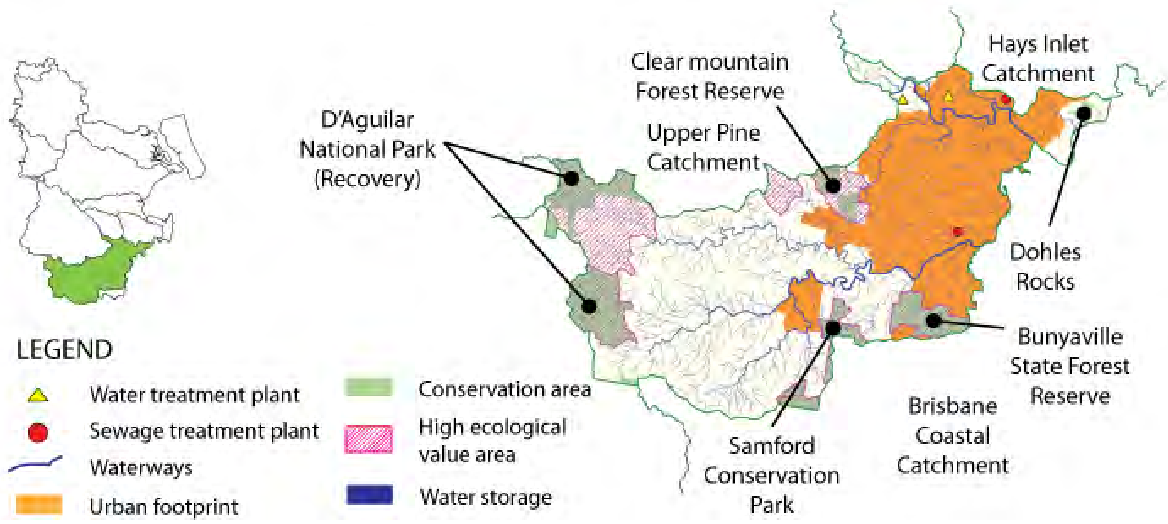
**Table E- 15 Hays Inlet Management Scenario Performance Summary**

| Indicator | Performance | Notes |
|---|---|---|
| Maximum Total CAPEX/EP | $2,471 | |
| Maximum Total Annual OPEX/EP | $19 | |
| Potable Water Saving (ML/year) | 830 | |
| Land Take (ha) | 43 | 0.6% of catchment |
| EHMP Grade 2010 | D+ | Receiving Waters Bramble Bay |
| Predicted EHMP Grade 2031 | C- | Meets 'no worsening' objectives for TSS and TP, not TN |

To achieve a 'no worsening' in water quality for TN, it is recommended that the following additional treatment measures be investigated:

- Upgrade of effluent nitrogen treatment process at Redcliffe STP
- Increased implementation of WSUD retrofit at a streetscape scale
- Potential cap on population growth.

***Lower Pine River Catchment***




Solutions in the preferred management scenario for Lower Pine River catchment (Scenario 3) that was initially selected from the MCA include:

- Future development meets QDC alternative water supply target
- Waterway riparian revegetation (3rd & 4th order streams)
- Increased implementation/ enforcement of E&SC on development sites
- Rural BMP for grazing – fencing and revegetation of 1st & 2nd order streams
- Rural BMP for horticulture – filter strips
- Greenfield WSUD achieves 'No Worsening'
- WSUD retrofit to existing urban areas
- Stormwater harvesting for non-potable use (Public open space irrigation and dual reticulation for toilet flushing and outdoor use)
- Indirect potable reuse of purified recycled water (PRW)
- Prevention of illegal stormwater inflow connections to sewer
- Education and capacity building to support implementation of solutions
- Upgrade WTP infrastructure
- Upgrade STP design capacity (Murrumba & Brendale)

A summary of the overall performance of this management scenario is detailed in Table E-16.

**Table E- 16 Lower Pine Management Scenario 3 Performance Summary**

| Indicator | Performance | Notes |
|---|---|---|
| Maximum Total CAPEX/EP | $2,255 | |
| Maximum Total Annual OPEX/EP | $41 | |
| Potable Water Saving (ML/year) | 15,714 | |
| Land Take (ha) | 104[1] | 0.4% of catchment |
| EHMP Grade 2010 | C- | Receiving Waters Pine River Estuary |
| Predicted EHMP Grade 2031 | C+ | Meets 'no worsening' objectives |

[1]Does not include storage area required for stormwater harvesting schemes

However, review of Scenario 3 indicated that significant implantation barriers exist that may prohibit implementation, and as such an alternative scenario was selected. Scenario 2 was selected as the next best alternative using results of the MCA. Solutions contained in Scenario 2 (the recommended fall back management scenario for the Lower Pine River catchment) include:

- Future development meets SPP HW targets
- Future development meets QDC alternative water supply target
- Waterway riparian revegetation (3rd & 4th order streams)
- Increased implementation/ enforcement of E&SC on development sites
- Rural BMP for grazing – fencing and revegetation of 1st & 2nd order streams
- Rural BMP for horticulture – filter strips
- Recycled water supplied to urban users (open space and commercial use)
- Prevention of illegal stormwater inflow connections to sewer
- Education and capacity building to support implementation of solutions
- Upgrade WTP infrastructure
- Upgrade STP design capacity (Murrumba & Brendale)

A summary of the overall performance of this recommended management scenario is detailed in Table E-17.

**Table E- 17 Lower Pine Management Scenario 2 Performance Summary**

| Indicator | Performance | Notes |
|---|---|---|
| Maximum Total CAPEX/EP | $1,997 | |
| Maximum Total Annual OPEX/EP | $58 | |
| Potable Water Saving (ML/year) | 1,393 | |
| Land Take (ha) | 82 | 0.3% of catchment |
| EHMP Grade 2010 | C- | Receiving Waters Pine River Estuary |
| Predicted EHMP Grade 2031 | D+ | Meets 'no worsening' objectives for TSS, not TN or TP |

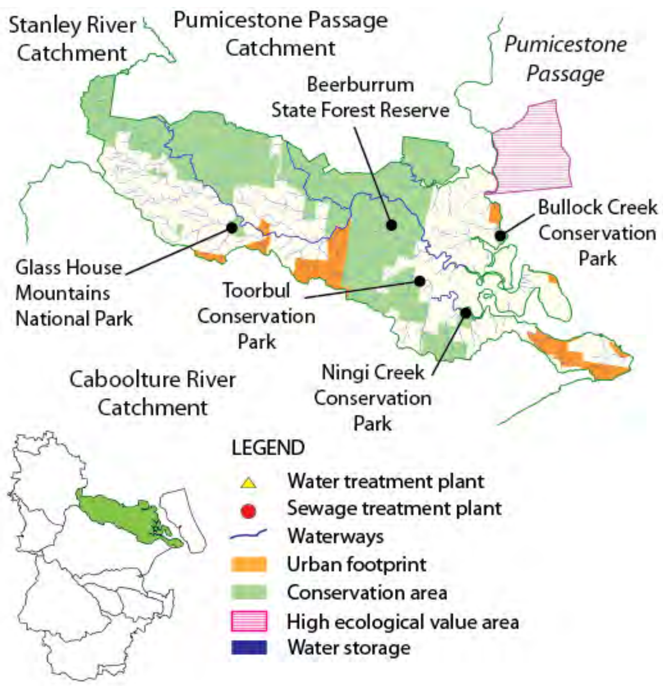
If the preferred scenario is not adopted, it is evident that the recommended alternative preference (Scenario 2) will need additional solutions investigated to achieve 'no worsening' in pollutant loads for TN and TP. The following solutions in Scenario 3 that target nutrient reduction may be added to work towards meeting these targets:

- WSUD retrofit to existing urban areas (end-of-pipe bioretention basins and wetlands)
- Stormwater harvesting for non-potable reuse

However it is noted that the above solutions investigated will still not achieve 'no-worsening' in nutrient pollutant loads. Therefore additional management measures will need to be investigated to work towards achieving these targets, including:

- Greater implementation of WSUD in existing areas (i.e. streetscape retrofit)
- Improved effluent treatment performance processes at Brendale and Murrumba STP
- Cap on population growth

***Pumicestone Catchment***




Solutions in the preferred and recommended management scenario for Pumicestone catchment include:

- Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN
- Future development meets QDC alternative water supply target
- Rural BMP for grazing – fencing and revegetation of 1st & 2nd order streams
- Rural BMP for horticulture – filter strips
- Waterway riparian revegetation on 3rd & 4th order streams

- Increased implementation/ enforcement of E&SC on development sites
- Education and capacity building to support implementation of solutions.

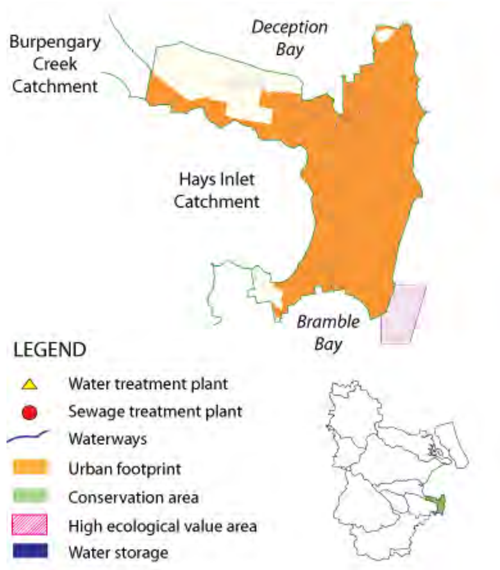
A summary of the overall performance of this management scenario is detailed in Table E-18.

**Table E- 18 Pumicestone Management Scenario Performance Summary**

| Indicator | Performance | Notes |
|---|---|---|
| Maximum Total CAPEX/EP | $2,601[1] | |
| Maximum Total Annual OPEX/EP | $28 | |
| Potable Water Saving (ML/year) | 15,714 | |
| Land Take (ha) | 126 | 0.1% of catchment |
| EHMP Grade 2010 | D+ | Receiving Waters Pumicestone Passage |
| Predicted EHMP Grade 2031 | C- | Meets sustainable load targets. |

[1]Does not account for cost of future development meeting SPP Healthy Water targets, a large proportion of which will be paid by industrial land developers.

***Redcliffe Catchment***




Solutions in the preferred and recommended management scenario for Redcliffe catchment include:

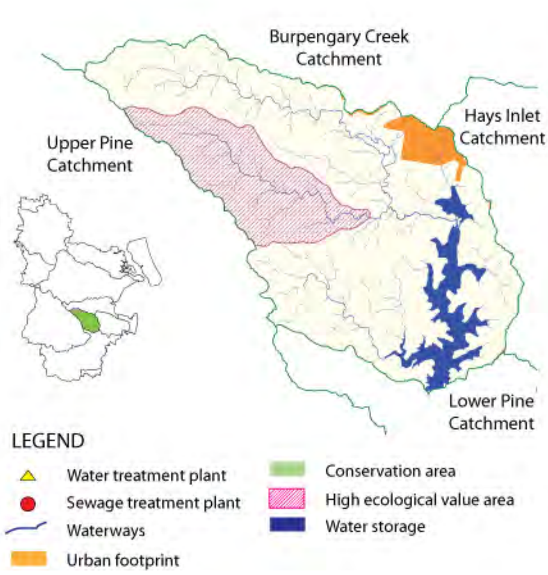
- Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN
- Future development meets QDC alternative water supply target.

A summary of the overall performance of this management scenario is detailed in Table E-19.

**Table E- 19 Redcliffe Management Scenario Performance Summary**

| Indicator | Performance | Notes |
|---|---|---|
| Maximum Total CAPEX/EP | $1,274 | |
| Maximum Total Annual OPEX/EP | $7.63 | |
| Potable Water Saving (ML/year) | 472 | |
| Land Take (ha) | 2 | 0.1% of catchment |
| EHMP Grade 2010 | D+ | Receiving Waters Deception/ Bramble Bay |
| Predicted EHMP Grade 2031 | D+ | Meets 'no worsening' objectives |

***Sideling Creek Catchment***




Solutions in the preferred and recommended management scenario for Sideling Creek catchment include:

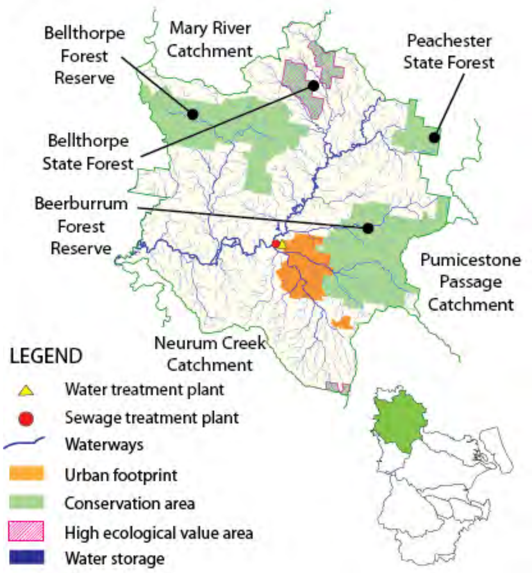
- Waterway riparian revegetation on 3rd & 4th order streams
- Rural BMP for grazing - fencing and revegetation of 1st & 2nd order streams
- Rural BMP for horticulture - filter strips
- Education and capacity building to support implementation of solutions.

A summary of the overall performance of this management scenario is detailed in Table E-20.

**Table E- 20 Sideling Management Scenario Performance Summary**

| Indicator | Performance | Notes |
|---|---|---|
| Maximum Total CAPEX/EP | $23 | |
| Maximum Total Annual OPEX/EP | $0.05 | |
| Potable Water Saving (ML/year) | 0 | |
| Land Take (ha) | 21 | 0.4% of catchment |
| EHMP Grade 2010 | C- | Receiving Waters Pine River (freshwater) |
| Predicted EHMP Grade 2031 | C | Meets 'no worsening' objectives |

***Stanley River Catchment***




Solutions in the preferred and recommended management scenario for Stanley River catchment include:

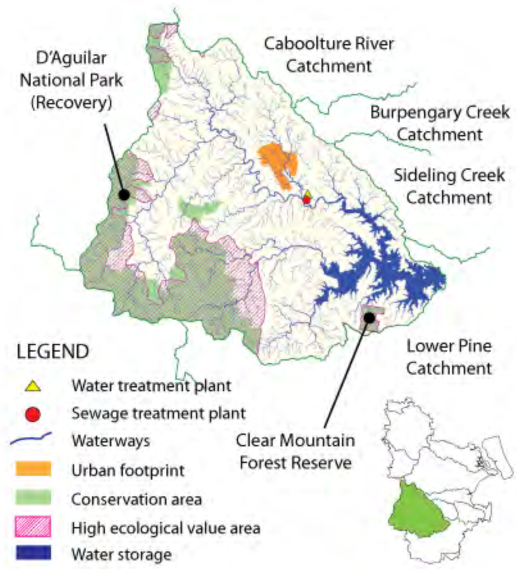
- Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN
- Future development meets QDC alternative water supply target
- Rural BMP for grazing – fencing and revegetation of 1st & 2nd order streams
- Rural BMP for Horticulture – filter strips
- Waterway riparian revegetation on 3rd & 4th order streams
- Increased implementation/ enforcement of E&SC on development sites
- Land disposal of STP effluent (Woodford)
- Prevention of illegal stormwater inflow connections to sewer
- Upgrade Woodford STP capacity
- Education and capacity building to support implementation of solutions

A summary of the overall performance of this management scenario is detailed in Table E-21.

**Table E- 21 Stanley Management Scenario Performance Summary**

| Indicator | Performance | Notes |
|---|---|---|
| Maximum Total CAPEX/EP | $5,709 | |
| Maximum Total Annual OPEX/EP | $33 | |
| Potable Water Saving (ML/year) | 93 | |
| Land Take (ha) | 250 | 0.8% of catchment |
| EHMP Grade 2010 | B- | Receiving Waters Stanley River |
| Predicted EHMP Grade 2031 | B | Meets 'no worsening' objectives |

***Upper Pine River Catchment***




Solutions in the preferred and recommended management scenario for Upper Pine River catchment include:

- Future development meets QDC alternative water supply target
- Waterway riparian revegetation on 3rd & 4th order streams
- Rural BMP for grazing – fencing and revegetation of 1st & 2nd order streams
- Rural BMP for horticulture – filter strips
- Increased implementation/ enforcement of E&SC on development sites
- Greenfield WSUD achieves 'no worsening'
- Prevention of illegal stormwater inflow connections to sewer
- Upgrade WTP capacity
- Upgrade STP capacity
- Education and capacity building to support implementation of solutions

A summary of the overall performance of this management scenario is detailed in Table E-22.

**Table E- 22 Upper Pine Management Scenario Performance Summary**

| Indicator | Performance | Notes |
|---|---|---|
| Maximum Total CAPEX/EP | $1,343 | |
| Maximum Total Annual OPEX/EP | $8.52 | |
| Potable Water Saving (ML/year) | 25 | |
| Land Take (ha) | 161 | 0.5% of catchment |
| EHMP Grade 2010 | C- | Receiving Waters Pine River (freshwater) |
| Predicted EHMP Grade 2031 | C+ | Meets 'no worsening' objectives |

# 1 INTRODUCTION

This Total Water Cycle Management (TWCM) Plan presents the findings from the detailed planning phase in a TWCM planning process for the Moreton Bay Regional Council (MBRC) area. This document builds on the initial phase of the process which was the development of a TWCM Strategy, prepared in 2010 (BMT WBM, 2010).

The TWCM Plan represents the **second** phase in a two phase process, as follows:

- **Phase 1 - Preparation of a TWCM Strategy document**. This involved the identification of water cycle management drivers and issues in the MBRC region, development of solutions to address the identified issues, and preliminary assessment of these solutions resulting in a short list of solutions for further detailed analysis in Phase 2.
- **Phase 2 - Preparation of the final TWCM Plan (this document).** This phase involves a detailed assessment of the costs and benefits of total water cycle management options. It identifies a preferred management option to assist with Council's priority infrastructure planning.

Some of the key findings of Phase 1 are outlined in the following section to provide some background to the project, however the reader is referred to the Phase 1 Strategy report (BMT WBM, 2010) for detailed documentation.

This TWCM Plan has been developed in accordance with *the TWCM Planning Guideline for South East Queensland* (WBD, 2010a) in order to satisfy requirements of the *Environmental Protection (Water) Policy (2009).*

# 2 BACKGROUND

With the recent 'Millennium Drought' experienced in SEQ, which saw regional bulk water supplies drop below 20%, the issue of water security has become a high priority. This, combined with the high population growth currently being experienced (and forecast to continue) in the region, demonstrates that detailed planning in regard to the utilisation of water resources in the SEQ region is essential. This planning will ensure that existing environmental, social and economic values in the region are maintained or improved.

In this context, the *Environmental Protection (Water) Policy 2009* (EPP Water) was revised and released in August 2009 and has replaced the original policy which was first released in 1997. This updated version of the EPP Water now prescribes that all Local Government Areas (LGAs) that contain over a certain population must develop and implement a TWCM Plan specific to its local government area (DERM, 2009).

The EPP Water describes the matters that must be taken into account when an LGA is preparing a TWCM Plan. 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* (DIP, 2009) 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.

Moreton Bay Regional Council (MBRC) is one of the first LGAs in Queensland to commence the process of TWCM Planning. Previous water cycle management plans have been developed in recent years for the Pine Rivers area. These studies include:

- Pine Rivers Integrated Urban Water Cycle Management Concept Study (MWH, 2005);
- Northern Growth Corridor (NGC) Integrated Urban Water Management Study (MWH, 2006); and
- Moreton Bay Regional Council Pine Rivers Area Integrated Urban Water Cycle Management Strategy (MWH, 2009).

The TWCM Plan for MBRC builds on the findings of these previous studies, along with other studies undertaken in the area such as sustainable load studies for a number of major waterways in the region.

Under Section 19 (3)(d) of the EPP Water (2009), TWCM Plans must have regard to the findings of subregional TWCM Plans. Concurrent to the TWCM planning activities being undertaken by MBRC and other LGAs, the Queensland Water Commission (QWC) is also required to develop sub-regional TWCM Plans (S-R TWCM Plans) in areas identified in the *South East Queensland Regional Plan 2009-2031* (SEQ Regional Plan), where large scale development and significant infrastructure is to occur. The focus of sub-regional TWCM Plans is to plan water service infrastructure needs using TWCM principles. In this context, within the MBRC region, a sub-regional TWCM Plan also needs to be prepared for an area west of Caboolture referred to herein as the "Caboolture Identified Growth Area" (CIGA). This area has been identified as a significant growth area within the SEQ Regional Plan.

As the CIGA is located within one of the major catchments in the MBRC jurisdiction (i.e. Caboolture River catchment), the TWCM Strategy developed by Council considered the implications of this potential growth area. Subsequently, during the detailed planning phase (Phase 2), a collaborative approach was adopted between MBRC and QWC to build on the work that had been undertaken in Phase 1 (strategy development) to prepare a S-R TWCM Plan for the CIGA as part of Phase 2 of the local government TWCM Planning process.

Despite these two planning processes being undertaken concurrently, the S-R TWCM Plan for the CIGA has been documented separately to meet the requirements of the QWC framework for preparing S-R TWCM Plans. However, TWCM planning outcomes for the CIGA are also investigated and documented in this TWCM Plan.

## 2.1 EPP Water Requirements

Although there are many legislative and policy drivers for Total Water Cycle Management Planning, of key importance is regulatory requirements of the EPP Water (2009), which requires that MBRC develop and implement a TWCM Plan that addresses issues specific to its local government area prior to 1 July 2012. The specific requirements of the EPP Water (2009) are reproduced in Box 1 below.

**Box 1: EPP Water (2009) Requirements for Developing Total Water Cycle Management Plans** (*Reprint No 1B, as in force on 16 July 2010, Division 2).*

**S19 Total water cycle management—general**

(2) A local government's total water cycle management plan must include provisions about—

(a) the collection, treatment and recycling of waste water, stormwater, ground water and other water sources; and

(b) the integration of water use in its area.

(3) In developing and implementing the plan, the local government must have regard to (a) any guidelines published by the department about water cycle management; and

(b) any regional water security program made under the Water Act 2000, section 360M applying to its local government area; and

(c) any regional water supply strategy applying to its local government area; and

(d) for a local government within the SEQ region, each of the following plans, to the extent the plan applies to its local government area—

(i) SEQ regional plan;

(ii) any sub-regional total water cycle management plan under the SEQ regional plan.

(4) The local government must consider including in the plan—

(a) a strategy for demand management for water in its local government area; and

(b) ways to increase recycling of waste water and stormwater for purposes including, for example, industrial or agricultural purposes; and

(c) ways to use recycled waste water; and

(d) opportunities for stormwater harvesting for use as a water source; and

(e) the impacts of existing and future land use in the area on water cycle management, including the following—

(i) impacts of the use on the natural flow of waters;

(ii) impacts of the use on water quality objectives for waters;

(iii) the risks to drinking water supplies caused by the use; and

(f) a forecast of the water supply requirements for the area.

**S21 Total water cycle management—urban stormwater quality management**

(1) A local government's total water cycle management plan must include provisions about its stormwater quality management to improve the quality and flow of stormwater in ways that protect the environmental values of waters affected by the local government's urban stormwater system.

(2) The local government must consider including in the plan provisions about—

(a) identifying urban stormwater quality management needs for developed and developing areas that are consistent with the local government's priority infrastructure plan under the Planning Act; and

(b) the opportunities for stormwater harvesting, recycling or re-use; and

(c) incorporating water sensitive urban design in developed areas within a stated period; and

(d) managing urban stormwater quality and flows for development in the local government's area, having regard to the following documents—

(i) any site specific documents;

(ii) the QWQ guidelines;

(iii) relevant guidelines published by the department about stormwater quality; and

(e) monitoring and reporting processes for stormwater quality management.

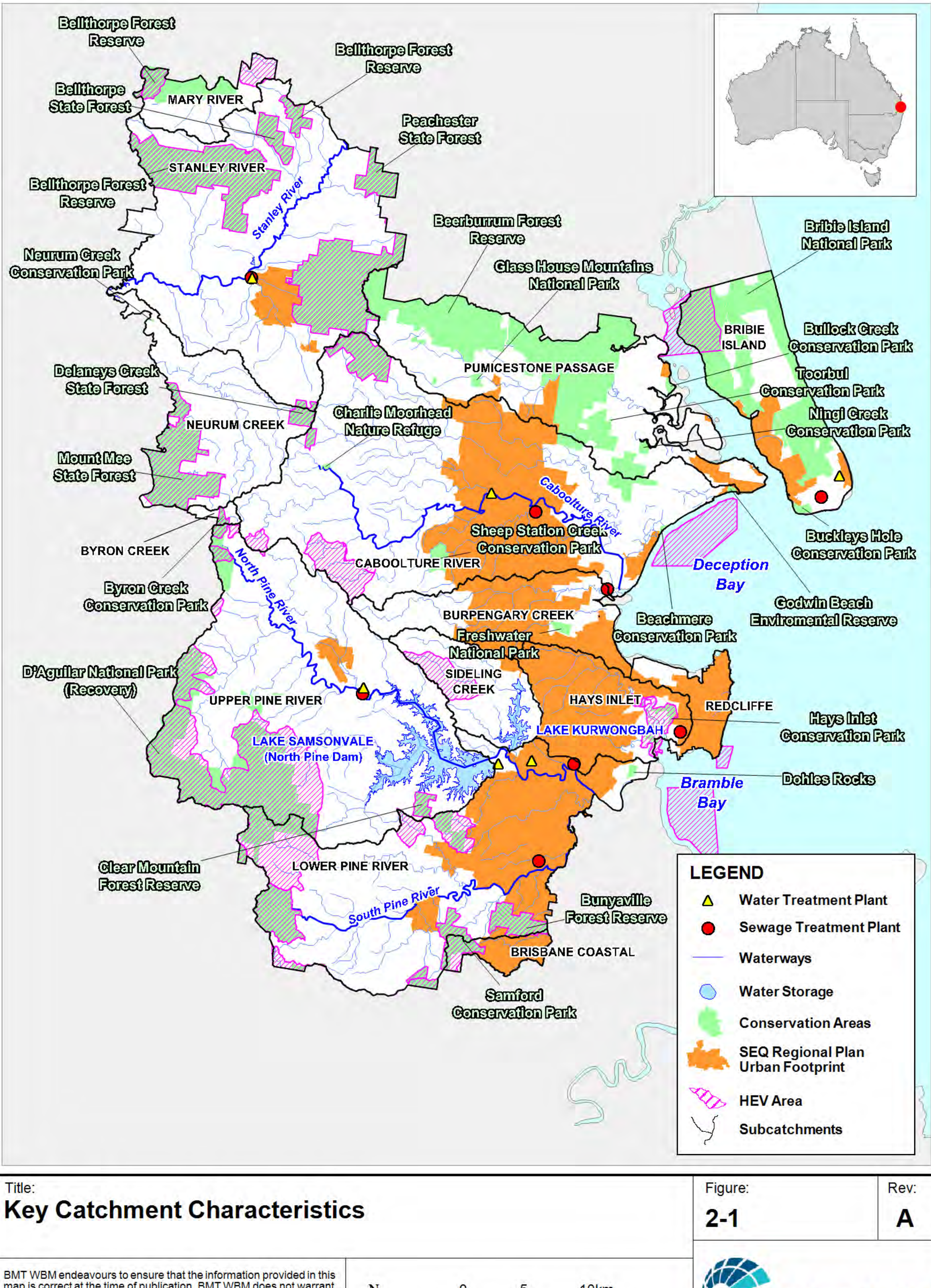
## 2.2 Study Area

The detailed planning study area and key catchment characteristics are summarised in Table 2-1 and Figure 2-1. It is noted that the Mary River, Byron Creek and Neurum Creek catchments are not included in the detailed planning area, as no key water management issues were identified for these catchments during the Strategy development phase.

**Table 2-1 Key Characteristics of Detailed Planning Area**

| Catchment | Area | Residential Population[1] | | Land Use [2] | | Water Treatment Plant | Sewage Treatment Plant | Potable Water Storage |
|---|---|---|---|---|---|---|---|---|
| | (Ha) | 2010 | 2031 | Urban | Rural[4] | | | |
| Bribie Island | 10,710[3] | 17,133 | 21,830 | 11% | 89% | Banksia Beach WTP | Bribie Island STP | Bribie Island Borefields |
| Pumicestone Passage | 18,480[3] | 11,415 | 12,183 | 9% | 91% | - | - | - |
| Redcliffe | 2,662 | 49,638 | 72,858 | 73% | 27% | - | - | - |
| Caboolture River [6] | 34,830 | 69,546 | 112,227 | 20% | 80% | Caboolture WTP | South Caboolture and Burpengary East STPs | Caboolture Weir |
| CIGA | 4,160 | 0 | 52,500 | 73% | 27% | - | New STP Required | - |
| Burpengary Creek | 8,435 | 42,766 | 64,396 | 33% | 67% | - | - | - |
| Hays Inlet | 7,599 | 63,613 | 111,641 | 56% | 44% | - | Redcliffe STP[5] | - |
| Brisbane Coastal | 1,530 | 22,601 | 24,058 | 39% | 61% | - | - | - |
| Sideling Creek | 5,267 | 1,397 | 2,609 | 11% | 89% | Petrie WTP | - | Lake Kurwongbah |
| Lower Pine River | 28,280 | 90,695 | 132,974 | 21% | 79% | - | Murrumba Downs and Brendale STPs | - |
| Upper Pine River | 34,890 | 2,014 | 3,223 | 3% | 97% | North Pine and Dayboro WTPs | Dayboro STP | North Pine Dam, Dayboro Borefields |
| Stanley River | 31,830 | 4,073 | 8,642 | 3% | 97% | Woodford WTP | Woodford STP | Woodford Weir |

Notes:
[1]Population sourced from Unitywater Demand Model (Residential EP)
[2] Land use based on 2031 mapping for medium growth scenario ('Scenario 3 Medium – Low Density')
[3] Does not include area outside of MBRC's jurisdiction
[4] This includes green space
[5]While the Redcliffe STP is physically located in Hays Catchment, Murrumba Downs STP treats the majority of wastewater generated in this catchment
[6] Future population figure does not include the Caboolture Investigation Growth Area (CIGA)




Title:
**Key Catchment Characteristics**

Figure: 2-1

Rev: A



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## 2.3 Key Drivers for TWCM Planning

The TWCM Strategy (BMT WBM, 2010), identified the key drivers in terms of TWCM planning in MBRC. These key drivers can be summarised as follows:

**Population growth** – it is estimated that population growth will remain strong in SEQ and in certain parts of MBRC in particular (e.g. Northern Growth Corridor). This additional population growth will need to be considered in terms of additional resources and infrastructure required along with additional pressures on environmental values. Future scenarios will require detailed analysis of where the population growth will occur, how it will occur (i.e. population densities), and the additional inputs and outputs into the water accounting equation.

**Water supply** – despite the 'water supply guarantee' outlined in the SEQ Water Strategy, it is evident that security of water supply in the MBRC area is a driver of the TWCM planning process. When developing the TWCM Plan for MBRC, these water supply sources and their future security will need to be considered. It will also be important to investigate other potential sources of potable water in the region (such as recycled water and stormwater harvesting) so that reliance on the current, largely catchment runoff-based sources is diversified.

**Environmental flows** – environmental flow objectives for a number of waterways in MBRC are contained in the *Water Resource (Moreton) Plan 2007.* The consequence of having to maintain environmental flow objectives in these waterways can potentially adversely impact on the available water supply and associated harvestable yield in the region. If water storages are required to release a certain amount of water to downstream reaches, this can reduce yields. Combine this with the potential impacts of climate change and increasing population on water supplies, and it is evident that the TWCM planning process will need to account for environmental flow requirements in any future water accounting scenarios to ensure that storage yields are properly determined.

**Climate change** – in SEQ, it is estimated that climate change may impact on future water supplies. This impact may potentially result in a 10% reduction in surface water supply/yield, and it is therefore essential that this impact is considered in any future scenarios from a water supply perspective. This also places emphasis on the need for the investigation of other sources of water which are less susceptible to climate change impacts, given the current reliance on surface water supplies in the region.

**Water conservation** – water savings targets have been set in the SEQ Regional Plan in order to reduce residential and non-residential water demand. While the TWCM Plan may include solutions for additional water supplies, it is essential that water conservation maintains a continued focus in order to minimise inefficient water use. This may delay or eliminate the need for future water infrastructure upgrades, such as desalination plants, and also contributes to wastewater flow/load reduction targets.

**Wastewater management** – the key driver in terms of wastewater management is the current need for STPs to comply with legislative requirements of the *Environmental Protection Act 1994* and the EPP Water while also accommodating for future development and growth within MBRC. In order to achieve this, sustainable pollutant loads for receiving waterways (i.e. the annual pollutant load that waterways can assimilate without exceeding concentration based WQOs) will need to be quantified and inputs from wastewater will need to be considered along with other inputs (i.e. diffuse loads) in the context of Total Water Cycle Management.

Additionally, Council's commitment to the SEQ Healthy Waterways Strategy 2007 - 2012, and specifically the Point Source Pollution Management Action Plan - which has a target to prevent 100% of nutrient point sources from entering Moreton Bay by 2026 - is another key driver.

**Water quality** - the key water quality drivers in terms of water quality are: to meet regulatory requirements of the *EP Act 1994* and EPP Water 2009 which prescribe the development of a TWCM Plan and to achieve WQOs to protect Environmental Values; to meet commitments of the SEQ Healthy Waterways Strategy 2007-2012, which aims to achieve waterways and catchments that are healthy ecosystems supporting the livelihoods and lifestyles of people in SEQ by 2026; meet targets set in the SEQ Natural Resources Management Plan that are aligned with desired regional outcomes and policies for Water Management in the SEQ Regional Plan; and to implement planning and management of urban stormwater to comply with the design objectives as set out in the *SEQ Regional Plan 2009-2031 Implementation Guideline No. 7: Water Sensitive Urban Design,* as well as management of urban stormwater and waste water to comply with the *SPA (2009)* and State Planning Policy for Healthy Waters (effective 28 February 2011).

Considering the current condition of waterways, and the future population growth and development pressures in the region, existing water quality pressures on receiving waters in the region are likely to significantly increase. These are key challenges that will need to be addressed in the TWCM planning process.

**Water quantity (flooding)** - the TWCM planning process will need to consider flooding impacts when developing management solutions. There should be no increase in flooding risk from any of the solutions developed, and ideally the target should be to decrease the flooding risk in each catchment as well as downstream impacts, where possible.

**Water industry institutional arrangements** - a recent water industry reform has resulted in the formation of a new water distribution and retail business serving the needs of both the Moreton Bay and Sunshine Coast communities. This new entity is called Unitywater and commenced operations on 1 July 2010. Any implications associated with the establishment of this new entity and the functional responsibility split between MBRC and Unitywater will need to be considered in the TWCM Plan. Unitywater will be the responsible organisation for delivering many of the water cycle solutions developed for the TWCM Plan and a foreshadowed amendment to the EPP Water will require MBRC to seek the endorsement of the TWCM Plan by the local Water Distribution Retailer.

**Protection of environmentally sensitive areas** - a number of areas have been identified within MBRC which are environmentally sensitive and require protection from adverse environmental stressors. These areas are important environmental assets, on both a local and regional scale. One outcome from the TWCM planning process will be the development of measures which minimise existing and future environmental impacts on these areas.

**Legislative and Policy Drivers** - the various legislation and policy which are relevant in the context of TWCM planning include the following:

- *Sustainable Planning Act 2009;*
- *Environmental Protection Act 1994;*
- *Water Act 2000;*
- *Water Supply (Safety and Reliability) Act 2008;*
- *Public Health Regulation 2008;*
- State Planning Policy for Healthy Waters (SPP for Healthy Waters, effective 28 February 2011);
- SEQ Regional Plan 2009-2031 Implementation Guideline No. 7: Water Sensitive Urban Design;
- SEQ Regional Plan 2009-2031;
- SEQ Water Strategy;
- SEQ Healthy Waterways Strategy;
- SEQ Natural Resource Management Plan;
- SEQ Regional Water Security Program; and
- Draft SEQ Climate Change Management Plan.

## 2.4 Key Issues for Total Water Cycle Management

Existing and future water cycle accounts and catchment constraints together with findings from a literature review were used to identify the key water cycle management issues within each catchment during the Strategy development phase. A summary of the key water cycle management issues and the assessment criteria/ information used to identify whether the issue was flagged in each individual catchment is summarised in Table 2-2.

**Table 2-2 Assessment Criteria Used to Identify Key Water Cycle Management Issues**

| Water Cycle Management Issue | Assessment Criteria |
|---|---|
| Population Growth | Significant increase in urban population by 2031, defined as >20,000 people or > 100% (i.e. doubling of population). |
| Water Supply | Demand greater than known sustainable storage yields or nominal water treatment plant capacity. Level of Service objectives not met. |
| Environmental Flows | Modelled catchment flows do not meet the minimum mean annual flow criteria set out in the Water Resource (Moreton) Plan 2007. |
| Sewage Treatment Plant (STP) Capacity | Population exceeds the design or the licence capacity (in EP) of STP, or predicted nutrient or discharge loads exceed licence conditions. |
| Water Quality | Waterway Report Card Results below 'C', predicted increase in pollutant loads/catchment loads exceed sustainable load targets, Council water quality monitoring results indicating water quality hotspots which do not meet WQOs, development pressures in drinking water catchments. |
| Flooding | Due to limited availability of information, this was flagged as an issue in catchments with large areas of urban development. |
| Environmentally Sensitive Areas | Presence of High Ecological Value receiving waters, potential for development to impact on other environmentally sensitive areas. |

A summary of the key water cycle management issues identified in each catchment for further detailed planning investigations is presented in Table 2-3.

**Table 2-3 Key Catchment Issues for Water Cycle Management**

| Catchment | Water Cycle Management Issue | | | | | | |
|---|---|---|---|---|---|---|---|
| | Water Quality | Environmentally Sensitive Areas | Population Growth | Water Supply | STP Capacity | Environmental Flows | Flooding |
| Bribie | ✓ | ✓ | | | | | |
| Brisbane Coastal | ✓ | | | | | | |
| Burpengary | ✓ | | ✓ | | ✓ | | ✓ |
| Caboolture | ✓ | ✓ | ✓ | | ✓ | | ✓ |
| Hays Inlet | ✓ | ✓ | ✓ | | ✓ | | ✓ |
| Lower Pine | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Pumicestone | ✓ | ✓ | ✓ | | | | |
| Redcliffe | ✓ | ✓ | ✓ | | ✓ | | ✓ |
| Sideling | ✓ | | | | | | |
| Stanley | ✓ | | ✓ | ✓ | ✓ | ✓ | |
| Upper Pine | ✓ | | | ✓ | ✓ | | |

It is noted that a detailed assessment to identify flooding issues in catchments was not undertaken. During the strategy development, it was noted that detailed flood studies were being undertaken in parallel with the TWCMP that would identify and address flooding issues within the region. It was decided that these studies would be referred to as a companion document to the TWCMP, until such time that the TWCMP may be reviewed to incorporate the findings of the detailed flood studies.

From Table 2-3 it can be seen that water quality was identified as a key management issue requiring detailed planning in order to ensure sustainable development within MBRC. Pressures on water quality within the region are reflected by the Ecosystem Health Monitoring Program (EHMP) results (undertaken by the SEQ Healthy Waterways Partnership), in which only freshwaters within the Stanley River catchment received an Ecosystem Health rating of 'good' in 2010 (B+), with borderline 'sound' ratings recorded for freshwaters in Caboolture River (C+), Pine River (C-) and Pumicestone Passage (C-) catchments. Furthermore, receiving estuaries in Pumicestone Passage (D+) and Caboolture River (D) Catchments as well as Bramble (D+) and Deception Bay (D+) recorded 'poor' water quality. EHMP monitoring trends show that a key challenge to maintaining waterway health in SEQ is managing diffuse stormwater pollutant loads in both urban and non-urban areas. This is likely to be a key pressure within MBRC catchments due to future predicted increases in population and development in the region. While Stanley River catchment received an ecosystem health rating of 'good' in 2010, it is a drinking water catchment and hence was flagged to have water quality management issues due to future development pressures in the catchment.

In addition to diffuse loads, the future increase in pollutant loads from STPs is significant and will place additional pressures on the ecological health of receiving waters (should loads be discharged rather than reused/ treated), which are already under pressure as demonstrated by EHMP report card scores.

Many of the catchments in Table 2-3 have been flagged as having STP capacity issues. Importantly, those STPs predicted to exceed licence capacities present key management issues, as development approvals will be required to proceed with upgrades to cater for population growth. Future development approvals and STP licences are likely to impose nutrient load limit conditions in addition to volumetric discharges in order to satisfy the intent of legislative requirements (EPP Water). To gain these approvals, it is likely that significant treatment and/or reuse will be required.

Hence it can be seen that environmental management issues in the region (meeting receiving water quality objectives with increased point and diffuse load pressures) will largely influence total water cycle management solutions and planning requirements.

# 3 INITIAL SOLUTION ASSESSMENT

A number of potential management responses or ‘solutions’ were developed during the strategy development phase (BMT WBM, 2010) to address the key issues identified within each catchment.

To assist in the selection of solutions for further investigations during the detailed planning stage, a Multi Criteria Analysis (MCA) assessment approach was used.

Objectives for the TWCM Strategy were set to reflect triple bottom line (environmental, social and economic) performance targets of the region, as well as meeting legislative and policy requirements. Criteria with which to assess the performance of each solution in meeting these overarching objectives were then developed. The criteria developed were divided into environmental, social and economic categories, and were based on previous work undertaken for the Northern Growth Corridor Integrated Urban Water Cycle Management Strategy (MWH, 2006) and consultation with Councillors, representatives from MBRC and UnityWater and an Expert Panel comprising of senior Bligh Tanner, and BMT WBM staff. Each criteria was assigned a weighting in consensus with key stakeholders according to the importance placed on that criteria.

Sensitivity analyses undertaken indicated that changing the weighting of Environmental, Social and Economic criteria categories did not significantly affect the preferred solutions for each catchment. Therefore an even weighting distribution between Environmental, Social and Economic criteria categories was adopted. Table 3-1 lists the criteria and weightings adopted to assess solutions in the study.

Solutions were scored over 3 half day workshops by an Options Analysis Team that was nominated by MBRC and approved by Councillors. Workshop participants invited to attend included Councillors, members of the Strategic Coordination Advisory Group, MBRC representatives, and Unitywater representatives.

During the workshops, each solution was scored by the Options Analysis Team for all relevant catchments. The scoring was undertaken using a consensus method. That is, each solution was discussed and debated in terms of how it satisfied each individual criteria and was scored by the workshop facilitator with the consensus of workshop participants.

A qualitative scoring system was used. Where appropriate, solution scores in catchments were adjusted to reflect the potential scale of pressures from development of that particular catchment in comparison to the whole MBRC Region. Scoring of the outcomes generated by each solution against each individual assessment criteria was undertaken using the scoring system detailed in Table 2-3. The scoring was undertaken by comparison of the proposed solution scenario against the future case of 2031 with business as usual (BAU) (i.e. with no solutions implemented).

The overall score of each solution was then determined by adding together the weighted scores for each of the 16 criteria. An overall weighted score was then determined to represent the performance of all relevant solutions in each catchment.

Using the overall weighted solution scores, solutions were ranked from highest to lowest for each catchment. The top ranking solutions were then selected for each catchment until it was satisfied that a group of solutions or 'solution set' had been selected that sufficiently addressed all issues identified within the catchment of interest. This process allowed all options to be initially screened and the best options (i.e. solution set) to be selected for further investigation and refinement in the detailed planning phase (this study).

**Table 3-1 Adopted Criteria and Weighting for Use in the MCA**

| Criteria Category and Weighting | Criteria | Criteria Weighting |
|---|---|---|
| **Environmental Weighting = 33.3%** | Changes in water quality in inland water systems, as well as changes to biodiversity, and bed and bank integrity | 10% |
| | Changes in hydrology | 10% |
| | Changes to water quality and biodiversity in estuaries and Moreton Bay | 30% |
| | Changes in water quality and flow and biodiversity of groundwater systems | 5% |
| | Changes in emissions of greenhouse gases | 15% |
| | Impact on environmentally sensitive values. | 30% |
| | *Total Environmental Criteria Weighting* | *100%* |
| **Social Weighting = 33.3%** | Impacts on water supply | 20% |
| | Impacts on human health | 20% |
| | Impacts on public amenity/recreation | 20% |
| | Impacts on flooding hazard | 10% |
| | Level of community understanding, engagement and ownership | 10% |
| | Public acceptability | 20% |
| | *Total Social Criteria Weighting* | *100%* |
| **Economic Weighting = 33.3%** | Financial impacts on MBRC – Outlays, capital and operating expenditure and revenue | 30% |
| | Financial impacts including costs and cost savings on consumers (e.g. infrastructure charges) and other organisations | 30% |
| | Impacts on local industries that rely on the environment (Fisheries, tourism) | 15% |
| | Employment plus local economic sustainability | 25% |
| | *Total Economic Criteria Weighting* | *100%* |

**Table 3-2 MCA Scoring System**

| Qualitative Description | Score |
|---|---|
| Very much better | 4 |
| Much better | 3 |
| Moderately better | 2 |
| Little better | 1 |
| No better (same as BAU) | 0 |
| Little worse | -1 |
| Moderately worse | -2 |
| Much worse | -3 |
| Very much worse | -4 |

## 3.1 Screening of Solutions

The TWCM Strategy developed in Phase 1 identified the top ranking solutions (using Multi Criteria Analysis) for each catchment to address the key water cycle management issues identified in each catchment. These solutions were recommended for further investigation in the detailed planning phase of the project (this study).

Feasibility assessment workshops were scheduled with key stakeholders (MBRC and Unitywater) to assist in screening and selecting refined solution sets (from those identified in Phase 1) for each catchment. Feasibility assessment workshops were undertaken on 24 and 25 February 2011.

Participants at the workshops included representatives from Council and Unitywater, as well as the consultancy team.

During the workshops, shortlisted solutions for each catchment identified in Phase 1 were examined in more detail using the input, expertise and local knowledge of workshop participants to identify the benefits, constraints, risks and opportunities associated with all of the solutions in each catchment.

Supporting mapping information was prepared prior to the workshops to assist in the assessment process and in determining the suitability of solutions to be adopted within each catchment. This enabled workshop participants to better identify opportunities and constraints specific to each catchment. For example, to identify where STPs were located and identify potential surrounding opportunities to use recycled water, or to identify where development approvals were already underway, which constrained management actions that may be taken on these sites.

An indication of the likely costs of the solutions were noted where possible (i.e. high, medium, low), as well as any actions that were needed to further establish the feasibility of the solution in that catchment.

The workshop assessment resulted in an improved understanding of the opportunities for solutions in each catchment. It also resulted in a set of actions to assist further detailed investigations of solutions. Through the screening workshop the following management solutions were excluded from further assessment in management scenarios:

- **Smart Sewers:** Limited practical opportunities to use smart sewers were identified in developed areas, as in urban renewal/upgrade projects it was likely to be more cost effective to reline sewers, which would have similar benefits to smart sewers (reduced infiltration). In Greenfield developments, it was identified that risks remained that there could be illegal stormwater connections that would need larger pipe sizes, and that design standards would need to be changed to address this. It was hence noted that although smart sewers in Greenfield developments may have advantages including reduced infiltration/inflows and capital costs, it will be the distributor retailers responsibility to investigate and amend design standards and policies to realise the potential of smart sewers. The adoption of smart sewers in Greenfield developments is recommended, however this plan does not enforce or assess the potential impact of implementing them.
- **Sewer Mining:** this solution was identified to address water supply issues only (by providing an alternative supply source), and not STP capacity issues as previously assumed (as solids are usually put back into the sewer). It was identified to have significant risks and not likely to be

cost effective on a small scale basis. Furthermore, the solution was deemed less appropriate as the critical issue was managing STP capacity, rather than water supply, in most of the catchments. In summary it was decided that it would not be feasible to consider this solution further in this study, but that it may happen on a case by case basis in the future, especially where there were challenges to water supply security and existing trunk sewer infrastructure was readily accessible.

Although the workshop increased understanding of the suitability and practicality of implementing individual solutions in each catchment, it was unable to determine which solutions would be optimal in terms of treatment effectiveness and costs. As a result, each of the individual solutions required further investigation in an attempt to quantify their treatment effectiveness and approximate costs so that stakeholders could make more informed decisions about the individual solutions.

A list of the final shortlisted solutions for each catchment is included in Table 3-3 in the following section.

## 3.2 Selection of Management Scenarios

Management scenarios for each catchment were developed consisting of a combination of individual solutions ('solutions sets') at targeted locations throughout the catchments using information gained through the feasibility assessment workshops.

Three incremental management scenarios were developed for each catchment, each one building upon the previous solution set (unless there were competing demands, in which case a solution may be replaced). This way the efficacy and value of incorporating additional management measures could be easily assessed using our modelling framework. The three management scenarios investigated for each catchment included:

1. **Low Intensity**: These management scenarios included those solutions deemed to reflect "business as usual", that is compliance with pollutant load reduction targets for new development under the State Planning Policy for Healthy Waters (SPP Healthy Waters), and water saving targets required by the Queensland Development Code (QDC).

2. **Medium Intensity:** These management scenarios added those solutions identified in each catchment as 'easy to do' and most preferred (considered most cost effective opportunities, low risks) as a result of stakeholder feasibility assessment workshops.

3. **High Intensity:** These management scenarios will then add those solutions that may be considered to stretch the limits in terms of the expected costs and risks identified during the solution feasibility workshops.

A summary of the management scenarios developed for assessment in each catchment is detailed in Table 3-3.

**Table 3-3 Solutions and Management Scenarios**

| Management Scenarios | Catchment | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stanley | Pumicestone | Bribie | Caboolture | CIGA | Burpengary | Upper Pine | Lower Pine | Sideling | Hays | Redcliffe | Brisbane Coastal |
| **Scenario 1: Low Intensity** | | | | | | | | | | | | |
| Future development meets 80/60/45% load reduction for TSS/TP/TN (SPP Healthy waters) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Future development meets QDC alternative water supply mandate | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| **Scenario 2: Medium Intensity** | | | | | | | | | | | | |
| Increased implementation / enforcement of E&SC management practices | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Waterway riparian revegetation of 3rd & 4th order streams | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| Rural BMP for grazing land - revegetation of 1st & 2nd order streams | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | | | |
| Rural BMP for horticultural land - implementation of filter/buffer strips | ✓ | ✓ | | ✓ | | | ✓ | ✓ | ✓ | | | |
| Education & /or capacity building and investment in incentive schemes | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Prevention of illegal stormwater inflow connections to sewer | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | |
| Recycled water supplied to land / agricultural users | ✓ | | | ✓ | | | | | | | | |
| Recycled water supplied to urban users | | | | | ✓ | | | ✓ | | ✓ | | |
| **Scenario 3: High Intensity** | | | | | | | | | | | | |
| WSUD retrofit to existing urban areas | | ✓ | ✓ | ✓ | | ✓ | | ✓ | | ✓ | ✓ | ✓ |
| Future greenfield development WSUD measures achieve 'no worsening' | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | |
| Recycled water supplied to urban users | | | | ✓ | | | | | | | | |
| Large-scale stormwater harvesting for non-potable use (greenfield sites) | ✓ | | | | ✓ | ✓ | | ✓ | | ✓ | ✓ | |
| Indirect potable reuse of Purified Recycled Water (PRW) | | | | | ✓ | | | ✓ | | | | |
| Rainwater tanks retrofitted to existing urban areas for non-potable use | | ✓ | ✓ | | | | | | | | ✓ | ✓ |

# 4 MODELLING FRAMEWORK

To quantify the performance of individual solutions, and management scenarios in later sections, the development of an integrated water cycle, catchment and receiving water quality modelling framework was necessary. This modelling framework consists of a suite of models including catchment models, receiving water quality models and smaller scale urban water balance and urban water quality models.

The catchment modelling software package applied is eWater's Source Catchments, and this model was used to determine flows and pollutant loads being delivered from the catchment, including diffuse loads (e.g. stormwater runoff) and point source loads (e.g. sewage treatment plants).

Flows and loads from the catchment model were used to force a receiving water quality model (version 2 of the HWP Receiving Water Quality Model (RWQM) (i.e. RWQMV2)) to determine the behaviour and concentrations of pollutants in the study area estuary and Moreton Bay for comparisons with relevant WQOs.

Smaller scale catchment and urban water balance models were developed to assess each individual solution in terms of stormwater discharge reductions and the extent of potential water source substitution (e.g. yield from rainwater tanks, impacts of water recycling schemes, etc). The modelling software applied included eWater's MUSIC (Model for Urban Stormwater Improvement Conceptualisation) and Urban Developer models, with these software packages being driven by locally appropriate hydrologic, water use and pollutant export parameterisations.

Further details in regard to the Urban Developer model and associated modelling results are included in the Urban Developer Modelling Report in Appendix A. Further details on the Source Catchments and RWQMV2 model and associated modelling results are included in the Source Catchments and Receiving Water Quality Modelling Report in Appendix B.

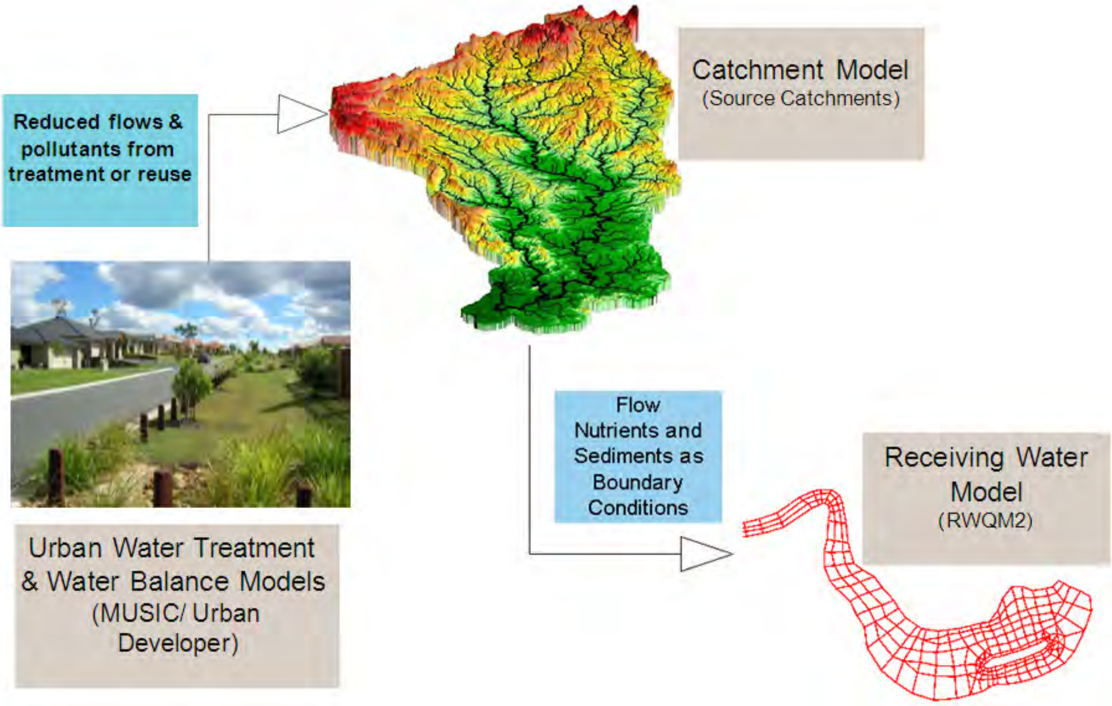



**Figure 4-1 Modelling Framework**

# 5 ASSESSMENT OF SOLUTION PERFORMANCE

Investigation of the costs and treatment performance of each solution has been undertaken to assist in evaluating the cumulative effectiveness of each of the grouped management scenarios. By investigating the individual performance of each solution prior to undertaking receiving water quality modelling, there was the opportunity for the management scenarios to be further refined if required prior to detailed assessment (using Multi Criteria Analysis) and receiving water quality modelling.

A summary of the solutions assessed in each catchment is outlined in Table 3-3. The performance of individual solutions in each applicable catchment is summarised in the following sections. Each solution has been assessed over the 20 year planning period between 2011 and 2031. For simplicity, the annual performance of each solution has been assessed assuming most solutions will be implemented at full potential for 20 years (unless otherwise stated).

A description of the key indicators and assumptions used to evaluate each solutions performance is summarised below:

**Net Present Value (NPV):** This is the total cost incurred over the planning period for establishment (i.e. capital) and during the operational phase (including maintenance), discounted to provide the cost in today's dollars (i.e. $2011). Net present value was calculated in accordance with AS/NZS 4536:1999. In determining NPV, a real discount rate of 6% per annum was used. It is noted that the costs to upgrade STP capacity were not included, as these costs were assumed as necessary in all scenarios.

**Levelised Cost:** The levelised cost is calculated as the ratio of the net present value (NPV) of projected capital and operating costs of an option, to the present value of the projected annual demand supplied or saved by the option. This is consistent with levelised cost methodology outlined by Fane et al (2002, 2003) to be an appropriate measure for identifying least cost options in Integrated Resource Planning.

## 5.1 Future Development meets QDC Requirements

This solution relates to the requirement from the Queensland Development Code (QDC) (Mandatory Part 4.2 – Water Saving Targets) which states that all new detached dwellings must provide a source of alternate water supply equivalent to 70kL per household per year. This is typically achieved by installing a rainwater tank in each new detached dwelling, but may also be achieved through the installation of a community stormwater harvesting system.

For the purposes of this assessment however, it has been assumed that all new residential development in the MBRC region will comply with the QDC through the installation of rainwater tanks.

Future population numbers in each catchment were determined using the GIS water demand model developed by Unitywater. Using an assumed number of people per household (2.8 per household), an approximation of the number of new detached dwellings in each catchment was derived.

Potable water demands that may be supplemented by implementing this solution were based on daily water usage rates for areas of the house which are typically plumbed into rainwater tanks as follows (based on SEQ End Use study):

- Internal (laundry/toilet): 54.7 L/person/day
- Outdoor: 25 L/person/day

It was assumed that rainwater tank supply met 70% of the above water demands on average each year, based on Urban Developer modelling over a typical 10 year period (that reflected long term Mean Annual Rainfall (MAR)).

After assessing the volume of water used from the rainwater tanks, pollutant load reductions were estimated by applying pollutant export rates from roof areas as follows (WBD, 2010):

- TSS: 20 mg/L
- TN: 1.82 mg/L
- TP: 0.129 mg/L

Potential pollutant load reduction from first flush systems were not taken into account, however this component is considered to provide only minor additional treatment performance,

An indicative establishment cost for the rainwater tanks was sourced from a study into the cost effectiveness of rainwater tanks in urban Australia (NWC, 2007), which determined an average cost for a rainwater tank to be $3,016, which includes the cost of the tank, installation and plumbing. Operational costs were assumed to be $20/tank/year for electricity costs due to pumping.

The performance results of this solution is summarised in Table 5-1, which includes net present value of retrofitting the tanks along with potable water savings, pollutant load reductions and the levelised costs.

**Table 5-1 Performance Results for Future Development Meets QDC Requirements**

| Catchment | Net Present Value ($2011) | Potable Water Savings | Reduction in Loads (kg/yr) | | | Levelised Water Cost | Levelised Cost ($/kg) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | TSS | TN | TP | | TSS | TN | TP |
| Bribie Island | $5,443,800 | 96 | 1,911 | 174 | 12 | $4.97 | $142 | $1,565 | $22,078 |
| Pumicestone | $890,100 | 16 | 313 | 28 | 2 | $4.97 | $142 | $1,565 | $22,078 |
| Redcliffe | $26,913,600 | 472 | 9,450 | 860 | 61 | $4.97 | $142 | $1,565 | $22,078 |
| Caboolture | $49,470,400 | 869 | 17,370 | 1,581 | 112 | $4.97 | $142 | $1,565 | $22,078 |
| CIGA | $28,342,000 | 1,064 | 21,280 | 1,940 | 137 | $8.14 | $175 | $1,930 | $27,200 |
| Burpengary | $25,070,700 | 440 | 8,803 | 801 | 57 | $4.97 | $142 | $1,565 | $22,078 |
| Hays | $55,667,900 | 977 | 19,550 | 1,780 | 126 | $4.97 | $142 | $1,565 | $22,078 |
| Brisbane Coastal | $1,689,900 | 30 | 593 | 54 | 4 | $4.97 | $142 | $1,565 | $22,078 |
| Lower Pine | $49,004,000 | 860 | 17,200 | 1,560 | 111 | $4.97 | $142 | $1,565 | $22,078 |
| Upper Pine | $1,402,000 | 25 | 492 | 45 | 3 | $4.97 | $142 | $1,565 | $22,078 |
| Stanley | $5,295,900 | 93 | 1,860 | 169 | 12 | $4.97 | $142 | $1,565 | $22,078 |

## 5.2 Water Sensitive Urban Design Meets SPP Healthy Waters Best Practice Targets

Water Sensitive Urban Design (WSUD) has traditionally been used to manage pollutant loads from urban stormwater. Although the term WSUD encompasses a design philosophy that includes managing the total water cycle, it should be made clear that for the purposes of this study, WSUD focuses on improvements to urban stormwater quality only.

This solution has been investigated to assess the effectiveness of implementing WSUD in all new assessable urban development areas (planned for until 2031) to meet best practice load reduction targets of 80%, 60% and 45% removal of Total Suspended Solids (TSS), Total Phosphorus (TP), and Total Nitrogen (TN) respectively. Achieving these targets is mandatory for all new assessable development (greater than 2,500m2 or >5 lots) under the State Planning Policy for Healthy Waters (SPP Healthy Waters).

To investigate the effectiveness of this management solution, all new applicable development areas were identified in each catchment, and bioretention systems were sized to achieve best practice targets using the stormwater quality modelling software MUSIC version 4. Bioretention systems were selected to achieve target load reductions as they have superior treatment performance per unit area compared to other water quality treatment devices (such as wetlands, swales), require the least take in land area and are commonly used in new urban developments. Furthermore, a streetscape configuration was assumed (with minimal extended detention) as this type of system can be easily incorporated into constrained development sites. The typical configuration modelled is shown in Figure 5-1.

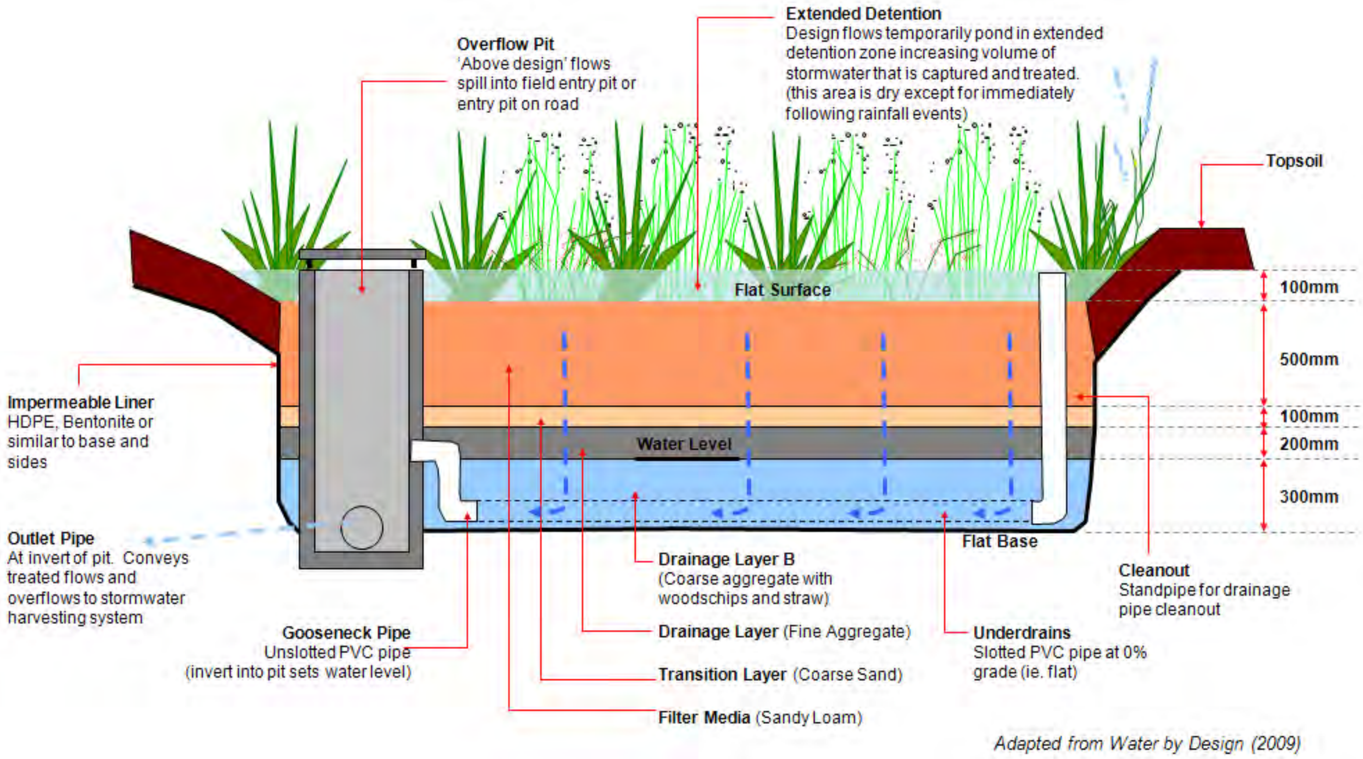



**Figure 5-1 Typical Configuration of Bioretention System**

The performance of these systems in reducing pollutant loads from each catchment was determined over the planning period (2011 - 2031). All MUSIC modelling was undertaken in accordance with MUSIC Modelling Guidelines for SEQ (WBD, 2010b). Appendix C contains a summary of the key modelling parameters used.

The following expenses for establishing and maintaining bioretention systems were used to estimate the cost of implementing this solution in each catchment:

- Establishment: $277/m$^2$ (MBRC, 2011)
- Annual Maintenance: $2/m$^2$ (BCC, 2011)

It is noted that the establishment cost would generally be borne by the developer, while the maintenance cost would eventually (after the asset is handed over) be a Council responsibility in most cases. In calculating the net present value, an operating period of 20 years has been assumed (for maintenance costs). Levelised costs have also been calculated, and represent the ratio of the total cost (NPV) to total pollutant load reduction over the planning period.

Predicted performance results of implementing this solution in each catchment is detailed in Table 5-2.

**Table 5-2 Performance Results for Best Practice WSUD**

| Catchment | Treatment Area (% of catchment) | Net Present Value ($2011) | Reduction in Pollutant Loads (kg/yr) | | | Levelised Cost ($/kg) | | |
|---|---|---|---|---|---|---|---|---|
| | | | TSS | TN | TP | TSS | TN | TP |
| Bribie | 1.5% | $3,621,500 | 88,900 | 625 | 149 | $2.04 | $290 | $1,213 |
| Brisbane Coastal | 1.5% | $810,800 | 21,830 | 148 | 35 | $1.86 | $274 | $1,148 |
| Burpengary | 1.5% | $20,155,900 | 472,000 | 3,720 | 819 | $2.14 | $271 | $1,231 |
| Caboolture | 1.7% | $62,474,200 | 1,460,000 | 12,900 | 2,750 | $2.14 | $242 | $1,136 |
| CIGA | 1.7% | $153,764,000 | 5,320,000 | 26,200 | 7,160 | $1.45 | $293 | $1,074 |
| Hays Inlet | 1.7% | $46,932,500 | 1,128,000 | 9,900 | 2,210 | $2.08 | $237 | $1,062 |
| Lower Pine | 1.7% | $27,683,000 | 628,000 | 5,470 | 1,249 | $2.20 | $253 | $1,108 |
| Pumicestone | 1.6% | $33,118,200 | 775,000 | 6,690 | 1,379 | $2.14 | $248 | $1,201 |
| Redcliffe | 1.5% | $6,788,200 | 162,400 | 1,190 | 272 | $2.09 | $285 | $1,248 |
| Stanley | 1.5% | $2,762,426 | 62,700 | 473 | 108 | $2.20 | $292 | $1,275 |
| Upper Pine | 2.1% | $138,100 | 3,217 | 30 | 6 | $2.15 | $231 | $1,151 |

## 5.3 Increased Enforcement and Implementation of Erosion and Sediment Control on Development Sites

Increased implementation of erosion and sediment control (E&SC) on development sites through increased enforcement was identified as a key management solution to address future impacts to water quality from large development areas within the Moreton Bay region.

Although development sites are required by law to use appropriate E&SC measures, sediment from construction sites continues to be a major source of pollution to receiving waters. A literature review by Taylor and Wong (2002) indicated that education alone is not sufficient to ensure compliance and that enforcement is essential for the successful implementation of erosion and sediment control programs. The literature review of case studies by Taylor and Wong (2002) notes that E&SC programs with strong educational and enforcement elements may represent the best performing non-structural BMP for managing stormwater pollutants.

In order to assess the potential effectiveness of this management solution, future development areas within each catchment over the planning period (2011-2031) were identified. Development areas for each catchment were summed and divided by the time period under review (20 years) to identify the approximate *annual* development area within each catchment.

Annual sediment load generation from development sites within each catchment were then estimated using MUSIC. As E&SC measures targets course sediment, this solution was assumed not to provide any treatment of nutrients, which are typically associated with fine sediment. Results from an E&SC monitoring program within Brisbane City Council (BCC, 2000) were used to estimate event mean sediment concentrations from construction sites in MUSIC as follows:

- Baseflow: 25 mg/L
- Stormflow: 1,000 mg/L

Taylor & Wong's (2002) review of case studies found that strong enforcement of E&SC regulation (supported by town planning and education), could reduce Total Suspended Solids (TSS) generated from development sites by approximately 12-18% in the short term (<3 yrs) and 36-42% over a decade. This equates to an average annual sediment load reduction of 39% based on the 20 year time period of this investigation.

A summary of the future developable land in each catchment, and the estimated annual average sediment load reduction during the construction phase through improved enforcement of E&SC regulations is summarised in Table 5-3.

**Table 5-3 Annual Sediment Reduction from Increased Enforcement of E&SC**

| Catchment | Total Developable Area 2011- 2031 (ha) | Average Annual Developable Area (ha) | TSS Generation Without Enforcement (kg/yr) | TSS Generation with Enforcement (kg/yr) | TSS Reduction from Enforcement (kg/yr) |
|---|---|---|---|---|---|
| Bribie Island | 127 | 6.3 | 37,600 | 24,300 | 13,300 |
| Pumicestone | 718 | 35.9 | 216,000 | 139,500 | 76,500 |
| Redcliffe | 151 | 7.6 | 43,900 | 28,400 | 15,500 |
| Caboolture | 1,628 | 81.4 | 482,000 | 311,400 | 170,600 |
| Burpengary | 453 | 22.6 | 135,000 | 87,200 | 47,800 |
| Hays Inlet | 1,132 | 56.6 | 331,000 | 218,900 | 117,200 |
| Brisbane Coastal | 18 | 0.9 | 5,330 | 3,400 | 1,900 |
| Lower Pine | 2 | 31.7 | 183,000 | 118,200 | 64,800 |
| Upper Pine | 62 | 0.1 | 650 | 420 | 230 |
| Stanley | 634 | 3.1 | 17,300 | 11,200 | 6,100 |
| **Total** | **4,924** | **246.2** | **1,451,856** | **937,900** | **514,000** |
| CIGA[1] | 2,996 | 150 | 883,000 | 570,000 | 313,000 |

[1]Caboolture Identified Growth Area (based on developable area estimate)

The cost of implementing a regional E&SC program in Australia with increased enforcement was estimated by Taylor and Wong (2002) to range between $0.19 to $0.51 per capita per year, and on average $0.32 per capita per year. The per capita relates to the population in the Council area. Assuming an average inflation rate of 3%, this equates to an average $0.42 per capita per year ($2011).

The net present value of implementing this solution and an estimate of the levelised cost for TSS reduction was determined using the total residential population within MBRC over the planning period. Costs were then distributed among catchments in proportion to anticipated population growth in each catchment. Discussion with the author of the paper indicated that the capital cost of implementing the E&SC program is not included in the per capita estimate, however constitutes a small proportion of the cost to implement (approx. 10%) (A Taylor 2012, pers. comm. 10 May). As such an establishment cost has been assumed of 10% of annual operating costs. A summary of the NPV and levelised cost to implement this solution is detailed in Table 5-4.

**Table 5-4 Performance Results for Increased Enforcement of E&SC**

| Catchment | NPV ($2011) | TSS Reduction (kg/yr) | Levelised Cost ($/kg TSS) |
|---|---|---|---|
| Bribie Island | $44,713 | 13,300 | $0.17 |
| Pumicestone Passage | $7,311 | 76,500 | $0.005 |
| Redcliffe | $221,058 | 15,500 | $0.71 |
| Caboolture River | $406,330 | 170,600 | $0.12 |
| Burpengary Creek | $205,921 | 47,800 | $0.22 |
| Hays Inlet | $457,234 | 117,200 | $0.20 |
| Brisbane Coastal | $13,880 | 1,900 | $0.37 |
| Lower Pine River | $402,499 | 64,800 | $0.31 |
| Upper Pine River | $11,515 | 230 | $2.50 |
| Stanley River | $43,499 | 6,100 | $0.36 |
| CIGA | $499,951 | 313,000 | $0.08 |

While the cost to implement this solution as estimated in Table 5-4 is considered low, it is noted that E&SC programs can be self-funding, with revenue gained through enforcement used to fund all E&SC activities undertaken by the regulatory authority (Taylor and Wong, 2002). The review of case studies by Taylor and Wong (2002) highlighted the need for sustained levels of enforcement to ensure continued compliance and improvement over the long term. It also highlighted a need for the program to be self–funding or have a secure funding base to ensure long term goals are achieved.

## 5.4 Waterway Riparian Revegetation

The condition of riparian vegetation along the banks of waterways plays an important role in the stability of these banks. In areas where riparian vegetation is fully intact, waterway banks are stabilised by the root systems which provides some protection against erosive forces from the flow of water in the waterways.

In areas where riparian vegetation is minimal and waterway banks are more susceptible to erosive forces, revegetating these riparian areas would be expected to decrease the amount of sediment transported downstream by minimising stream bank erosion.

The solution of waterway riparian revegetation relates to 3$^{rd}$ and 4$^{th}$ order streams, which are typically found lower in a catchment. The methodology used to determine stream order is illustrated in Figure 5-2. The largest waterways in the MBRC region (e.g. Caboolture and Pine Rivers) are classified as 5$^{th}$/6$^{th}$ order streams. These waterways are considered too large for riparian revegetation to have any meaningful effect, hence the decision to focus on mid sized waterways (i.e. 3$^{rd}$/4$^{th}$ order streams).


**Figure 5-2 Stream Ordering**

To quantify the reduction in sediment loads from riparian revegetation of 3rd/4th order streams in each catchment, the current condition of riparian vegetation was first assessed. This data was collected and compiled by MBRC, and current stream bank erosion rates were calculated using this data (refer to Appendix D for detailed methodology). The output from this assessment was a determination of the expected reduction in sediment loads as a result of restoring all riparian vegetation (assumed to be 95% vegetative cover) along the length of all 3rd/4th order streams.

However, the sediment load reductions determined using this method relate to stream bank erosion only, and do not include sediment loads from gully and hillslope erosion. When this is taken into account, the initial sediment load reductions appeared to be somewhat overstated. When compared to recent studies of erosion rates in the Knapp Creek catchment (Olley *et al*, 2009), the sediment export rates are comparable when erosion type is not taken into account. For example, Olley *et al* (2009) reported 6,250 t/yr of sediment load from a 7,528 ha catchment, which gives an export rate of 0.8 t/ha/yr. This compares well with average sediment export rate for catchments using the methodology in Appendix D (i.e. 0.4 t/ha/yr). However, Olley *et al* (2009) report that of the total sediment load (6,250 t/yr), only 120t/yr is from stream bank erosion, which is an export rate of only 0.02 t/ha/yr. Furthermore, the majority of sediment load from the Knapp Creek catchment was found to be attributable to gully erosion.

To correct for this overestimation of sediment loads, the stream bank erosion data was revised using contributing catchment areas for each stream and total catchment loads from model outputs (i.e. Source Catchments model), so that the revised stream bank erosion data was consistent with modelled sediment loads.

The results of this assessment are summarised in Table 5-5. This table presents the area of riparian zone requiring revegetation works, the expected sediment load reduction as a result of revegetation, the total costs over the planning period (i.e. 20 years), and the levelised cost of revegetation. Levelised cost has been estimated by dividing the total cost by the total sediment load reduction anticipated over the planning period.

**Table 5-5 Performance Results for Waterway Riparian Revegetation of 3rd/4th Order Streams**

| Catchment | Total Revegetation Area (ha) | Sediment Load Reduction (kg/yr) | Total Sediment Load Reduction (kg/20yr) | Revegetation Cost - Net Present Value ($2011) | Levelised Cost ($/kg sediment reduction) |
|---|---|---|---|---|---|
| Pumicestone | 32 | 522,200 | 10,440,000 | $4,800,000 | $0.46 |
| Caboolture | 100 | 1,760,000 | 35,200,000 | $15,000,000 | $0.43 |
| CIGA | 24 | 598,900 | 11,977,800 | $3,600,000 | $0.30 |
| Burpengary | 54 | 4,109,000 | 82,180,000 | $8,000,000 | $0.10 |
| Hays | 12 | 309,700 | 6,194,300 | $1,800,000 | $0.29 |
| Sideling | 2 | 35,200 | 704,900 | $300,000 | $0.49 |
| Lower Pine | 65 | 650,200 | 13,004,800 | $ 9,800,000 | $0.75 |
| Upper Pine | 56 | 697,900 | 13,958,300 | $8,300,000 | $0.60 |
| Stanley | 58 | 795,500 | 15,910,100 | $8,600,000 | $0.54 |

The cost of riparian revegetation works was assumed to be $15/m$^2$, which was the figure provided by MBRC.

## 5.5 Rural Best Management Practices

Rural farming areas are potentially a significant source of pollutant loads to receiving waters. These loads are typically as a result of channel and hillslope erosion transporting sediment and accumulated nutrients from exposed farming areas. By implementing best management practices (BMPs) on farming land (i.e. grazing and horticulture), these pollutant loads can be reduced.

While there are numerous BMPs applicable to rural farming areas, two BMPs were used as indicators of the types of load reductions that may be achievable by rural BMPs. These include the following:

- Rehabilitation of 1st and 2nd order streams and gullies on cattle grazing land; and
- Buffer strips incorporated into horticultural land.

The methodology used to determine which BMP should be used in the assessment is detailed in Appendix D.

### 5.5.1 Rehabilitation of 1st / 2nd Order Streams

This BMP includes the revegetation of 1st and 2nd order streams and gullies on cattle grazing land. These small streams and gullies are typically degraded as a result of stock entering the waterways to access drinking water, destroying the bank structure and stability. This leads to an increase in erosion and downstream sediment loads.

In conjunction with revegetation of these streams and gullies, this solution would entail installation of stock exclusion fencing along the riparian boundary to prevent stock from entering the waterway. To address the issue of stock not being able to access drinking water, off-channel stock watering points would need to be constructed at defined areas.

The issue of who would ultimately be responsible for implementing this solution in grazing areas would need to be resolved. However, it would probably require a coordinated effort of both the landholders and government.

The sediment load reductions for this solution were quantified using a similar methodology to waterway riparian revegetation of 3rd/4th order streams (refer to Section 5.4), whereby current riparian vegetation condition data combined with stream bank erosion calculations was used (supplied by MBRC). This data was then revised based on contributing catchment areas and modelled loads. This was applied to 1st and 2nd order streams in grazing land only.

The costs for implementing this solution were sourced from literature values and MBRC, and include the following:

- Establishment cost - $179,000/ha (which includes $14,000/ha for cost of fencing and $15,000 for one off-channel stock watering point every 5 ha based on Olley, 2009; plus $150,000/ha for revegetation works based on data supplied by MBRC)
- Maintenance cost - $230 /ha (annual cost of maintaining fencing and stock water point - ABARE, 1999)

The results of this assessment are summarised in Table 5-6.

**Table 5-6 Performance Results for Stock Exclusion & Revegetation of 1st/2nd Order Streams**

| Catchment | Total Revegetation Area (ha) | Sediment Load Reduction (kg/yr) | Total Sediment Load Reduction (kg/20yr) | Net Present Value ($2011) | Levelised Cost ($/kg sediment reduction) |
|---|---|---|---|---|---|
| Pumicestone | 83 | 970,700 | 19,414,600 | $15,140,000 | $0.78 |
| Caboolture | 254 | 2,899,800 | 57,995,100 | $46,205,000 | $0.80 |
| Burpengary | 43 | 492,300 | 9,845,200 | $7,755,200 | $0.79 |
| Sideling | 19 | 334,500 | 6,690,000 | $3,510,000 | $0.52 |
| Lower Pine | 8 | 297,600 | 5,952,300 | $1,520,000 | $0.26 |
| Upper Pine | 105 | 1,356,800 | 27,136,900 | $19,080,000 | $0.70 |
| Stanley | 191 | 1,803,000 | 36,059,200 | $34,715,000 | $0.96 |

## 5.5.2 Buffer Strips

Buffer strips are areas of woody or grassed vegetation generally placed between an area of disturbance and a receiving waterway for the purposes of trapping sediments, nutrients and other pollutants. In a tracer study reported by Croke *et al* (1999), buffer areas retained the greatest volume of sediment per unit area than any other landscape feature of a forestry operation.

Buffer strips may be established using vegetation such as grass or trees to provide a filtering function between a land disturbing activity and an adjacent waterway. For the purposes of this assessment, buffer strips do not include riparian revegetation. Riparian revegetation is usually performed for a range of reasons (streambank stabilisation, shading, sediment buffering, fauna habitat etc), consequently its performance in managing lateral sediment movement may not be as efficient as measures specifically developed for that purpose, such as buffer strips. Furthermore, riparian revegetation is already assessed in Section 5.5.1.

The methodology for assessing pollutant load reductions for buffer strips, and the establishment and maintenance costs, is detailed in Appendix D. Current pollutant loads were determined from catchment modelling results, and pollutant load reductions subsequently derived from values specified in Appendix D. The results from this assessment are summarised in Table 5-7.

**Table 5-7 Performance Results for Buffer Strips**

| Catchment | Net Present Value ($2011) | Reduction in Loads (kg/yr) | | | Levelised Cost ($/kg reduction) | | |
|---|---|---|---|---|---|---|---|
| | | TSS | TN | TP | TSS | TN | TP |
| Pumicestone | $521,200 | 82,481 | 548 | 94 | $0.32 | $48 | $277 |
| Caboolture | $187,400 | 12,299 | 44 | 8 | $0.76 | $214 | $1,169 |
| Sideling | $68,600 | 7,883 | 50 | 9 | $0.43 | $68 | $365 |
| Lower Pine | $1,296,500 | 108,496 | 717 | 133 | $0.60 | $90 | $489 |
| Upper Pine | $3,452,500 | 559,383 | 3,538 | 657 | $0.31 | $49 | $263 |
| Stanley | $1,440,100 | 316,624 | 7,394 | 403 | $0.23 | $10 | $179 |

## 5.6 Recycled Water to Agricultural Users

Recycled water supplied to agricultural users or irrigated to land was identified as another solution to manage impacts to receiving water quality from point sources of discharge (i.e. STPs). Depending on the end use of the water, this solution is likely to require less treatment than dual reticulation schemes. The other advantage with such schemes is the reduced monitoring expenses when compared to dual reticulation. The reason this solution was not considered more widely was the lack of surrounding available land /agricultural demand around existing STPs.

Supplying A+ recycled water currently produced at Caboolture South AWTP (and discharged to the Caboolture River) to Wamuran for surrounding agricultural use was identified as a preferred solution (over supply of urban users) during the feasibility assessment workshop. A business case is currently being investigated to assess this scheme in more detail, however the intent of this scheme would be for Unitywater to sell water to a third party, who would implement the scheme and on sell the water to agricultural users. This was identified to have less risk and less expense to Unitywater than an alternative third pipe urban use scheme. It is proposed that an old quarry at Wamuran is used to store recycled water. Figure 5-3 shows the location of the proposed quarry and South Caboolture AWTP. Due to the close proximity of this scheme to the CIGA, it was identified that if the Wamuran scheme were to go ahead, it would be unlikely that sufficient agricultural demand would remain to implement such a scheme at a new STP at CIGA.

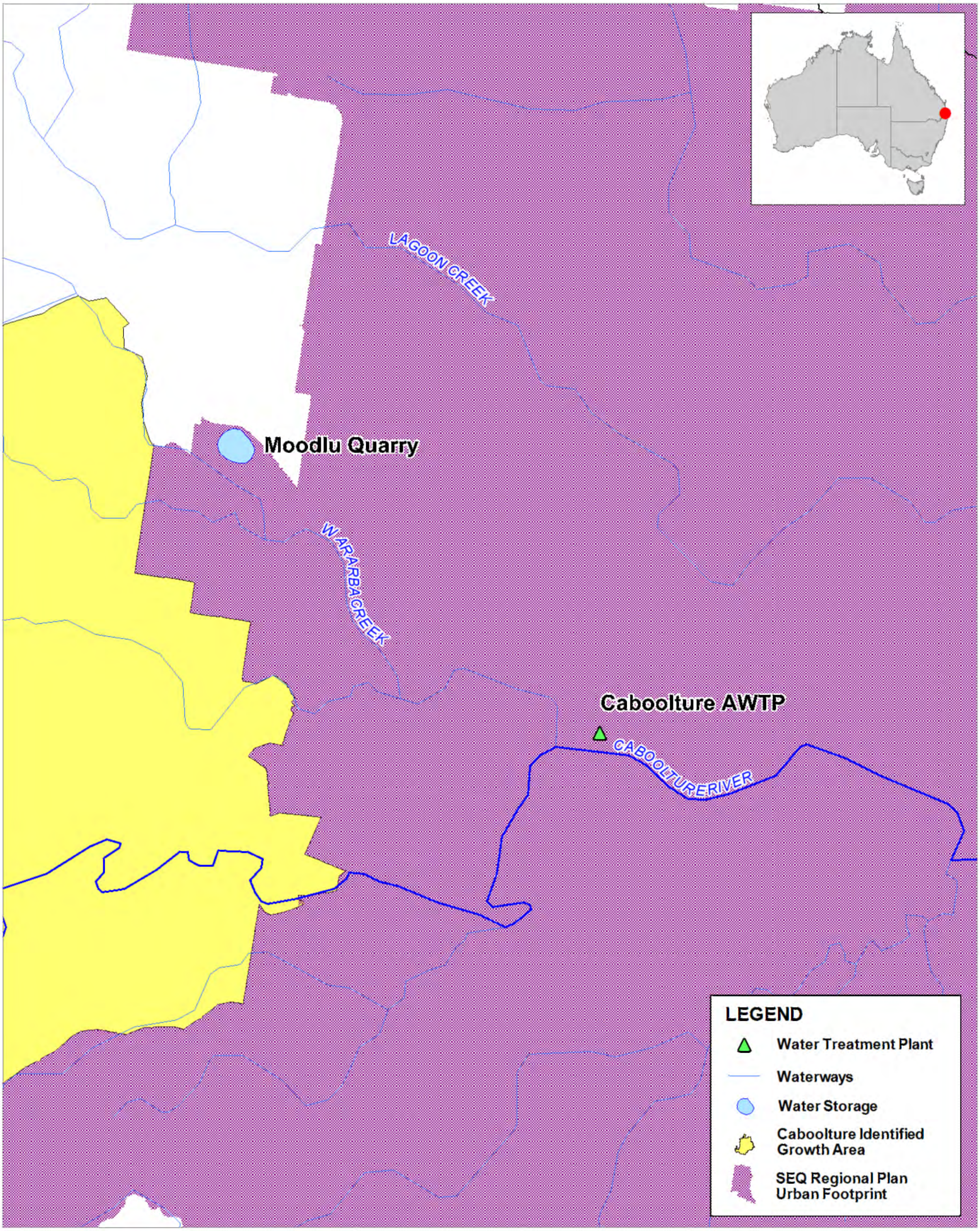
Irrigation of Class B effluent to land was identified as a planned solution to accommodate for future population growth in the Woodford region. The existing STP is close to exceeding its licence discharge capacity (to Stanley River). As the Stanley River eventually flows to Lake Somerset, a regional water storage, it is important to maintain water quality and limit discharge to the River in accordance with licence conditions. This solution proposes that upgrades constructed to accommodate future population growth (beyond licence conditions) irrigate effluent to land rather than discharge to the Stanley River. This solution was assessed assuming it would be implemented in 2020 (when licence conditions require it be implemented), hence its performance is only measured over 12 years (within the planning period). It is based on results of a Unitywater planning study which has since been adopted for implementation.

A summary of the solutions performance for both schemes is outlined in Table 5-8. Effluent discharge concentrations from Caboolture South and Woodford STP that were used to estimate pollutant load reductions for the recycling schemes are detailed in Table 5-9.

**Table 5-8 Performance Results for Recycled Water Schemes at Wamuran and Woodford**

| | Caboolture Catchment (Wamuran Scheme) | Stanley Catchment (Woodford Scheme) |
|---|---|---|
| **NPV ($2011)** | $14,904,000 | $2,039,900 |
| **Water Savings (ML/yr)** | 2,920 | N/A * |
| **Pollutant Reduction** | | |
| **TSS (kg/yr)** | 5,840 | 290 |
| **TN (kg/yr)** | 7,300 | 726 |
| **TP (kg/yr)** | 876 | 145 |
| **Levelised Cost** | | |
| **Water ($/kL)** | $0.45 | N/A * |
| **TSS ($/kg)** | $128 | $351 |
| **TN ($/kg)** | $102 | $140 |
| **TP ($/kg)** | $851 | $702 |

* Not applicable as there would be no water savings as the Woodford scheme involves irrigation of effluent to otherwise non-irrigated land.




Title:
**Location of Moodlu Quarry**

Figure: **5-3**

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BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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## 5.7 Recycled Water to Urban Users

Recycled water supplied to urban users was identified as a solution to manage impacts to receiving water quality from point sources of discharge (i.e. STPs). It also provides the dual benefit of providing an alternative supply of water in line with fit for use principles. *Under the Water Supply (Safety and Reliability) Act 2008*, this solution also constitutes 'demand management' by "substituting one water resource for another", effectively reducing the demand on potable water supplies.

A number of potential water recycling schemes in urban areas were identified by Unitywater for investigation. Information such as the scale, demands and costs for these schemes were compiled from existing planning reports and investigations where available. In some instances, planning assumptions were changed to reflect more realistic demands based on results of the South East Queensland End Use Study (Beal et al, 2010) and discussions with key stakeholders (MBRC, Unitywater, QWC). Figure 5-4 indicates the location of various urban recycled water schemes investigated.

When assessing the potential pollutant load reduction of recycled water schemes, median discharge concentrations or design standards for effluent from relevant STPs were used. Table 5-9 summarises the discharge concentrations adopted for each STP that were used to estimate pollutant load reductions from each recycling scheme.

**Table 5-9 STP Effluent Discharge Concentrations**

| STP | Total Suspended Solids (mg/L) | Total Nitrogen (mg/L) | Total Phosphorus (mg/L) |
|---|---|---|---|
| Caboolture South | 2 | 2.5 | 0.3 |
| Burpengary East | 2 | 3.0 | 0.3 |
| Murrumba Downs | 2 | 3.0 | 0.5 |
| Brendale[2] | 2 | 2.5 | 0.5 |
| Redcliffe | 2 | 5.0 | 0.1 |
| Woodford | 2 | 5.0 | 1.0 |
| New for CIGA[1] | 2 | 2.5 | 0.3 |

[1] Caboolture South effluent quality assumed
[2] Assumes performance based on plant upgrade

In accordance with state and national guidelines for recycled water (DNRW 2008, EPA 2005, NRMMC et al 2006) it has been assumed that recycled water for dual reticulation (i.e. to households) would be required to meet Class A+ treatment standards. Due to the variable quality required for commercial and industrial uses (unknown at this time), Class A+ has also assumed for these demands.

Irrigation of public open space was identified to require Class A treatment (EPA, 2005). This assumes above ground irrigation and uncontrolled access, with E.coli <10 cfu/100 mL. It is noted that a lesser quality may be used, however appropriate control measures would be required to limit risk of exposure (i.e. controlled access, subsurface irrigation), the suitability of which would need to be assessed on a site by site basis. Furthermore, it is noted that the National Guidelines (NRMCC et al 2006) specify that for uncontrolled public open space irrigation, E.coli should be <1 cfu/100 mL, which is the water quality required for Class A+ water (under the *Public Health Regulation 2005, reprinted 6*

*June 2011*). However it has been assumed that Class A treatment would be appropriate for public open space irrigation access, as per the Queensland Recycled Water Guidelines (2005).

The solution was assessed for two options as follows:

1. Option 1: Dual reticulation (Class A+) and Public Open Space (POS) irrigation (Class A).
2. Option 2: POS irrigation only (Class A).

The following assumptions were used in estimating demands and costs of the recycled water schemes:

- 24L/EP/day for toilets.
- 25L/EP/day for outdoor use.
- 20 EP/ha for industrial/ commercial land use in the CIGA.
- 80 L/EP for industrial/ commercial land use in the CIGA.
- $2,307/ML annual operation & maintenance (O&M) costs for dual reticulation (based on data collated from Caboolture South AWTP).
- $1,678/ML annual O&M cost for irrigation to POS, derived from Caboolture South AWTP data assuming that monitoring costs were half that of dual reticulation.
- $445/ML annual O&M cost for treating and discharging effluent to river (based on Caboolture South AWTP)

It is noted that where possible, information on demands (where reasonable) and costs were derived from the following sources:

- North East Business Park EIA (GHD, 2007)
- Old Bay Structure Plan Project, Phase 2 Report (Burpengary East LAP) (Buckley Vann et al, 2009)
- Morayfield-Burpengary Local Planning Area Investigation (AECOM et al, 2010)
- Caboolture Identified Growth Area Infrastructure & Staging Report (Cardno, 2010)
- Moreton Bay Regional Council Integrated Urban Water Cycle Management Strategy (MWH, 2009)
- Redcliffe City Council Effluent Reuse Project Feasibility Study (GHD, 2002)

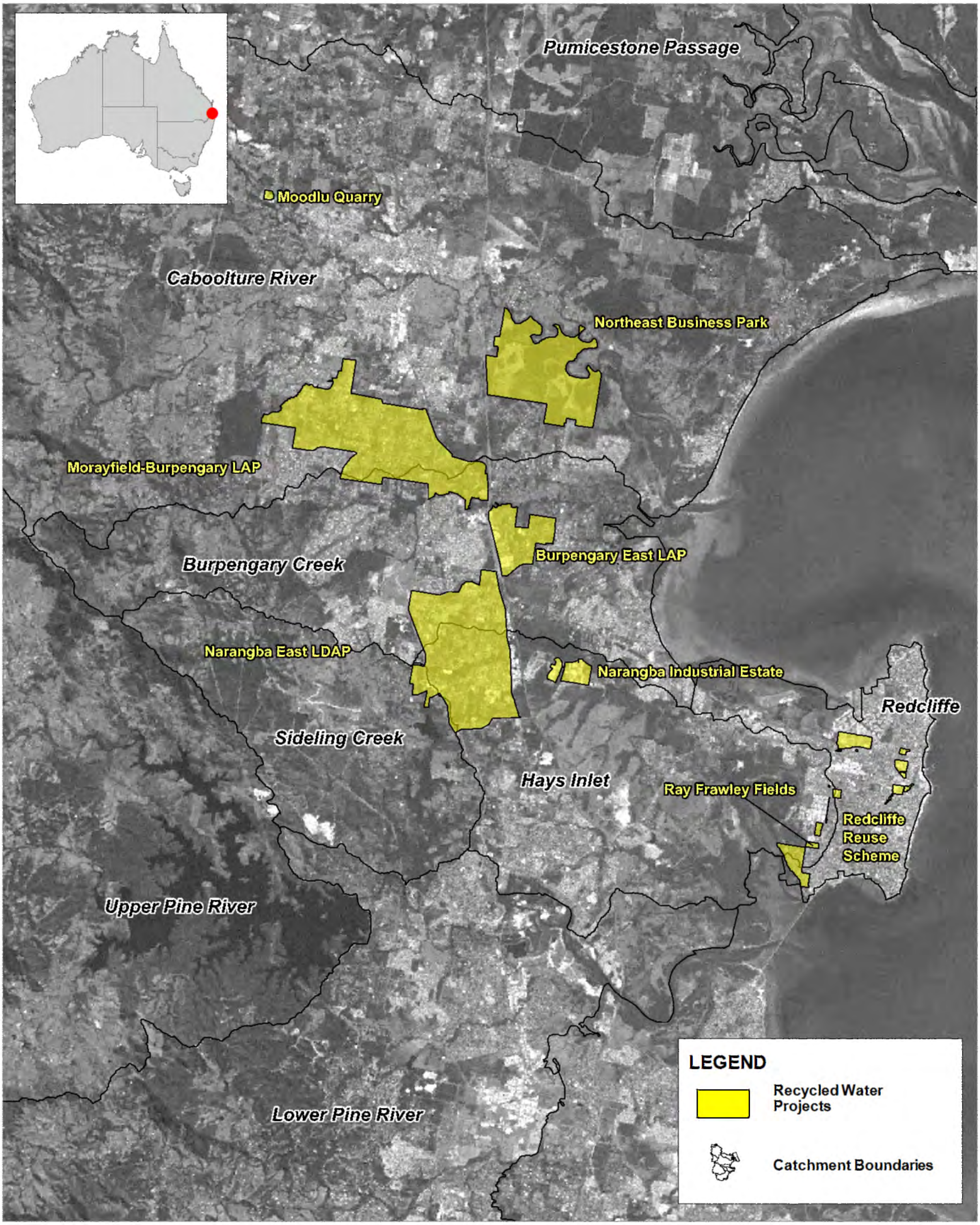
For the recycled water options in the CIGA catchment, it was assumed that the remaining recycled water produced would need to be irrigated or disposed of to land to meet DERM requirements of ‘no worsening’ to pollutant loads (or achievement of sustainable loads) in the Caboolture River. MEDLI modelling (refer to Appendix E) was undertaken to assist in determining the land area required for sustainable disposal to land in both options. The modelling report indicated that a sustainable effluent disposal rate to land (assuming Sodosol soils) is 0.02 ML/ha/day. The land required for effluent disposal was costed at approximately $50,000/ha through phone discussions with LJ Hooker Caboolture (B Harris 2011, pers. comm. 1 August). The size and cost of wet storage requirements for the CIGA was also estimated. Table 5-10 summarises the irrigation area and associated costs of effluent disposal for the CIGA scenarios

**Table 5-10 Land Disposal Costs for CIGA Options**

| Option | Irrigation Area Required (ha) | Cost of Land[1] | Wet Storage Size[2] (ML) | Cost of Storage |
|---|---|---|---|---|
| 1. Dual Reticulation & POS | 220 | $11,022,816 | 485 | $3,774,509 |
| 2. POS only | 360 | $17,982,518 | 791 | $4,895,168 |

[1] $50,000/ha (B. Harris 2011, pers comm. 1 August)
[2] Sized to provide 110 days storage volume (ML), based on wet weather storage licence conditions for Dayboro STP

A summary of the performance of this solution in each catchment for Option 1 (Dual reticulation and POS) and Option 2 (POS only) is shown in Table 5-11 and Table 5-12 respectively.




Title:

# Location of Recycled Water Projects

Figure: 5-4

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**Table 5-11 Performance Results for Recycled Water for Urban Users, Option 1**

| Recycled Water Scheme | NPV (Million $2011) | Potable Water Savings (ML/yr) | Total Water Savings (ML/yr) | Pollutant Reduction (kg/yr) | | | Levelised Water Cost ($/kL) | Levelised Cost ($/kg) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | TSS | TN | TP | | TSS | TN | TP |
| **South Caboolture STP** | | | | | | | | | | |
| North East Business Park | $23.1[5] | 717 | 847 | 1,694 | 2,117 | 254 | $2.38 | $681 | $545 | $4,542 |
| Narangba East LDAP | $9.0 | 257 | 388 | 777 | 971 | 117 | $2.01 | $577 | $461 | $3,845 |
| Burpengary East LAP | $3.4 | 105 | 144 | 288 | 360 | 43 | $2.04 | $586 | $469 | $3,907 |
| Morayfield Burpengary | $23.8 | 671 | 1,039 | 2,078 | 2,598 | 312 | $2.00 | $573 | $458 | $3,819 |
| **Burpengary East STP** | | | | | | | | | | |
| Narangba Industrial Estate | $22.4 | 548 | 548 | 1,095 | 1,643 | 164 | $3.57 | $1,023 | $682 | $6,818 |
| ***Total Caboolture Catchment[1]*** | ***$81.6*** | ***2,297*** | ***2,966*** | ***5,932*** | ***7,689*** | ***890*** | ***$2.40*** | **$688** | **$531** | **$4,587** |
| **Burpengary East STP** | | | | | | | | | | |
| Narangba Industrial Estate | $22.4 | 717 | 548 | 1,095 | 1,643 | 164 | $3.57 | $1,023 | $682 | $6,818 |
| North East Business Park | $32.0 | 257 | 847 | 1,694 | 2,540 | 254 | $3.30 | $945 | $630 | $6,301 |
| Narangba East LDAP | $14.6 | 105 | 388 | 777 | 1,165 | 117 | $3.27 | $938 | $625 | $6,254 |
| Burpengary East LAP | $5.5 | 671 | 144 | 288 | 432 | 43 | $3.30 | $947 | $632 | $6,315 |
| Morayfield Burpengary | $38.8 | 548 | 1,039 | 2,078 | 3,118 | 312 | $3.26 | $934 | $623 | $6,228 |
| ***Total Caboolture Catchment[2]*** | ***$113.3*** | ***2,297*** | ***2,966*** | ***5,932*** | ***8,898*** | ***890*** | ***$3.33*** | **$955** | **$637** | **$6,365** |
| **Murrumba Downs STP** | | | | | | | | | | |
| *Northern Growth Corridor [3,4]* | *$51.5* | *621* | *1,460* | *2,920* | *4,380* | *730* | *$3.08* | *$882* | *$588* | *$3,528* |
| Northern Growth Corridor[3] | $57.8 | 621 | 1,716 | 3,431 | 5,147 | 858 | $2.94 | $843 | $562 | $3,370 |
| **Brendale STP** | | | | | | | | | | |
| Brendale | $12.9 | 365 | 365 | 730 | 913 | 183 | $3.07 | $881 | $705 | $3,526 |
| ***Total Lower Pine Catchment*** | ***$70.7*** | ***986*** | ***2,081*** | ***4,161*** | ***6,059*** | ***1,040*** | **$2.96** | **$849** | **$583** | **$3,398** |
| **Redcliffe STP** | | | | | | | | | | |
| Ray Frawley Fields Clontarf[3] | $2.0 | 53 | 67 | 133 | 334 | 7 | $2.55 | $732 | $293 | $14,631 |
| Redcliffe Reuse Scheme[3] | $17.6 | 100 | 600 | 1,200 | 3,000 | 60 | | | | |
| ***Total Hays Inlet*** | ***$19.5*** | ***153*** | ***667*** | ***1,333*** | ***3,334*** | ***67*** | ***$2.55*** | ***$732*** | ***$293*** | ***$14,631*** |
| **New STP Caboolture Identified Growth Area** | | | | | | | | | | |
| ***Total CIGA*** | ***$37.0*** | ***1,688*** | ***2,924*** | ***5,848*** | ***7,309*** | ***877*** | ***$4.13*** | ***$863*** | ***$691*** | ***$5,755*** |

[1] Option assuming Wamuram Scheme is *not* implemented. This option assumes A+ water currently produced at Caboolture South is available for use, and no additional treatment is required. It excludes capital costs of distribution network for Caboolture South.

[2] Option assuming Wamuram Scheme is implemented (A+ water currently produced at Caboolture South *not* available for use)

[3] Note no dual reticulation for urban users proposed, POS/industrial use only

[4] Meets Licence Requirements to recycle additional 4 ML/day only

[5] Includes capital cost for upgrading treatment capacity

**Table 5-12 Performance Results for Recycled Water for Urban Users, Option 2**

| Recycled Water Scheme | NPV (Million $2011) | Potable Water Savings (ML/yr) | Total Water Savings (ML/yr) | Pollutant Reduction (kg/yr) | | | Levelised Water Cost ($/kL) | Levelised Cost ($/kg) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | TSS | TN | TP | | TSS | TN | TP |
| **South Caboolture STP** | | | | | | | | | | |
| North East Business Park[3] | $10.3 | 235 | 365 | 730 | 913 | 110 | $2.47 | $707 | $566 | $4,716 |
| Narangba East LDAP | $3.5 | 51 | 183 | 365 | 456 | 55 | $1.68 | $481 | $385 | $3,209 |
| Burpengary East LAP | $1.2 | 21 | 60 | 121 | 151 | 18 | | | | |
| Morayfield Burpengary | $9.8 | 143 | 511 | 1,022 | 1,278 | 153 | | | | |
| ***Total Caboolture Catchment*[1]** | ***$24.8*** | ***450*** | ***1119*** | ***2,238*** | ***2,797*** | ***336*** | ***$1.11*** | ***$555*** | ***$444*** | ***$3,700*** |
| **Burpengary East STP** | | | | | | | | | | |
| North East Business Park | $12.3 | 235 | 365 | 730 | 1,095 | 110 | $2.94 | $843 | $562 | $5,617 |
| Narangba East LDAP | $6.2 | 51 | 183 | 365 | 548 | 55 | | | | |
| Burpengary East LAP | $2.0 | 21 | 60 | 121 | 181 | 18 | | | | |
| Morayfield Burpengary | $17.2 | 143 | 511 | 1,022 | 1,533 | 153 | | | | |
| ***Total Caboolture Catchment*[2]** | ***$37.7*** | ***450*** | ***1,119*** | ***2,238*** | ***3,356*** | ***336*** | ***$2.94*** | ***$843*** | ***$562*** | ***$5,617*** |
| **Murrumba Downs STP** | | | | | | | | | | |
| *Northern Growth Corridor*[4] | *$51.5* | *621* | *1,460* | *2,920* | *4,380* | *730* | *$3.08* | *$882* | *$588* | *$3,528* |
| Northern Growth Corridor | $57.8 | 621 | 1,716 | 3,431 | 5,147 | 858 | $2.94 | $843 | $562 | $3,370 |
| **Brendale STP** | | | | | | | | | | |
| Brendale | $5.8 | 183 | 183 | 365 | 456 | 91 | $2.76 | $791 | $633 | $3,165 |
| **Total Lower Pine** | ***$63.6*** | ***803*** | ***1,898*** | ***3,796*** | ***5,603*** | ***949*** | ***$2.92*** | ***$838*** | ***$568*** | ***$3,351*** |
| **Redcliffe STP** | | | | | | | | | | |
| Ray Frawley Fields Clontarf | $2.0 | 53 | 67 | 133 | 334 | 7 | $2.55 | $732 | $293 | $14,631 |
| Redcliffe Reuse Scheme | $17.6 | 100 | 600 | 1,200 | 3,000 | 60 | | | | |
| **Total Hays Inlet** | ***$19.5*** | ***153*** | ***667*** | ***1,333*** | ***3,334*** | ***67*** | ***$2.55*** | ***$732*** | ***$293*** | ***$14,631*** |
| **New STP Caboolture Identified Growth Area** | | | | | | | | | | |
| ***Total CIGA*** | ***$28.6*** | ***671*** | ***1,908*** | ***3,815*** | ***4,769*** | ***572*** | ***$4.94*** | ***$1,031*** | ***$825*** | ***$6,873*** |

[1] Option assuming Wamuram Scheme is *not* implemented. This option assumes A+ water currently produced at Caboolture South is available for use, and no additional treatment is required. It excludes capital costs of distribution network for Caboolture South.

[2] Option assuming Wamuram Scheme is implemented (A+ water currently produced at Caboolture South *not* available for use)

[3] Includes capital cost for upgrading treatment capacity

[4] Meets Licence Requirements to recycle additional 4 ML/day only

## 5.8 WSUD Retrofit to Existing Urban Areas

Urbanised catchments can be a significant source of diffuse pollutant loads. One way of reducing these loads is to retrofit water sensitive urban design (WSUD) devices into urban areas. These devices typically consist of a range of measures, typically wetlands and bioretention basins, which treat stormwater runoff through detention of peak flows and filtering of water through vegetated systems. These devices are able to capture and reduce the loads of suspended sediment and nutrients.

For the purpose of this assessment, only large end of pipe devices were investigated. These are devices typically located at the bottom of catchments which aim to treat large volumes of stormwater. It should be noted that while it is also possible to retrofit smaller streetscape systems throughout an urbanised catchment, MBRC decided to focus solely on end of pipe devices for this TWCM Plan. During the course of this planning study, however, Council has gained an appreciation of the additional opportunities and benefits associated with retrofitting WSUD at a streetscape scale. As such, retrofit of streetscape WSUD devices is currently under investigation by MBRC as a separate project.

An assessment was undertaken by MBRC to determine suitable locations where end of pipe WSUD devices could be retrofitted into existing urban areas. This involved using GIS and applying mapping rules, details of which are included in Appendix D. The location identified by the mapping assessment are presented in Figure 5-5.

To determine the pollutant removal performance of these retrofitted WSUD devices, MUSIC modelling was undertaken for the combined WSUD devices within each catchment in accordance with the MUSIC Modelling Guidelines for SEQ (WBD, 2010b). Appendix B contains a description of the key modelling parameters used.

To develop indicative costs for the WSUD devices, establishment costs were sourced from MBRC (Priority Infrastructure Planning costs) and include the following:

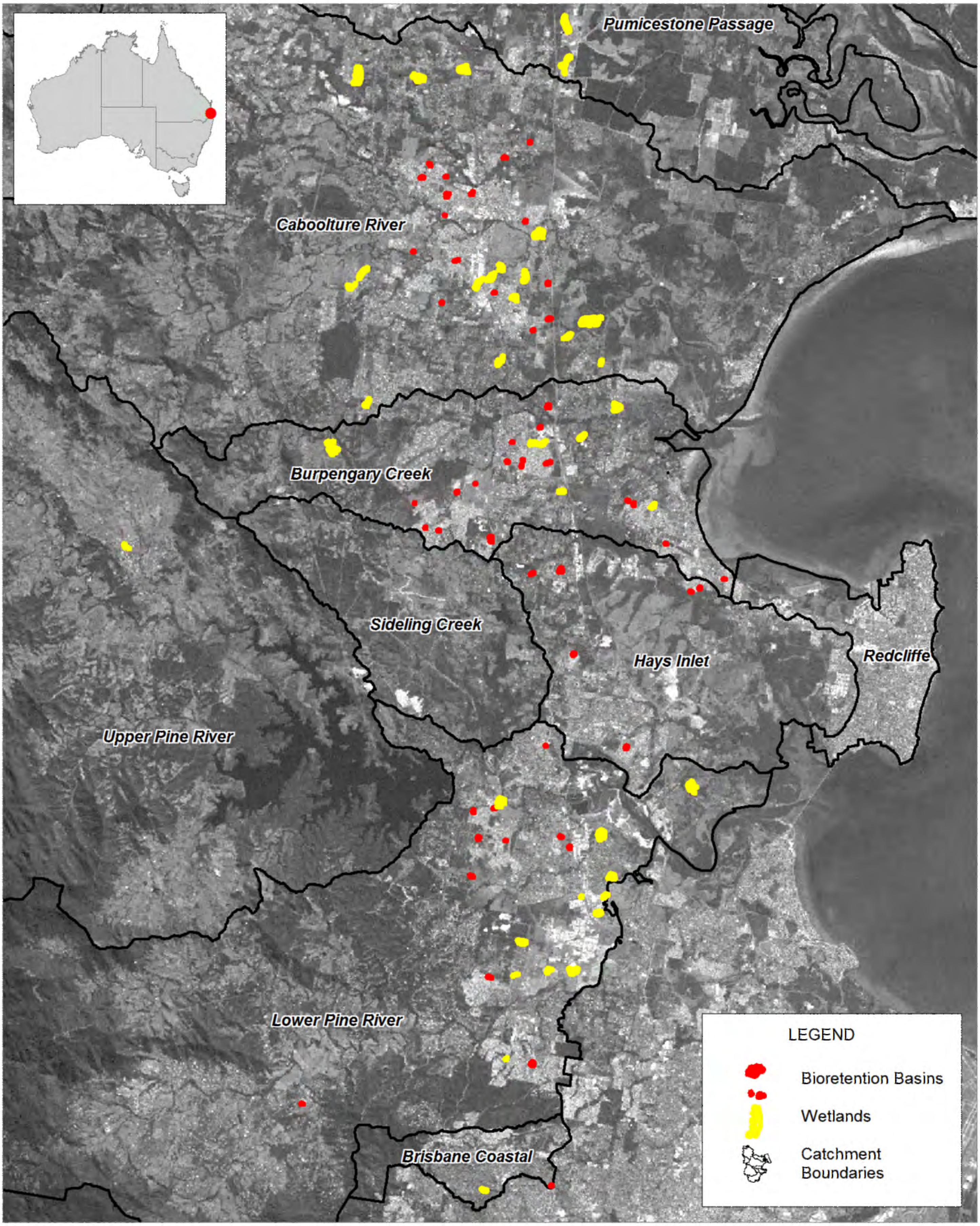
- Bioretention basin: $275/m$^2$
- Wetland: $90/m$^2$

Annual maintenance costs of $2/m$^2$ were sourced from the Brisbane City Council Streetscape Planning & Design Package (BCC, 2011).

The expected pollutant load reductions, net present value ($2011), and levelised costs for WSUD retrofit into existing urban areas are summarised in Table 5-13.

**Table 5-13 Performance Results for WSUD Retrofit in Existing Urban Areas**

| Catchment | Net Present Value ($2011) | Reduction in Loads (kg/yr) | | | Levelised Cost ($/kg reduction) | | |
|---|---|---|---|---|---|---|---|
| | | TSS | TN | TP | TSS | TN | TP |
| Pumicestone | $4,528,900 | 106,000 | 550 | 200 | $2.14 | $412 | $1,127 |
| Caboolture | $45,704,600 | 1,600,000 | 8,000 | 2,800 | $1.43 | $286 | $816 |
| Burpengary | $22,151,000 | 730,000 | 3,100 | 1,310 | $1.52 | $357 | $845 |
| Hays | $8,841,200 | 251,000 | 1,200 | 425 | $1.76 | $365 | $1,040 |
| Brisbane Coastal | $3,867,800 | 129,000 | 500 | 195 | $1.50 | $372 | $982 |
| Lower Pine | $38,332,100 | 1,280,000 | 5,700 | 2,180 | $1.50 | $336 | $879 |




Title:

**Location of WSUD Retrofit Opportunities**

Figure: 5-5

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Approx. Scale

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Filepath : I:\B18282_NJR_MBRC_Phase_2\DRG\WQU_014_110629 Location of WSUD Retrofit Opportunities.wor

## 5.9 WSUD to Achieve 'No Worsening' Pollutant Loads

Implementing WSUD to achieve a 'no worsening' in pollutant loads was identified as a 'stretch target' management solution to address urban stormwater quality. This solution was proposed as going beyond the regulatory SPP Healthy Waters requirement of 80%/60%/45% annual pollutant load reduction of TSS/TP/TN to achieve a 'no worsening' in catchment pollutant loads from existing conditions. However, it is noted that the applicability of this solution will largely depend on the existing state of the catchment, and in some cases (such as where large areas of agricultural land exists), best practice SPP Healthy Waters targets also achieve the 'no worsening' objective. The reason for this approach is that where urban lands are developed from existing grassed or heavily vegetated catchments, the regulatory target mentioned above applies to reductions from the developed land, not the existing loads, hence if the development produces a significant increase in loads compared to the existing land area, a 45% reduction in TN load for example would still result in an overall increase in loads. In sensitive catchments, or in those where a large reduction in existing loads is required to improve overall waterway health, a "no-worsening" approach to loads from new development may be necessary to prevent further degradation.

To assess this solution within applicable catchments, MUSIC modelling scenario results from implementing best practice WSUD were examined. Where results indicated that future catchment loads with best management practices (i.e. achieving 80%/60%/45% load reduction of TSS/TN/TP) were greater than predicted existing catchment loads (i.e. pre-development), MUSIC was used to determine what additional treatment area would be required to meet 'no worsening' pollutant export targets. As per the best practice WSUD solution, the treatment area was modelled assuming streetscape bioretention systems (refer to Figure 5-1) due to their efficacy and ability to be incorporated into constrained sites.

All MUSIC modelling was undertaken in accordance with MUSIC Modelling Guidelines for SEQ (WBD, 2010b). Appendix B contains a summary of the key parameters used.

The following expenses for establishing and maintaining bioretention systems were used to estimate the cost of implementing this solution in each catchment:

- Establishment: \$275/$m^2$ (Sourced from MBRC)
- Annual Maintenance: \$2/$m^2$ (Sourced from BCC, 2011)

In calculating the net present value, an operating period of 20 years was assumed (for maintenance costs). Similar to implementing best practice WSUD, it is envisaged that the establishment cost of this solution would generally be borne by the developer, while the maintenance cost would eventually (after the asset is handed over) be a Council responsibility. A risk with implementing this solution may be that developers increase the lot price in order to recoup additional money spent in implementing this solution. As this solution goes beyond that required by the SPP Healthy Waters, Council would need to include this solution as a planning provision for Development Approval in order to ensure it is implemented.

Predicted performance results of implementing this solution in each catchment is detailed in Table 5-14.

**Table 5-14 Performance Results for 'No Worsening' WSUD**

| Catchment | Treatment Area (% of catchment) | Net Present Value ($2011) | Reduction in Pollutant Loads (kg/yr) | | | Levelised Cost ($/kg) | | |
|---|---|---|---|---|---|---|---|---|
| | | | TSS | TN | TP | TSS | TN | TP |
| Burpengary | 1.5% | $20,155,910 | 472,000 | 3,720 | 819 | $2.14 | $271 | $1,231 |
| Caboolture | 2.0% (+0.3%)[1] | $73,623,637 | 1,509,000 | 13,900 | 2,870 | $2.44 | $265 | $1,283 |
| CIGA | 1.7% | $153,764,000 | 5,320,000 | 26,200 | 7,160 | $1.45 | $293 | $1,074 |
| Hays Inlet | 2.8% (+1.1%)[1] | $82,821,834 | 1,229,000 | 12,010 | 2,475 | $3.37 | $345 | $1,673 |
| Lower Pine | 1.7% | $27,682,988 | 628,000 | 5,470 | 1,249 | $2.20 | $253 | $1,108 |
| Pumicestone | 2.0% (+0.4%)[1] | $41,397,733 | 808,000 | 7,340 | 1,459 | $2.56 | $282 | $1,419 |
| Upper Pine | 3.3% (+1.2%)[1] | $219,640 | 3,495 | 36 | 7 | $3.14 | $308 | $1,664 |
| Stanley | 1.5% | $2,762,426 | 62,700 | 473 | 108 | $2.20 | $292 | $1,275 |

Shaded cells indicate best practice WSUD (meeting SPP Healthy Waters load reduction targets) in catchment also meets 'No Worsening' pollutant export targets, therefore solution not applicable

[1] Indicates increase in treatment area (as percentage of catchment) required to achieve 'no worsening'

## 5.10 Stormwater Harvesting

Stormwater harvesting was identified as a potential solution to improve stormwater quality from urban areas. In addition to improving water quality (by reducing stormwater pollutant loads from catchments through reuse), it provides an alternative source of water supply, and also assists to reduce the increased frequency of flows and ecological impacts to waterways caused by urbanisation.

The performance of this solution was assessed for large (>20ha) land areas of future Greenfield development with no existing development approvals, whereby the opportunity remains to implement stormwater harvesting. The land area criteria was based on information from a study commissioned by the Queensland Water Commission (QWC) (Bligh Tanner and Design Flow 2009) which identified that to be cost effective, stormwater harvesting schemes should be implemented on Greenfield development sites >20 ha and preferably greater than 100 ha. This criteria has also been adopted in the catchment rules for stormwater harvesting by Chowdhury et al (2011). Bligh Tanner & Design Flow (2009) documented results from case studies of different schemes in North Lakes and Sippy Downs. Of note, the North Lakes development is located within MBRC (Hays Inlet), and therefore study results were deemed to be relevant to this investigation.

Marginalised levelised costs for stormwater harvesting schemes in North Lake case studies (Bligh Tanner & Design Flow 2009) have been used to estimate the cost of implementing stormwater harvesting solutions in each catchment. A summary of these costs are detailed in Table 5-15. The costs were based on sizing storages to provide a 70-75% reliability of supply and include costs associated with land, capital investment and ongoing maintenance. It is important to note that these costs are indicative only, due to the largely variable nature of implementing stormwater harvesting projects.

**Table 5-15 Levelised Cost for Stormwater Harvesting (Bligh Tanner & Design Flow, 2009)**

| North Lakes Development Type | Levelised Cost for Dual Reticulation & Open Space ($2009/ML)[1] | Levelised Cost for Open Space Only ($2009/ML)[1] |
|---|---|---|
| Low Density 20ha | 7,500 | 5,700 |
| Low Density 100 ha | 4,700[2] | 5,700 |
| Low Density >500 ha | 4,200 | 3,900 |
| Industrial 20 ha | 5,600[3] | |

[1] Although costs are reported in $2009, the Rawlinson Building Price Index between 2009-2011 has in fact decreased (by approx. 3%) and therefore this price is considered to be representative of $2011.
[2] This cost was also assumed for medium density development
[3] This cost was based on dual reticulation only, with no open space irrigation

In those catchments where stormwater harvesting schemes were deemed viable (developments greater than 20 ha), the following assumptions were used as a basis for calculating demands in each catchment:

- Dual reticulation for toilets (24L/EP/day) and outdoor use (25L/EP/day).
- Industrial use based on 20 EP/ha, and 80L/EP (*pers comm* A Sloan). Industrial demands are noted to be highly variable.
- Low density residential development characterised by 15 dwellings/ha and 2.8 EP/dwelling.
- Medium density residential development characterised by 40 dwellings/ha and 1.9 EP/dwelling.
- Open space comprises of 10% of the development area (*pers comm*. C Jeavons), with a moderate irrigation rate of 548 mm/year.
- 75% of estimated water demand is met through supply of stormwater.

In determining the potable water savings, discussions with Council maintenance and landscaping staff indicated that in open space areas, only sports fields were generally irrigated with potable water. Potable water requirements for sports field were estimated by Council to make up approximately 80% of the demand (with other demand met from bore water or tank water). Sports fields were estimated to comprise of approximately 35% of all open space areas.

Stormwater harvesting in the CIGA was investigated through the use of the Urban Developer modelling tool (refer to Section 4). The stormwater harvesting scenario in the CIGA included the supply of stormwater to households for toilet and outdoor use, along with supply to public open space for irrigation. Further details on the findings of the Urban Developer modelling for the CIGA can be found in the Sub-Regional TWCM Plan for the CIGA (BMT WBM, 2011).

Figure 5-6 illustrates the sites that were investigated for stormwater harvesting in each catchment.

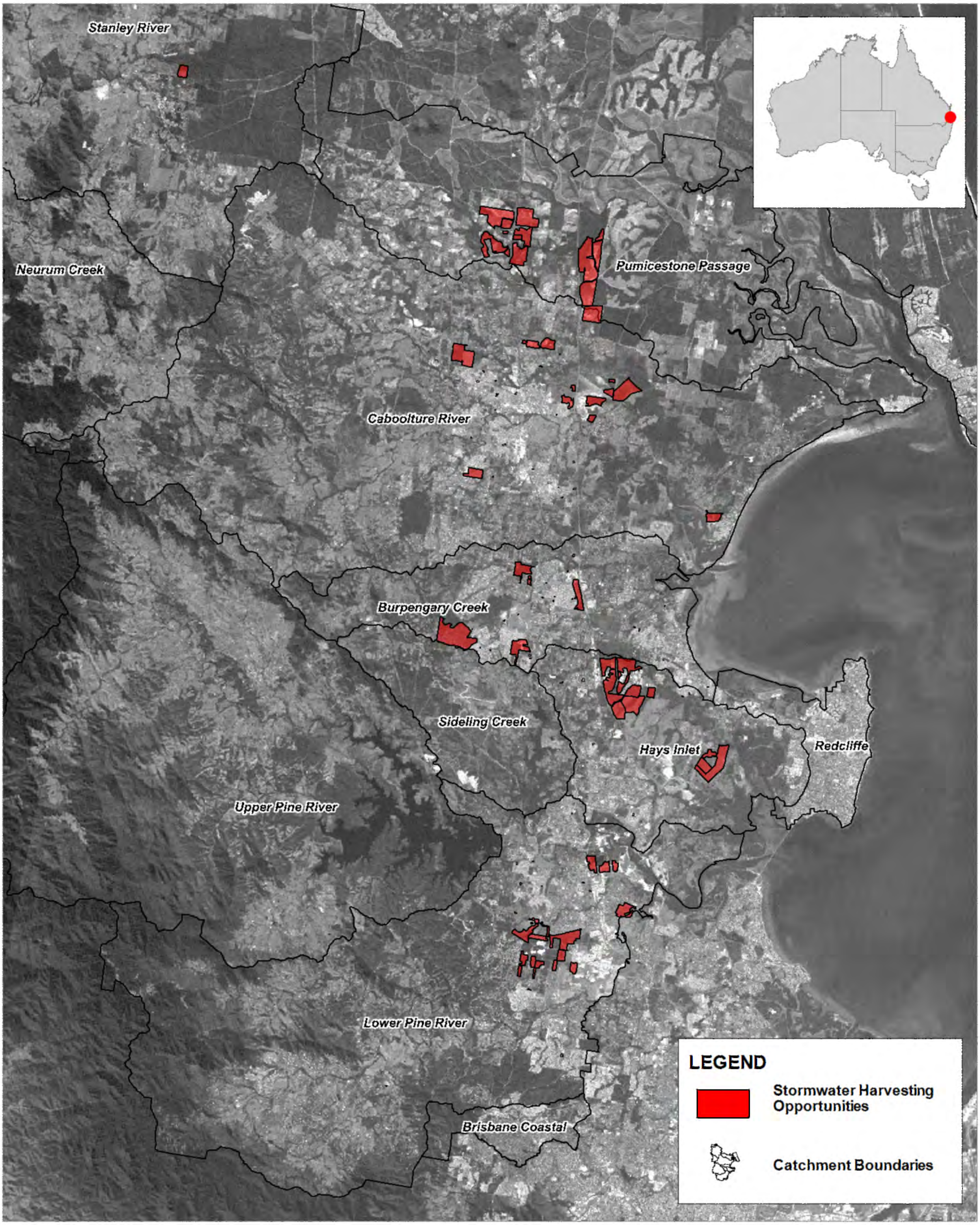
A summary of the performance of this solution in each catchment is detailed in Table 5-15.

**Table 5-16 Performance Results for Stormwater Harvesting**

| | Catchment | | | | | |
|---|---|---|---|---|---|---|
| | Pumicestone | CIGA | Caboolture | Burpengary | Hays Inlet | Lower Pine |
| **NPV ($2011)** | $28,348,934 | $29,693,661 | $16,039,868 | $15,236,654 | $15,497,928 | $15,412,979 |
| **Potable Water Savings (ML/yr)** | 385 | 1,232 | 184 | 178 | 246 | 197 |
| **Total Water Saving** | 499 | 2,161 | 239 | 254 | 246 | 257 |
| ***Pollutant Load Reduction*** | | | | | | |
| **TSS (kg/yr)** | 75,375 | 326,310 | 36,161 | 38,389 | 37,099 | 38,776 |
| **TN (kg/yr)** | 908 | 3,933 | 436 | 463 | 447 | 467 |
| **TP (kg/yr)** | 169 | 733 | 81 | 86 | 83 | 87 |
| ***Levelised Cost*** | | | | | | |
| **Stormwater ($/kL)** | $4.95 | $4.20 | $5.84 | $5.23 | $5.50 | $5.23 |
| **TSS ($/kg)** | $19 | $12 | $22 | $20 | $21 | $20 |
| **TN ($/kg)** | $1,560 | $995 | $1,840 | $1,646 | $1,733 | $1,649 |
| **TP ($/kg)** | $8,376 | $5,340 | $9,879 | $8,839 | $9,304 | $8,853 |

It is noted that the potential development areas assessed for stormwater harvesting are anticipated to consist of primarily low density (<15 dwelling/ha) housing, whereas it has been recognised that a housing density of >30 dwelling/ha is preferred to ensures a regular and sustained demand for stormwater, irrespective of external household demand (Chowdhury et al, 2011 & Bligh Tanner and Design Flow, 2009). Furthermore, industrial areas may have much higher demands than forecast in this study (and increased cost effectiveness), however this will largely depend on the type of industry, which is unknown at this time.

The presence of suitable aquifers is also recognised to be highly advantageous in providing cost effective stormwater harvesting schemes (through significant reductions in storage costs). A review of a broadscale study on the opportunities for aquifer storage and recovery (ASR) in South East Queensland (Helm et al, 2009) indicated that limited potential for ASR exists within the Moreton Bay region. However it is noted that more detailed localised assessment (beyond the scope of this study) would be required on a site by site basis to ascertain whether opportunities for ASR exist.




| Title: **Location of Stormwater Harvesting Opportunities** | Figure: **5-6** | Rev: **A** |
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Approx. Scale

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Filepath : I:\B18282_NJR_MBRC_Phase_2\DRG\WQU_043_120117 Location of Stormwater Harvesting.wor

## 5.11 Purified Recycled Water

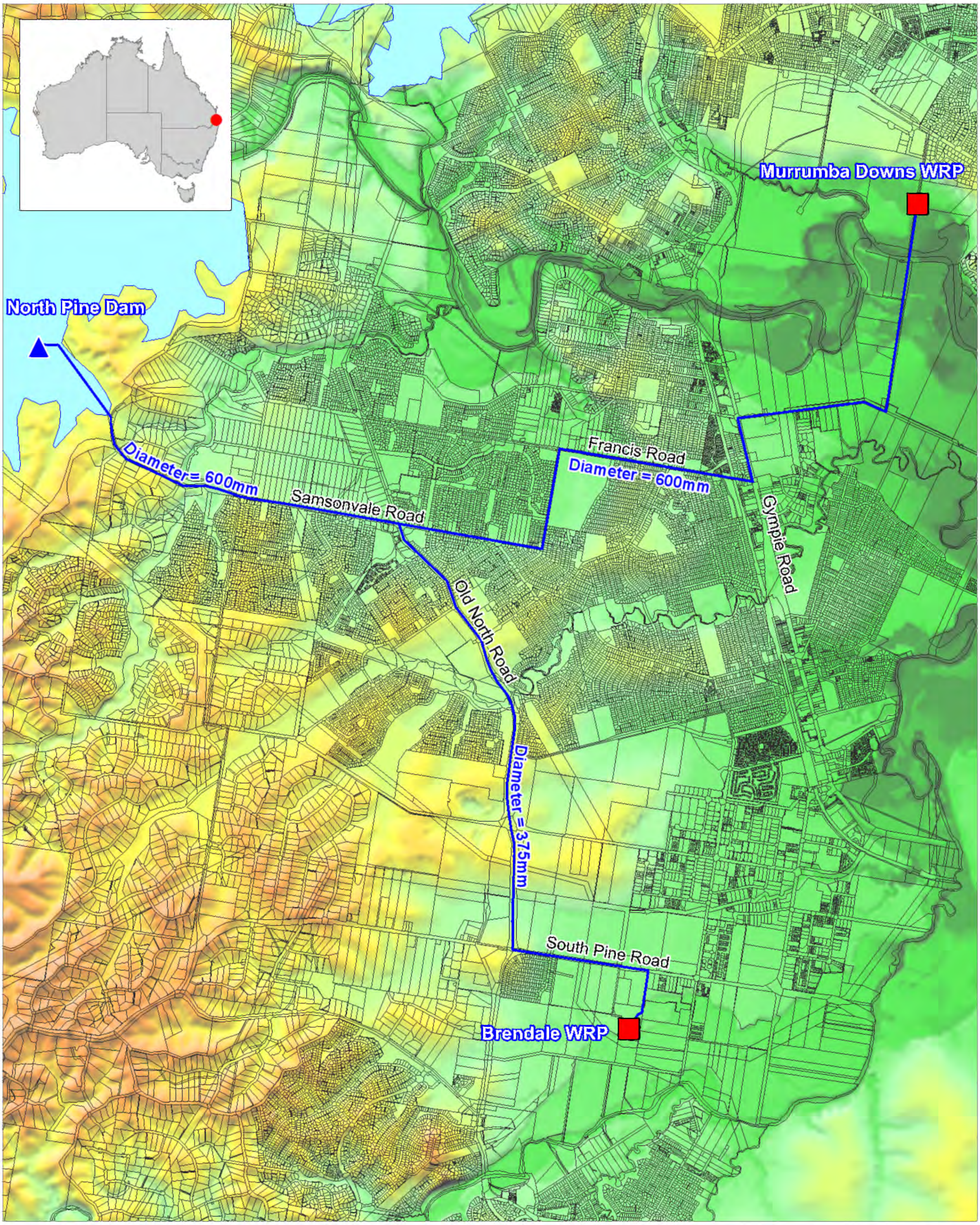
Purified Recycled Water (PRW) was considered as a solution in the Lower Pine catchment and in the CIGA. This solution targets pollutant load reduction while also providing an alternative supply of water fit for drinking.

For the Lower Pine catchment, it assumes effluent from both Brendale and Murrumba Downs STPs is treated to required standards and piped to North Pine Dam for indirect potable reuse. For the CIGA, it assumes effluent from Caboolture South STP is treated and pumped to North Pine Dam.

Consideration of a PRW scheme utilising the Caboolture weir was also considered during the options assessment workshop undertaken in this study. However, it was discounted due to the small storage size, which was expected not to provide the necessary dilution and environmental buffer required under the 7 barrier process required for producing PRW.

This solution was based on previous studies undertaken by MWH (2009). MWH (2009) gave consideration to returning flows to Lake Kurwongbah, however it was evident that the retention time for recycled water would be longer in the North Pine Dam resulting in a higher level of public acceptance of the scheme.

The proposed location of the PRW scheme in the Lower Pine catchment as developed by MWH (2009) is shown in Figure 5-7, while a summary of the capital and operational costs of the scheme is reproduced in Table 5-17.




Title:

**Location of Lower Pine Purified Recycled Water Scheme (MWH 2009)**

Figure: **5-7**

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**Table 5-17 Capital and Operating Costs of Lower Pine PRW Scheme (MWH, 2009)**

| Description | Capital Cost[1] | Average Annual Operational Cost[1] |
|---|---|---|
| Murrumba Downs PRW Treatment Plant (42 ML/day ADWF Capacity) | $177,322,454 | $1,572,000 |
| Brendale PRW Treatment Plant (11 ML/day ADWF Capacity) | $47,729,494 | $416,760 |
| Distribution System | $17,535,211 | $426,646 |
| **Total Cost** | **$242,587,159** | **$2,415,406** |

[1]The above costs were reported in $2009. As the building price index has decreased since this time, these costs are conservatively assumed to represent $2011.

As the capital costs presented in Table 5-17 represent ultimate capacity at 2050, these costs have proportioned to reflect the anticipated costs in 2031, based on the estimated capacity at this time. Using MWH cost estimates, the PRW AWTP costs are approximately $4.3 Million per ML/day of capacity. The revised capital cost estimate of the scheme is detailed in Table 5-18. Operating costs in

Table 5-17 were also revised by applying an average annual operating cost of $1,500 per ML to anticipated volumes over the planning period. This cost is based on the current operating costs of Murrumba Downs AWTP (for RO/UV treatment and network operational costs), and works out to be a much greater expense than previous estimates in

Table 5-17**.**

**Table 5-18 Revised Capital Cost Estimates for Lower Pine PRW Scheme**

| Description | Capital Cost[1] |
|---|---|
| Murrumba Downs PRW Treatment Plant (36.6 ML/day ADWF Capacity) | $154,616,390 |
| Brendale PRW Treatment Plant ( 15.4 ML/day ADWF Capacity) | $66,916,390 |
| Distribution System | $17,535,210 |
| **Total Cost** | **$239,067,990** |

[1]The above costs were derived from $2009. As the building price index has decreased since this time, these costs are conservatively assumed to represent $2011.

Capital cost estimates for the AWTP in the CIGA PRW scheme were based on capital costs for constructing the Murrumba Downs AWTP (sourced from Unitywater). These costs were scaled back assuming some economies of scale in constructing the larger plant, however still work out to be reasonably high ($6.3 Million per ML/day of capacity). Additional capital and operational cost estimates for infrastructure to pipe water from the CIGA to North Pine Dam were estimated by Bligh Tanner. A summary of the capital and operating costs assumed for the CIGA PRW scheme are detailed in Table 5-19.

**Table 5-19 Capital and Operating Cost Estimates for the CIGA PRW Scheme**

| Description | Cost Estimate[1] |
|---|---|
| Capital Cost PRW Treatment Plant (12.4 ML/day ADWF Capacity) | $78,240,820 |
| Capital Cost Distribution System | $23,827,180 |
| ***Total Capital Cost*** | ***$102,068,000***[2] |
| Operational Cost of Treatment | $1,500 /ML |
| Operational Costs of Reticulation (fixed cost) | $120,490 / yr |
| Operational Costs of Reticulation (power supply) | $36/ ML |

[1] $2011

[2] Note this does not include cost savings from traditional land and storage requirements

In determining the NPV of the CIGA scheme, capital costs were for the AWTP were spread out assuming capacity upgrades in 2017, 2022 and 2027 to accommodate for population growth. Capital cost of storage and land for effluent disposal (assumed required for conventional treatment requiring zero discharge to Caboolture River) was costed to be a cost saving of approximately $35.5M. This cost assumes land at a price of $50K/ha (B Harris 2011, pers. comm. 1 August) and storage sized to hold effluent for 110 days (typical DERM licence requirement).

It should be noted that the cost estimates provided are high level indicative estimates only for this planning study, and further detailed costing should be undertaken as required.

When assessing the potential pollutant load reduction of this solution, discharge design standards for Brendale, Murrumba Downs and Caboolture South STPs were used (refer Table 5-9). When calculating nitrogen load reductions, it was assumed that approximately 20% of the treated flow would be discharged as Reverse Osmosis Concentrate (ROC). As ROC contains elevated concentrations of nutrients (particularly nitrogen), these additional nutrient loads were estimated using typical ROC effluent concentrations (sourced from Bundamba AWTP) and deducted from the solutions treatment performance. Typical concentrations assumed for ROC are detailed in Table 5-20.

**Table 5-20 Typical Concentration Assumed for ROC**

| | Total Suspended Solids | Total Nitrogen | Total Phosphorus |
|---|---|---|---|
| Median ROC Concentration (mg/L) | 1 | 7.2 | 0.47 |

A summary of this solution's overall performance is outlined in Table 5-21.

**Table 5-21 Performance Results of PRW Scheme**

| | Catchment | |
|---|---|---|
| | Lower Pine | CIGA |
| Net Present Value ($2011) | $432,823,057 | $81,200,000 |
| Water Savings (ML/yr)[1] | 15,197 | 3,626 |
| *Pollutant Reduction*[1] | | |
| TSS (kg/yr) | 32,479 | 7,751 |
| TN (kg/yr) | 26,898 | 4,832 |
| TP (kg/yr) | 7,712 | 934 |
| *Levelised Cost* | | |
| Water ($/kL) | $3.35 | $6.71 |
| TSS ($/kg) | $857 | $1,358 |
| TN ($/kg) | $1,035 | $2,179 |
| TP ($/kg) | $3,611 | $11,275 |

[1] Predicted maximum performance over planning period

## 5.12 Retrofit of Rainwater Tanks in Existing Urban Areas

The effectiveness of retrofitting rainwater tanks in existing urban areas was investigated as a solution to reduce pollutant loads exported from urban catchments, as well as reduce reliance on potable water supplies. This solution can also reduce peak flow volumes from urban areas due to the detention capacity of rainwater tanks, thereby reducing the impacts on downstream waterways.

To assess this solution, existing population data was used to determine the number of people in each catchment. This was achieved using the GIS water demand model developed by Unitywater which was utilised in Phase 1 of this project (i.e. TWCM Strategy) to determine potable water demand.

From the TWCM Strategy, it was assumed that there was approximately a 25% uptake of rainwater tanks currently in the MBRC region. For the purposes of undertaking the assessment of rainwater tank retrofit, it was assumed that the remaining 75% of households in the four catchments investigated would be retrofitted with rainwater tanks.

To determine the amount of potable water saved by implementing this solution, it was assumed that rainwater tanks would be used for outdoor use, and internally plumbed into the toilet and laundry. Daily water usage was based on results of the SEQ End Use Study (Beal *et al*, 2011) and discussion with key stakeholders, and comprised:

- *Internal (laundry/toilet):* 54.7 L/EP/day.

- *Outdoor:* 25 L/EP/day.

It was assumed (from lot scale modelling results) that rainwater tanks typically meet 70% of the above demands.

After assessing the volume of water used from the rainwater tanks, pollutant load reductions were estimated by applying pollutant export rates from roofed areas as follows (WBD, 2010b):

- *TSS:* 20 mg/L.
- *TN:* 1.82 mg/L.
- *TP:* 0.129 mg/L.

Indicative establishment costs for rainwater tanks were sourced from a study into the cost effectiveness of rainwater tanks in urban Australia (NWC, 2007), which determined an average cost for a rainwater tank was $3,016 and included the cost of the tank, installation and plumbing. Operational costs were assumed to be $20/tank/year for electricity costs due to pumping.

Performance results of this solution are summarised in Table 5-22, which includes net present value of retrofitting the tanks along with potable water savings, pollutant load reductions and the levelised costs.

**Table 5-22 Performance Results for Retrofitting Rainwater Tanks**

| Catchment | Net Present Value ($2011) | Potable Water Savings | Reduction in Loads (kg/yr) | | | Levelised Water Cost ($/kL) | Levelised Cost ($/kg reduction) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | TSS | TN | TP | | TSS | TN | TP |
| Bribie Island | $14,298,000 | 251 | 5,020 | 457 | 32 | $4.97 | $142 | $1,565 | $22,078 |
| Redcliffe | $41,424,700 | 727 | 14,545 | 1,324 | 94 | $4.97 | $142 | $1,565 | $22,078 |
| Brisbane Coastal | $18,860,800 | 331 | 6,622 | 603 | 43 | $4.97 | $142 | $1,565 | $22,078 |
| Pumicestone | $9,526,100 | 167 | 3,345 | 304 | 22 | $4.97 | $142 | $1,565 | $22,078 |

## 5.13 Prevention of Illegal Stormwater Connections

Currently in the MBRC region there are a number of stormwater connections to the sewerage system which have not been authorised by Unitywater, and are therefore termed ‘illegal connections’. These illegal connections typically involve the connection of household downpipes and surface drains to the sewerage system. The consequence of these connections is that during periods of high rainfall the sewerage system is inundated with excess stormwater inflows, which results in overflows and bypass of some treatment at the STP.

While this solution has been included as an option in a number of catchments in the MBRC region, it has not been quantified or assessed further in this section for the following reasons:

- The complexity of trying to quantify the effectiveness of programs to prevent illegal connections prohibits any meaningful assessment.

- Illegal connections predominantly impact on STP overflows, which were not accounted for in this investigation.
- Unitywater already have a policy in place to attempt to rectify this issue.

As mentioned, Unitywater has a strategy in place currently to address illegal stormwater connections. This strategy, referred to as the 'Sewer Overflow Abatement Strategy', aims to minimise current and future illegal stormwater connections to sewer. As such, future development in the MBRC region will be scrutinised by Unitywater to ensure these illegal connections are prevented as much as practicable.

Therefore, this solution has not been included in the modelling assessment in later sections, but is included as part of the final preferred management scenario.

## 5.14 Education & / or Capacity Building

This solution relates to education and/or capacity building programs to promote water cycle management issues such as water efficiency, WSUD, recycled water, etc. Also included in the scope of this solution is the use of incentive schemes, such as rainwater tank rebates, to encourage the uptake of certain water management systems.

Due to the indeterminate nature of this solution, it has not been possible to quantify the effectiveness of implementing this solution in each catchment. Furthermore, this solution would be implemented to support other water cycle management solutions adopted, and therefore cannot be adequately quantified at this stage.

Therefore, this solution has not been included in the modelling assessment in later sections, but is included as part of the final preferred management scenario as a supporting solution to all other recommended solutions. Education and/or capacity building will play an integral role in ensuring water cycle management solutions are adopted fully and are effective.

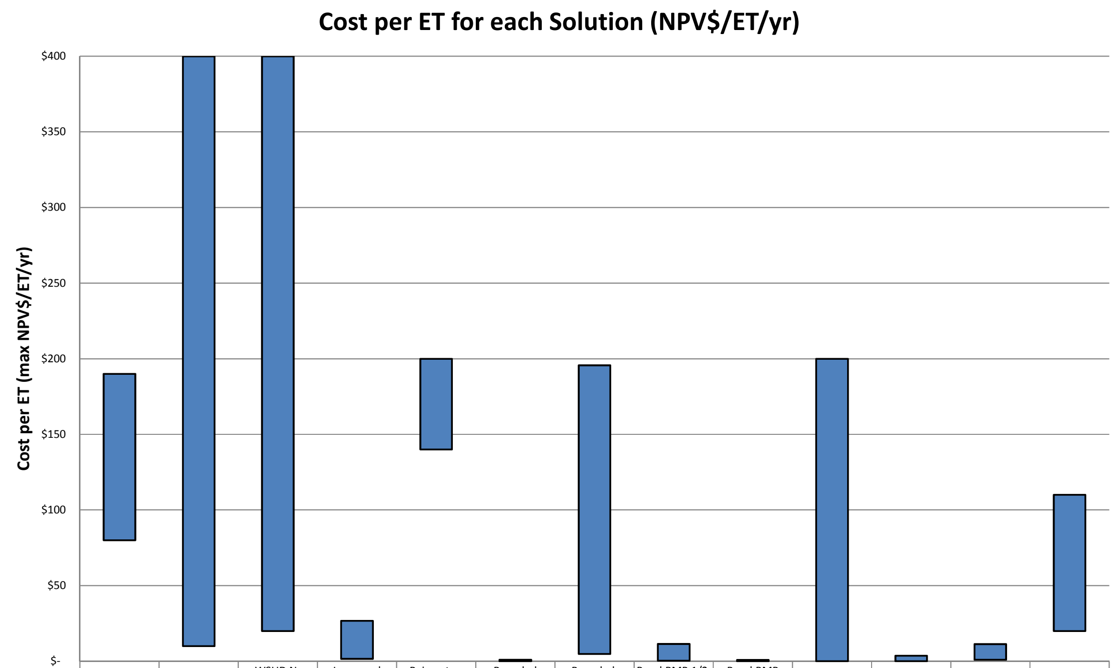
## 5.15 Solution Performance Summary

A summary of the each solution's performance amongst all catchments in terms of environmental performance and cost is summarised in the following sections.

This summary provides an indication of the relative performance of each individual solution, allowing a comparison to be made between solutions. To assist in determining the likely impacts on water quality from implementation of these solutions, the environmental performance presented in this section are used as inputs into the modelling framework (i.e. catchment and receiving water quality models discussed in Section 4), with results discussed in Section 6.

### 5.15.1.1 Net Present Value (NPV)

The Net Present Value of each solution over the planning period was used to determine the potential cost of each solution to land holders in a catchment. Figure 5-8 presents the cost per lot in each catchment, expressed as cost per equivalent tenement (ET) (i.e. lot) per year. This indicates that WSUD would potentially have the greatest cost per lot in some catchments, followed by stormwater harvesting. It is, however, noted that the costs presented below do not include detailed Project Support costings, which were undertaken using concept designs of the preferred (using MCA) recycled water schemes. Project Support costs were significantly greater than originally estimated.




| | QDC Target | WSUD SPP HW | WSUD No Worsen. | Increased E&SC | Rainwater Tank Retrofit | Recycled Water Ag. | Recycled Water Urban | Rural BMP 1/2 streams | Rural BMP Hort. | S/W Harvest | W/W Reveg. | WSUD Retrofit | PRW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min | $80 | $10 | $20 | $1.62 | $140 | $- | $4.82 | $0.40 | $0.02 | $- | $0.08 | $1.00 | $20 |
| Max | $190 | $400 | $400 | $26.66 | $200 | $1.00 | $196 | $11.40 | $0.85 | $200 | $3.70 | $11.30 | $110 |

**Figure 5-8 Cost per Equivalent Tenement (ET) per Year**

### 5.15.1.2 Alternative Water Supply

The range of each solution's performance in providing an alternative source of water, reducing mains water consumption, is shown in Figure 5-9. Figure 5-9 shows that purified recycled water (PRW) can potentially provide the greatest alternative water supply, followed by recycled water supplied to urban and agricultural users.

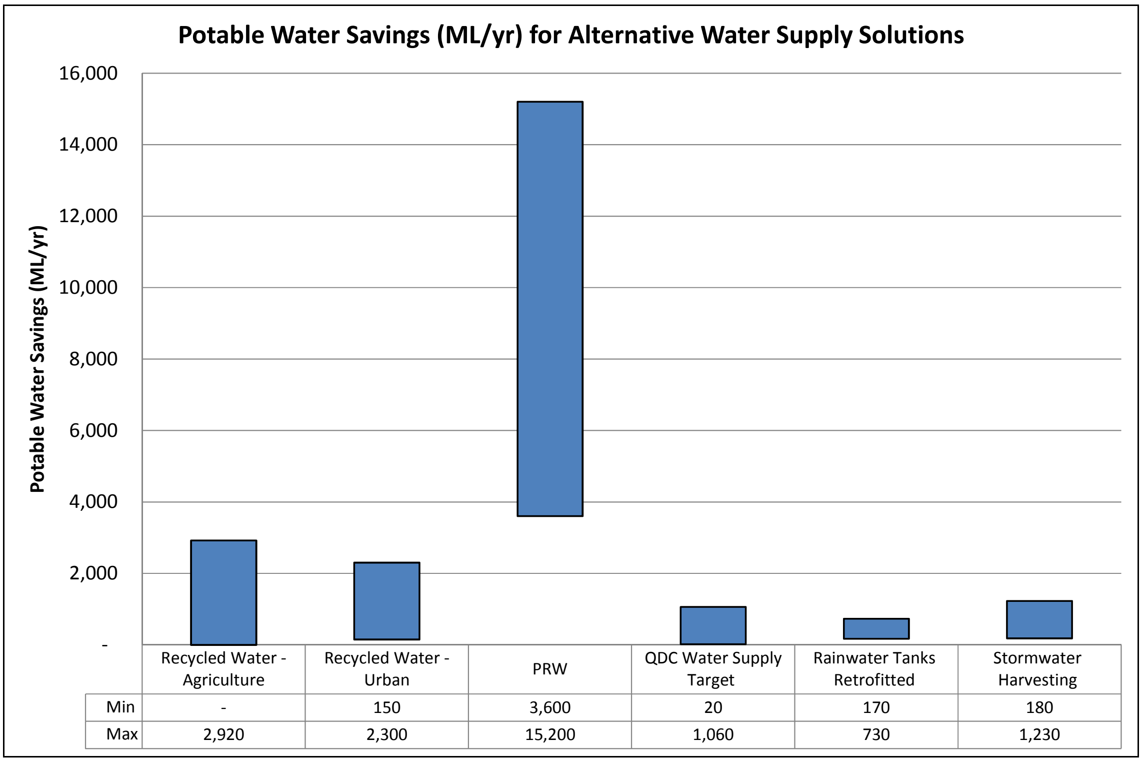


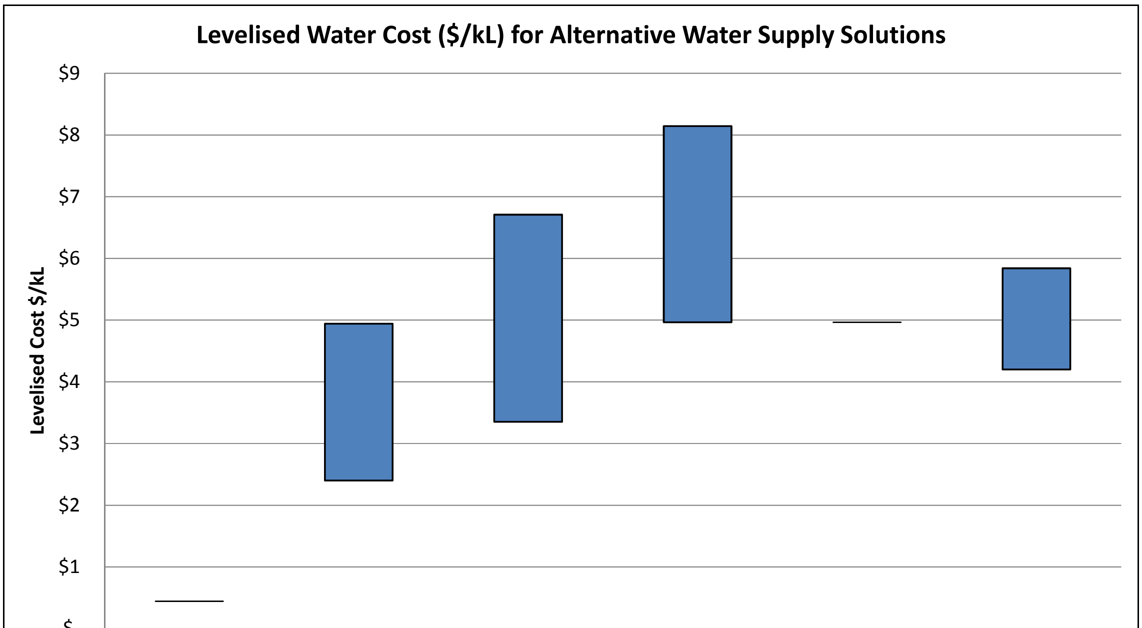

**Figure 5-9 Potable Water Savings (ML/yr) for Alternative Water Supply Solutions**

Levelised costs of providing an alternative water supply source are shown in Figure 5-10. Levelised costs represent the unit value of water taking into account the NPV over the planning period and the amount of water supplied by the scheme. This allows for the cost effectiveness of solutions to be examined.

The levelised costs in Figure 5-10 indicate that recycled water to agriculture provides the most cost effective solution (at $0.45kL). Recycled water to urban users is the next most cost effective solution, with levelised costs ranging from $2.40 to $4.94/kL. Rainwater tanks (to meet QDC target) has the highest levelised costs among catchments ranging from $4.97 to $8.14.

Of note is the disparity in levelised cost between the two PRW schemes, with the Lower Pine scheme producing potable water at $3.35/kL and the CIGA scheme producing water at $6.71/kL. This is due to the higher estimated capital costs for treatment and distribution of PRW at the CIGA, as well as additional operational costs from the transfer of PRW to North Pine Dam. This also highlights that despite the Lower Pine PRW scheme being the most expensive solution due to its large scale of operation (refer to Figure 5-8), it is nevertheless a relatively cost effective solution.

Furthermore, it is noted that the costs presented do not include detailed Project Support costings, undertaken for selected preferred (using MCA) recycled water schemes. Project Support costs were significantly greater than originally estimated, indicating some recycled water schemes are not financially viable. Further detailed investigations will be required prior to implementing any recycled water scheme.



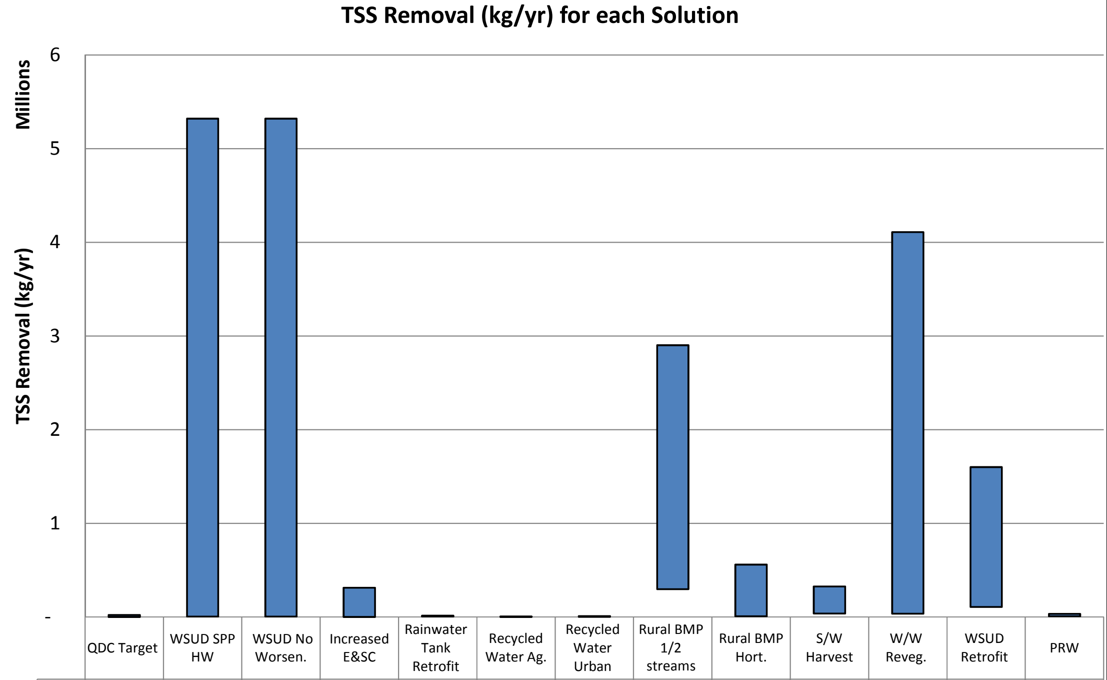

| | Recycled Water - Agriculture | Recycled Water - Urban | PRW | QDC Water Supply Target | Rainwater Tanks Retrofitted | Stormwater Harvesting |
|---|---|---|---|---|---|---|
| Min | $0.45 | $2.40 | $3.35 | $4.97 | $4.97 | $4.20 |
| Max | $0.45 | $4.94 | $6.71 | $8.14 | $4.97 | $5.84 |

**Figure 5-10 Cost ($/kL) for Alternative Water Supply Solutions**

### *5.15.1.3 Reduction in Total Suspended Solids Pollutant Loads*

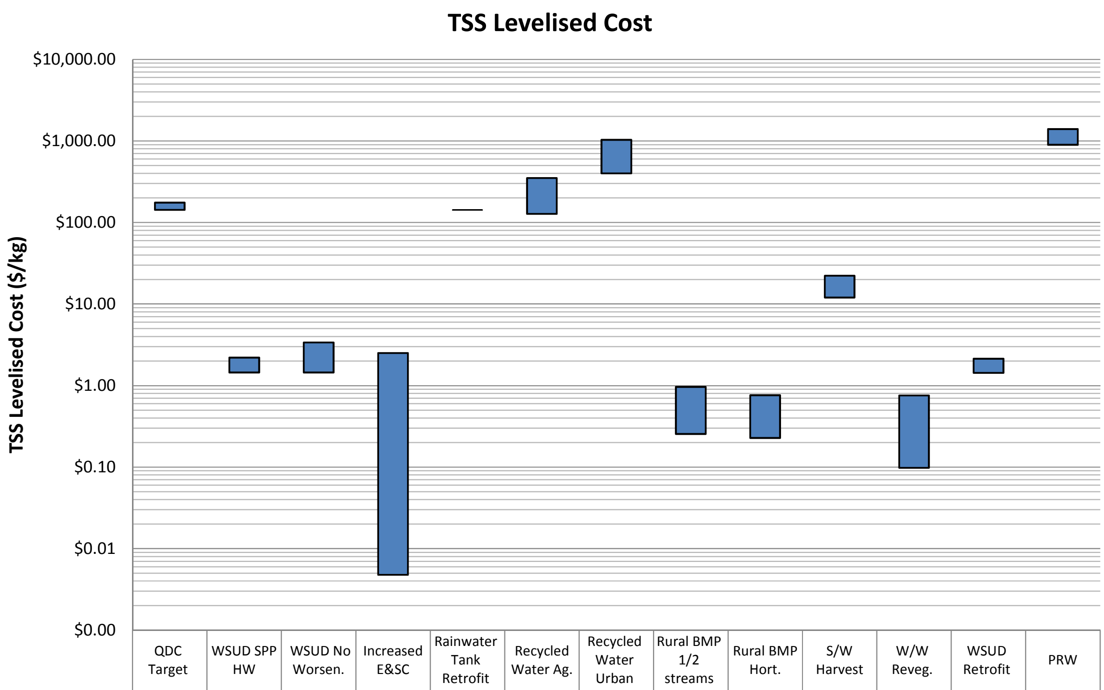
The range of each solution's performance in reducing total suspended sediment (TSS) loads is shown in Figure 5-11. This indicates that WSUD in greenfield development sites would provide the greatest reduction in sediment loads in some catchments. Waterway revegetation of 3$^{rd}$ and 4$^{th}$ order streams would potentially have the next greatest reduction in sediment loads, followed by rural best management practices involving revegetation of 1$^{st}$ and 2$^{nd}$ order streams on cattle grazing land.

When the cost of implementing each solution is levelised (Figure 5-12 – note the log scale used due to the large difference in costs of different schemes), it can be seen that increasing compliance of erosion and sediment control (E&SC) would be the most cost effective solution. Figure 5-12 also shows that revegetation of 1$^{st}$ and 2$^{nd}$ order streams in grazing land and waterway revegetation of 3$^{rd}$ and 4$^{th}$ order streams not only provide substantial sediment load reductions as mentioned above, but are also cost effective solutions.




| | QDC Target | WSUD SPP HW | WSUD No Worsen. | Increased E&SC | Rainwater Tank Retrofit | Recycled Water Ag. | Recycled Water Urban | Rural BMP 1/2 streams | Rural BMP Hort. | S/W Harvest | W/W Reveg. | WSUD Retrofit | PRW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min | 300 | 3,200 | 3,500 | 200 | 3,300 | 300 | 1,300 | 298,000 | 7,900 | 36,200 | 35,200 | 106,000 | 7,800 |
| Max | 21,300 | 5,320,000 | 5,320,000 | 312,600 | 14,500 | 5,800 | 9,100 | 2,900,000 | 559,000 | 326,300 | 4,109,000 | 1,600,000 | 32,500 |

**Figure 5-11 TSS Load Reduction (kg/yr) for Each Solution**



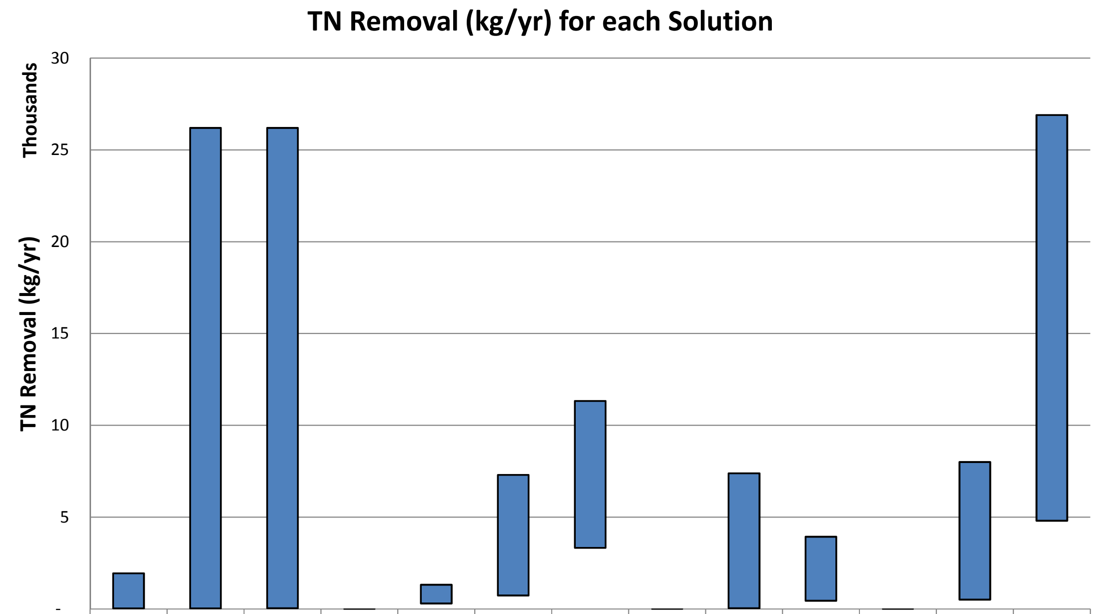

| | QDC Target | WSUD SPP HW | WSUD No Worsen. | Increased E&SC | Rainwater Tank Retrofit | Recycled Water Ag. | Recycled Water Urban | Rural BMP 1/2 streams | Rural BMP Hort. | S/W Harvest | W/W Reveg. | WSUD Retrofit | PRW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min | $142 | $1.45 | $1.45 | $0.00 | $142 | $128 | $402 | $0.26 | $0.23 | $12 | $0.10 | $1.43 | $900 |
| Max | $175 | $2.20 | $3.37 | $2.50 | $142 | $351 | $1,031 | $0.96 | $0.76 | $22 | $0.75 | $2.14 | $1,400 |

**Figure 5-12 Levelised Cost ($/kg) of TSS Reduction**

### *5.15.1.4 Reduction in Total Nitrogen Pollutant Loads*

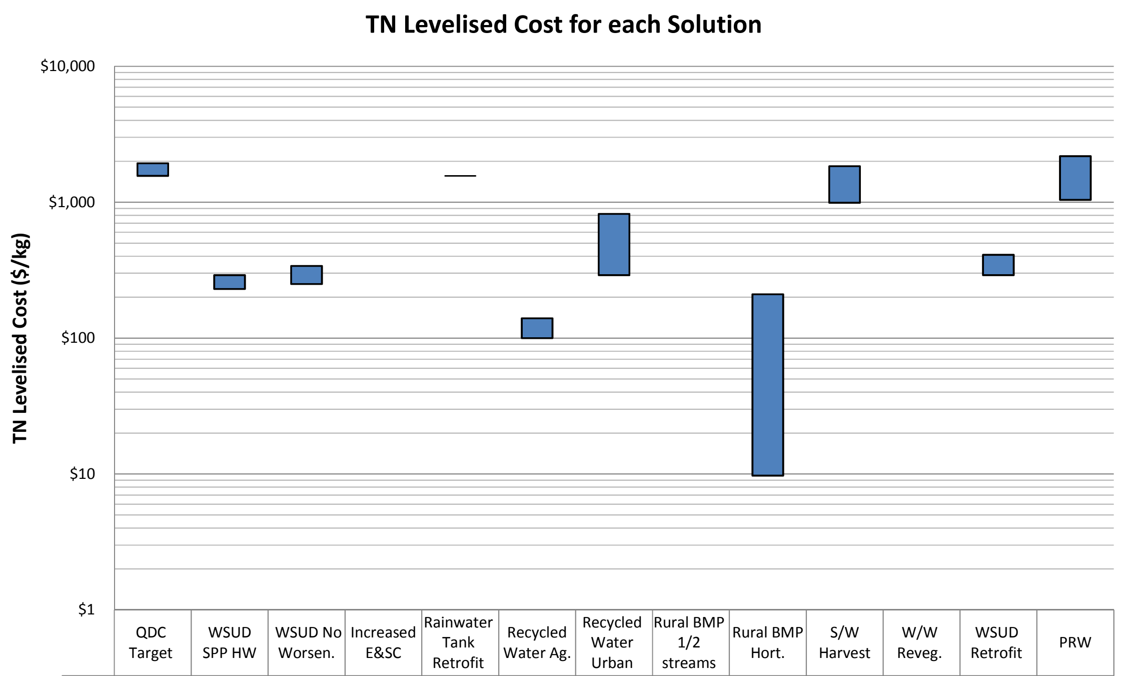
The range of each solution's performance in reducing total nitrogen (TN) loads is shown in Figure 5-13. This indicates that WSUD in greenfield development would potentially provide the greatest reduction in nitrogen loads, followed to a lesser extent by PRW.

With regard to levelised costs of reducing nitrogen loads, Figure 5-14 indicates that rural best management practices involving buffer strips on horticulture land uses is the most cost effective solution, followed by recycled water to agriculture.




| | QDC Target | WSUD SPP HW | WSUD No Worsen. | Increased E&SC | Rainwater Tank Retrofit | Recycled Water Ag. | Recycled Water Urban | Rural BMP 1/2 streams | Rural BMP Hort. | S/W Harvest | W/W Reveg. | WSUD Retrofit | PRW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min | 30 | 30 | 40 | - | 300 | 730 | 3,330 | - | 40 | 440 | - | 500 | 4,800 |
| Max | 1,940 | 26,200 | 26,200 | - | 1,320 | 7,300 | 11,330 | - | 7,390 | 3,930 | - | 8,000 | 26,900 |

**Figure 5-13 TN Load Reduction (kg/yr) for Each Solution**



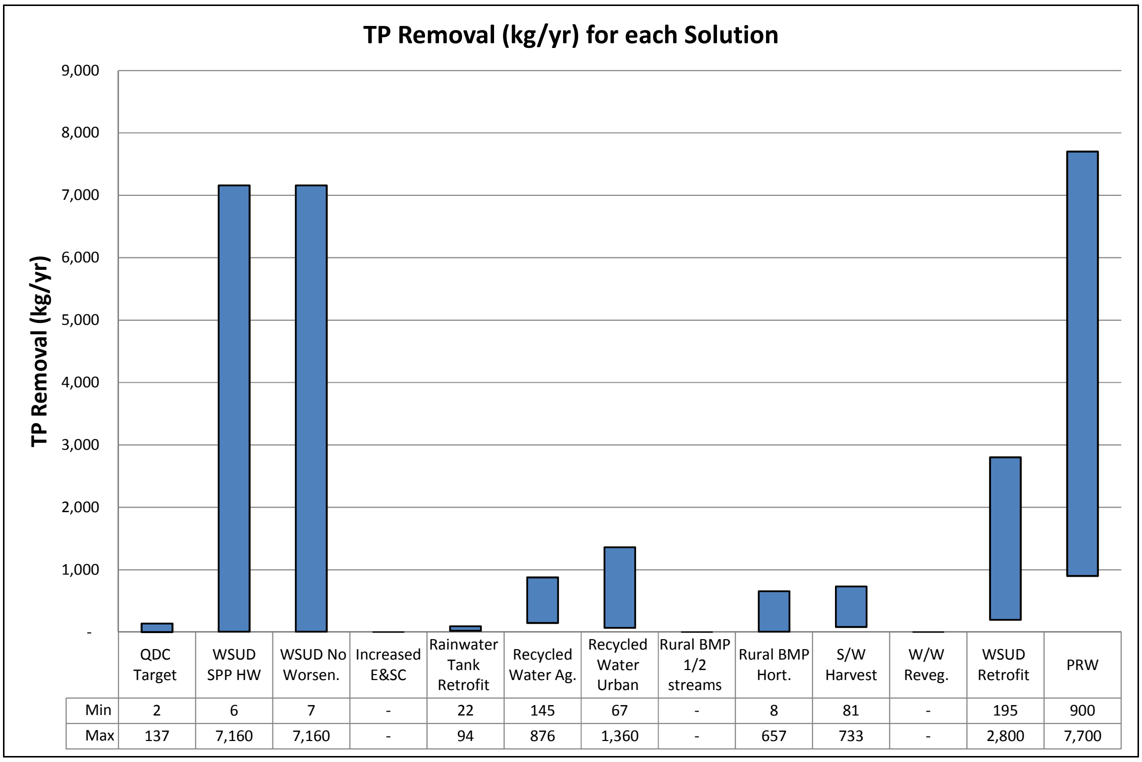

| | QDC Target | WSUD SPP HW | WSUD No Worsen. | Increased E&SC | Rainwater Tank Retrofit | Recycled Water Ag. | Recycled Water Urban | Rural BMP 1/2 streams | Rural BMP Hort. | S/W Harvest | W/W Reveg. | WSUD Retrofit | PRW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min | $1,560 | $230 | $250 | N/A | $1,560 | $100 | $290 | N/A | $10 | $990 | N/A | $290 | $1,040 |
| Max | $1,930 | $290 | $340 | N/A | $1,560 | $140 | $820 | N/A | $210 | $1,840 | N/A | $410 | $2,180 |

**Figure 5-14 Levelised Cost ($/kg) of TN Reduction**

### *5.15.1.5 Reduction in Total Phosphorus Pollutant Loads*

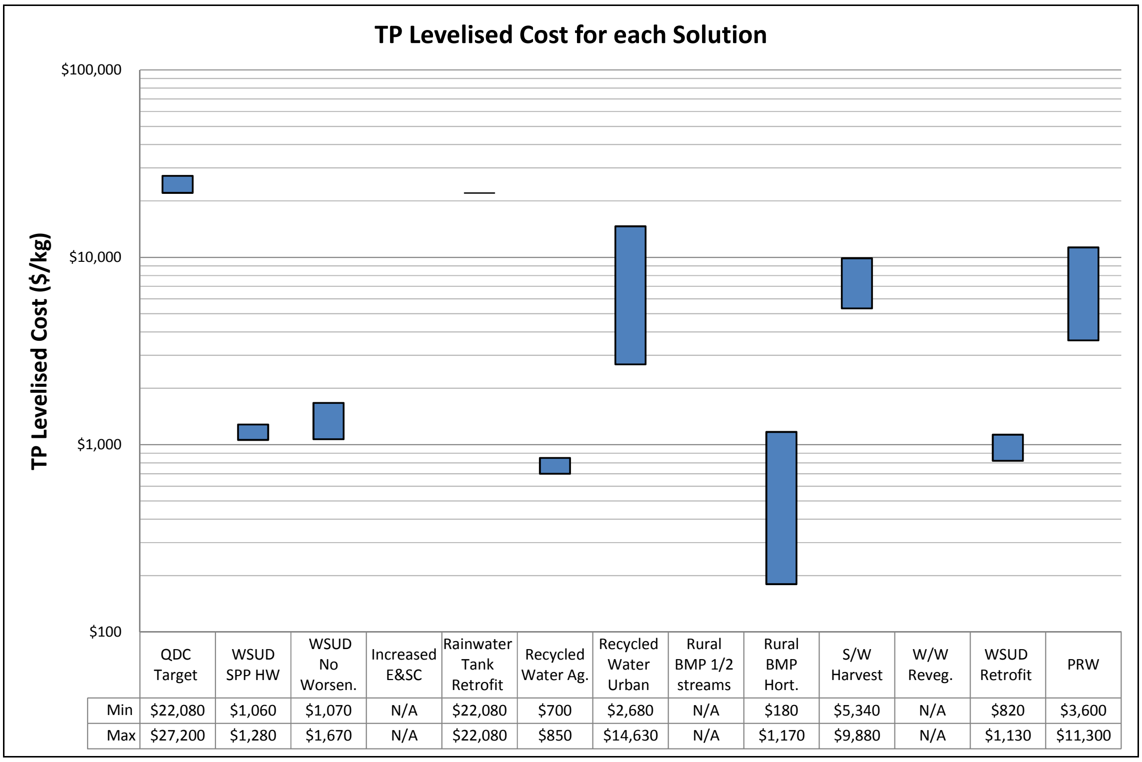
The range of each solution's performance in reducing total phosphorus (TP) loads is shown in Figure 5-15. This indicates that PRW and WSUD in greenfield development would potentially provide the greatest reduction in phosphorus loads.

Taking into account levelised costs, Figure 5-16 indicates that rural best management practices on horticultural land would provide the most cost effective reduction of phosphorus loads. Recycled water to agriculture and all WSUD solutions are also indicated as being cost effective solutions.




| | QDC Target | WSUD SPP HW | WSUD No Worsen. | Increased E&SC | Rainwater Tank Retrofit | Recycled Water Ag. | Recycled Water Urban | Rural BMP 1/2 streams | Rural BMP Hort. | S/W Harvest | W/W Reveg. | WSUD Retrofit | PRW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min | 2 | 6 | 7 | - | 22 | 145 | 67 | - | 8 | 81 | - | 195 | 900 |
| Max | 137 | 7,160 | 7,160 | - | 94 | 876 | 1,360 | - | 657 | 733 | - | 2,800 | 7,700 |

**Figure 5-15 TP Load Reduction (kg/yr) for Each Solution**




| | QDC Target | WSUD SPP HW | WSUD No Worsen. | Increased E&SC | Rainwater Tank Retrofit | Recycled Water Ag. | Recycled Water Urban | Rural BMP 1/2 streams | Rural BMP Hort. | S/W Harvest | W/W Reveg. | WSUD Retrofit | PRW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Min | $22,080 | $1,060 | $1,070 | N/A | $22,080 | $700 | $2,680 | N/A | $180 | $5,340 | N/A | $820 | $3,600 |
| Max | $27,200 | $1,280 | $1,670 | N/A | $22,080 | $850 | $14,630 | N/A | $1,170 | $9,880 | N/A | $1,130 | $11,300 |

**Figure 5-16 Levelised Cost ($/kg) of TP Reduction**

# 6 ASSESSMENT OF MANAGEMENT SCENARIOS

As discussed in Section 3.2, management scenarios for each catchment were developed to consist of a combination of individual solutions ('solutions sets'). Three incremental management scenarios were developed for each catchment, with each scenario building upon the previous solution set. This way the efficacy and value of incorporating additional management measures could be easily assessed using the modelling framework.

The three management scenarios comprised a low intensity scenario, a medium intensity scenario, and a high intensity scenario. The solution sets contained within these three scenarios were assessed to quantify outcomes in terms of environmental, economic and social performance. The results of this assessment are detailed further in Sections 6.1 to 6.3.

Results from the management scenario assessment were then used to determine the preferred scenario for implementation in each catchment, using a multi criteria assessment (MCA) process. This MCA process, discussed further in Section 7, takes into account environmental, social and economic factors when determining the preferred scenario.

## 6.1 Environmental Performance

### 6.1.1 Sustainable Load Targets

An important component in assessing the management scenarios is to determine the sustainable load targets for receiving waters. Sustainable load targets provide an indication of the capacity of receiving waters to assimilate pollutant loads without adversely impacting on aquatic ecosystems. The target refers to the quantity (tonnes/yearr) of catchment pollutant loads able to discharge into receiving waters without causing concentrations of those pollutants to exceed water quality objectives (WQOs).

To determine the sustainable load target for each catchment, the catchment modelling software package (i.e. Source Catchments) was utilised in conjunction with the receiving water quality modelling software package (i.e. RWQM2). Existing catchment loads were used as inputs into the RWQM2 modelling software package which provided an indication of the pollutant concentrations in receiving waters under existing conditions.

The catchment loads were then incrementally reduced until the point where water quality objectives were achieved. To test whether this sustainable load target was actually achievable in the catchment, a Green Space scenario was modelled in Source Catchments to represent the catchment condition prior to European settlement. This was modelled as an entirely forested catchment, and was deemed to represent the best achievable catchment pollutant loads.

It was necessary to conduct sustainable load modelling using the 2005/2006 period due to constraints with the catchment model / RWQM interface. This model period was relatively dry, and as such pollutant loads are less than typical mean annual loads.

For the majority of catchments, it was found that the sustainable load target was less than the Green Space scenario. This means that even if these catchments reverted back to natural condition (i.e. totally forested), the water quality objectives in receiving waters would still be exceeded. Therefore, the sustainable load targets for these catchments were deemed to be unachievable, and the Green Space condition was adopted as the revised sustainable load target.

To determine what the catchment conditions would be like in 2031 without any effort to implement management measures, a future scenario was developed and referred to as the 'future business as usual (BAU)' scenario. For Bribie Island and Pumicestone Passage catchments, the future BAU conditions met the sustainable load target, therefore this future BAU condition was adopted as the sustainable load target in these two catchments.

Sustainable load targets were only able to be determined for catchments with marine receiving waters, such as an estuary (e.g. Caboolture River estuary) or directly into Moreton Bay. Other catchments, such as Stanley River catchment, flow into freshwater receiving waters outside the extent of the RWQM.

Adopted sustainable load targets for each catchment discharging into marine receiving waters are presented in Table 6-1.

**Table 6-1 Sustainable Load Targets**

| Catchment | Sustainable Load Targets | | | Condition | Receiving Waters |
|---|---|---|---|---|---|
| | TSS (t/yr) | TN (t/yr) | TP (t/yr) | | |
| Bribie | 246 | 13.3 | 1.27 | Future BAU | Pumicestone Passage |
| Brisbane Coastal | 11 | 0.7 | 0.04 | Green Space | Bramble Bay |
| Burpengary | 140 | 11.1 | 0.52 | Sustainable load (TSS), Green Space (TN.TP) | Deception Bay |
| Caboolture | 786 | 55.3 | 2.61 | Green Space | Caboolture River Estuary |
| CIGA | 94 | 6.6 | 0.31 | Green Space | Caboolture River Estuary |
| Hays | 53 | 3.7 | 0.18 | Green Space | Bramble Bay |
| Lower Pine | 123 | 8.6 | 0.41 | Green Space | Pine River Estuary |
| Pumicestone | 1,261 | 38.2 | 3.12 | Future BAU | Pumicestone Passage |
| Redcliffe | 16 | 1.1 | 0.06 | Green Space | Deception Bay / Bramble Bay |

Table 6-1 shows that for all catchments, with the exception of Bribie Island, Pumicestone Passage and Burpengary for TSS, the Green Space conditions were adopted as sustainable load targets.

It should be noted that some catchments might experience difficulties in meeting sustainable loads, as the waterways to which they drain are influenced by sources of sediment and nutrients other than theirs alone. For example, the Brisbane Coastal catchment drains to Bramble Bay via Kedron Brook, Nudgee and Nundah Creeks, however the catchment comprises only 20% of the total catchment area that drains through these creeks, and much of the additional drainage occurs downstream of the Brisbane Coastal catchment.

Using the results from the future BAU scenario, the pollutant load reductions required to meet the sustainable load targets were determined. Table 6-2 presents the existing and future pollutant loads in each catchment, along with the load reductions required to meet sustainable loads. Also included are the load reductions required to maintain pollutant loads at existing levels, or a ‘no worsening’ scenario. As mentioned previously, these loads reflect the 2005-2006 typical water year, not the mean annual loads.

**Table 6-2 Load Reductions Required to Meet Targets**

| Catchment | Pollutant | Existing Condition (t/yr) | Future (2031) - Business as Usual (BAU) (t/yr) | Load Reduction Required (t/yr) | |
|---|---|---|---|---|---|
| | | | | For ‘No Worsening’ from Existing * | For Sustainable Load Target |
| Bribie | TSS | 228 | 246 | 18 | 0 |
| | TN | 10.9 | 13.3 | 2.4 | 0 |
| | TP | 1.01 | 1.27 | 0.3 | 0 |
| Brisbane Coastal | TSS | 149 | 150 | 1 | 139 |
| | TN | 4.39 | 4.43 | 0.04 | 3.7 |
| | TP | 0.444 | 0.448 | 0.004 | 0.4 |
| Burpengary | TSS | 869 | 827 | - 42 | 687 |
| | TN | 18.8 | 19.0 | 0.2 | 7.9 |
| | TP | 2.27 | 2.24 | - 0.03 | 1.7 |
| Caboolture | TSS | 3,648 | 3,631 | -17 | 2,845 |
| | TN | 95.0 | 115 | 20.1 | 59.8 |
| | TP | 9.18 | 9.78 | 0.6 | 7.2 |
| CIGA | TSS | 360 | 528 | 168 | 435 |
| | TN | 5.7 | 24.1 | 18.4 | 17.5 |
| | TP | 0.63 | 2.83 | 2.2 | 2.5 |
| Hays | TSS | 840 | 966 | 126 | 914 |
| | TN | 39.5 | 49.1 | 9.6 | 45.4 |
| | TP | 3.12 | 3.87 | 0.8 | 3.7 |
| Lower Pine | TSS | 1,466 | 1,531 | 65 | 1,408 |
| | TN | 57.5 | 79.8 | 22.3 | 71.2 |
| | TP | 8.41 | 13.34 | 4.9 | 12.9 |
| Pumicestone | TSS | 1,280 | 1,261 | - 19 | 0 |
| | TN | 37.0 | 38.2 | 1.2 | 0 |
| | TP | 3.02 | 3.12 | 0.1 | 0 |
| Redcliffe | TSS | 366 | 398 | 32 | 381 |
| | TN | 9.4 | 10.2 | 0.8 | 9.1 |
| | TP | 1.09 | 1.19 | 0.1 | 1.1 |
| Sideling | TSS | 518 | 518 | 0 | N/A |
| | TN | 8.4 | 8.4 | 0 | N/A |
| | TP | 1.03 | 1.03 | 0 | N/A |
| Stanley | TSS | 2,057 | 2,062 | 5 | N/A |
| | TN | 58.4 | 58.8 | 0.5 | N/A |
| | TP | 4.87 | 4.94 | 0.07 | N/A |
| Upper Pine | TSS | 2,713 | 2,714 | 1 | N/A |
| | TN | 41.2 | 41.2 | 0 | N/A |
| | TP | 4.56 | 4.56 | 0 | N/A |

* Negative load reductions are the result of future BAU loads being less than existing loads due to changes in land use affecting pollutant export rates

It should be noted that uncertainties within the modelling frameworks and the forcing data used to parameterise and calibrate them may influence the sustainable load targets which have been derived and whether the pre-European modelling scenario conditions would meet present day water quality objectives (WQOs). Both the catchment and receiving water quality models demonstrate good calibration outcomes for the current conditions scenarios, however both the hydrologic and pollutant export changes under each of the scenarios modelled are estimates only based on the likely differences from the current conditions. Obviously, such estimates are dependent upon the quality of the forcing data used, and in the case of pollutant export, it is necessary to use reasonably coarse estimates of pollutant loads for lumped land use categories which may not reflect all of the dynamics of land use changes as anticipated in each of the scenarios.

The pollutant export rates used to parameterise the catchment model were based on several recent studies for the SEQ region and represent median values from all of the sites involved. This means that the same values were used catchment wide. For example, the Green Space (i.e., fully forested) event mean concentration (EMC) for TSS used in the model represents a median value of 20 mg/l and was applied uniformly across the catchment model for areas of green space. These studies also indicate a degree of variability in the parameters (e.g. between 8 mg/L and 90 mg/L) that is not represented in the catchment model. While this variability may be present in the Moreton Bay catchments, there is insufficient data to spatially attribute variable pollutant export rates across the region and the median values have been used This approach is consistent with the majority of catchment modelling activities undertaken in Australia.

Further information on this, the degree to which these rates may vary, and more details regarding the sustainable load targets are discussed more in the Catchment and Receiving Water Quality Modelling Report provided in Appendix B.

### 6.1.2 Catchment Pollutant Loads

Using the results of individual solution performance (Section 5), the cumulative effectiveness of each management scenario in terms of improvements to water quality and waterway health could be estimated. The performance results of individual solutions were incorporated into the calibrated catchment model as pollutant load reductions (%), and the modelling software package was used to estimate catchment loads for the three management scenarios. By comparing these catchment loads with future catchment loads with no mitigation measures, it was possible to quantify the effectiveness of each management scenario in removing loads of TSS, TN and TP.

When incorporating the individual solution performance results (from Section 5) into the catchment model, it was necessary to apply percentage load reductions to represent the performance of a particular solution rather than absolute load reductions (i.e. kg/year). This was because pollutant loads modelled using MUSIC were generally much higher than those modelled in the catchment modelling software package (i.e. Source Catchments). This difference was in part due to the higher average annual flows generated in MUSIC over the recommended 10 year modelling period as the hydrologic parameters in the SEQ MUSIC Modelling Guidelines were different to those used in the catchment model, as were the pollutant export parameters. It should also be noted that the MUSIC modelling was undertaken at a finer scale than that done with Source Catchments. As such, the Source Catchments modelling software package typically has parameters that are “lumped” to represent broad catchment runoff characteristics, rather than the finer scale that MUSIC modelling is typically used at. As the Source Catchments model was calibrated together with the Receiving Water Quality Model, it was necessary to ensure the modelled loads remained consistent with the calibrated Source Catchments model.

Only those solutions that could be quantified in Section 5 were able to be modelled. Solutions that weren't modelled included: (i) prevention of illegal stormwater connections; and (ii) education and capacity building.

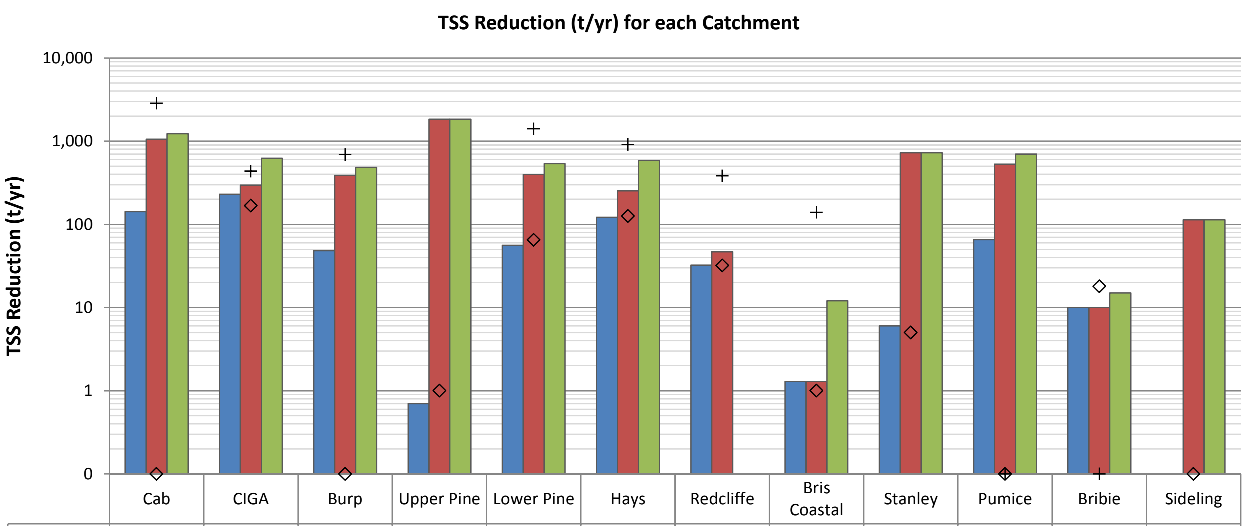
The effectiveness of each management scenario in reducing pollutant loads is presented in Figure 6-1 to Figure 6-3. These graphs present the pollutant load *reductions* (not to be mistaken for *total* catchment loads) able to be achieved through implementation of each management scenario. Also shown on the graphs are the pollutant load reductions required to meet both the sustainable load target ('+' symbol on graphs) and the 'no worsening' from existing conditions ('◊' symbol on graphs).

In each graph, if a bar exceeds the symbols, then this indicates that load reductions from implementing that particular management scenario would result in either sustainable load targets being met in that catchment, or otherwise a 'no worsening' from existing pollutant loads.

Figure 6-1 indicates that for TSS, the only catchments which would achieve sustainable load targets include Pumicestone and Bribie catchments for all scenarios, and the CIGA for scenario 3. All catchments would achieve a 'no worsening' condition, except for scenario 1 in Upper Pine, Lower Pine, and Hays catchments, and all scenarios in the Bribie catchment.

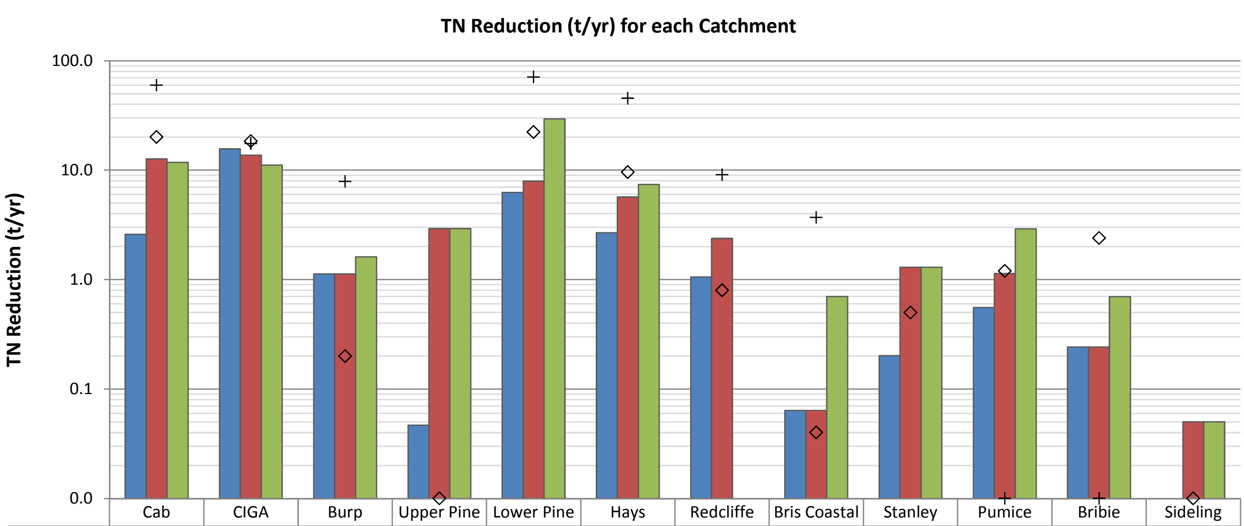
Figure 6-2 indicates that for TN, the only catchments which would achieve sustainable load targets are Pumicestone and Bribie catchments. However, these two catchments require a nil load reduction from future BAU, so these targets are not difficult to achieve. Catchments which would achieve a 'no worsening' in TN loads include Burpengary (all scenarios), Upper Pine (all scenarios), Lower Pine (scenario 3), Redcliffe (all scenarios), Brisbane Coastal (all scenarios), Stanley (scenarios 2 and 3), Pumicestone (scenario 3), and Sideling (all scenarios). Other catchments, such as Caboolture, CIGA, Hays, and Bribie, would not achieve 'no worsening' regardless of management scenario.

Figure 6-3 indicates that for TP, sustainable load targets would only be achieved in Pumicestone and Bribie catchments. Catchments in which a 'no worsening' condition would be achieved include Caboolture (scenarios 2 and 3), CIGA (scenario 3), Burpengary (all scenarios), Upper Pine (all scenarios), Lower Pine (scenario 3), Hays (scenario 3), Redcliffe (all scenarios), Brisbane Coastal (all scenarios), Stanley (scenarios 2 and 3), Pumicestone (all scenarios), and Sideling (all scenarios).




| | Cab | CIGA | Burp | Upper Pine | Lower Pine | Hays | Redcliffe | Bris Coastal | Stanley | Pumice | Bribie | Sideling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario 1 | 142 | 230 | 48 | 0.7 | 56 | 122 | 32 | 1.3 | 6 | 65 | 10 | - |
| Scenario 2 | 1,058 | 296 | 387 | 1,839 | 398 | 253 | 47 | 1 | 723 | 529 | 10 | 113 |
| Scenario 3 | 1,227 | 621 | 484 | 1,839 | 536 | 587 | - | 12 | 723 | 696 | 15 | 113 |
| + Sus Load | 2,845 | 435 | 687 | N/A | 1,408 | 914 | 381 | 139 | N/A | 0 | 0 | N/A |
| ◇ No Worse | 0 | 168 | 0 | 1.0 | 65 | 126 | 32 | 1.0 | 5 | 0 | 18 | 0 |

**Figure 6-1 TSS Reduction (t/yr) for Each Catchment and Scenario**

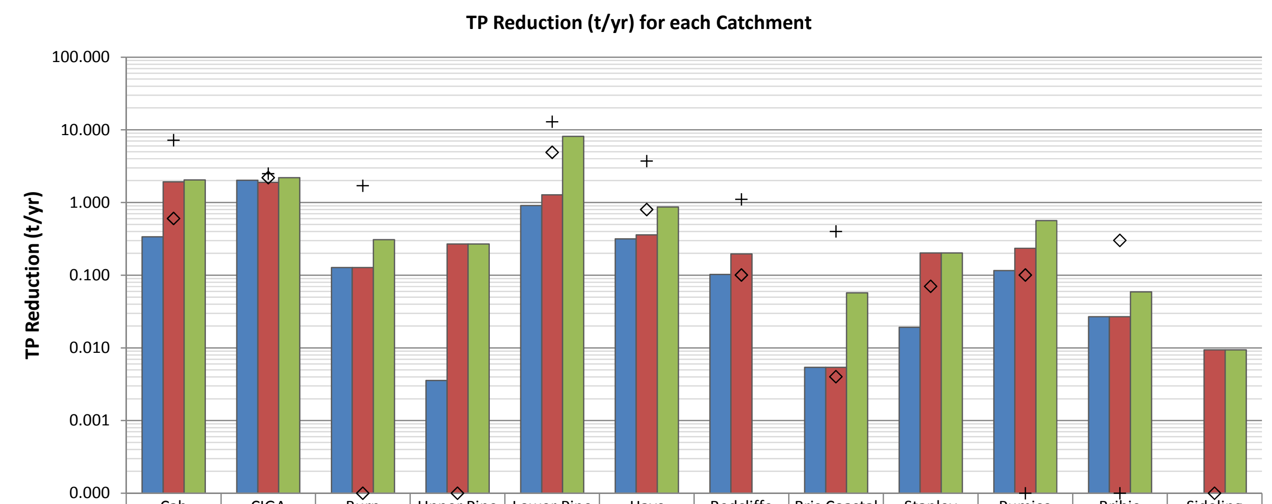



| | Cab | CIGA | Burp | Upper Pine | Lower Pine | Hays | Redcliffe | Bris Coastal | Stanley | Pumice | Bribie | Sideling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario 1 | 2.6 | 15.6 | 1.1 | 0.0 | 6.3 | 2.7 | 1.1 | 0.1 | 0.2 | 0.6 | 0.2 | - |
| Scenario 2 | 12.7 | 13.7 | 1.1 | 2.9 | 7.9 | 5.7 | 2.4 | 0.1 | 1.3 | 1.1 | 0.2 | 0.1 |
| Scenario 3 | 11.8 | 11.1 | 1.6 | 2.9 | 29.4 | 7.4 | - | 0.7 | 1.3 | 2.9 | 0.7 | 0.1 |
| + Sus Load | 59.8 | 17.5 | 7.9 | N/A | 71.2 | 45.4 | 9.1 | 3.7 | N/A | 0 | 0 | N/A |
| ◇ No Worse | 20.1 | 18.4 | 0.2 | 0 | 22.3 | 9.6 | 0.8 | 0.04 | 0.5 | 1.2 | 2.4 | 0 |

**Figure 6-2 TN Reduction (t/yr) for Each Catchment and Scenario**



BMT WBM




| | Cab | CIGA | Burp | Upper Pine | Lower Pine | Hays | Redcliffe | Bris Coastal | Stanley | Pumice | Bribie | Sideling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario 1 | 0.3 | 2.0 | 0.1 | 0.004 | 0.9 | 0.3 | 0.1 | 0.01 | 0.02 | 0.1 | 0.03 | - |
| Scenario 2 | 1.9 | 1.9 | 0.1 | 0.3 | 1.3 | 0.4 | 0.2 | 0.01 | 0.2 | 0.2 | 0.03 | 0.01 |
| Scenario 3 | 2.0 | 2.2 | 0.3 | 0.3 | 8.1 | 0.9 | - | 0.1 | 0.2 | 0.6 | 0.1 | 0.01 |
| + Sus Load | 7.2 | 2.5 | 1.7 | N/A | 12.9 | 3.7 | 1.1 | 0.4 | N/A | 0 | 0 | N/A |
| ◇ No Worse | 0.6 | 2.2 | 0 | 0 | 4.9 | 0.8 | 0.1 | 0.004 | 0.07 | 0.1 | 0.3 | 0 |

Catchment

**Figure 6-3 TP Reduction (t/yr) for Each Catchment and Scenario**

Further details in regard to the Source Catchments methodology, results, and uncertainty are included in the Source Catchments and Receiving Water Quality Modelling Report in Appendix B. Section 4.5.1.6 of this modelling report also includes mean annual loads for each management scenario in each catchment. These mean annual loads were modelled over a 10 year period (as specified by WBDb, 2010), and therefore differ somewhat to the loads presented above which were modelled over the 2005/2006 period.

Predicted pollutant load reductions in each management scenario were used to estimate how implementing each management scenario may affect EHMP grades of receiving waters. Table 6-3 and Figure 6-4 present the estimated EHMP grades for each management scenario.

**Table 6-3 Estimated EHMP Grades for Catchment Management Scenarios**

| Catchment | Estimated EHMP Grade | | | | Receiving Waters |
|---|---|---|---|---|---|
| | 2010 | | 2031 Scenario 2 | 2031 Scenario 3 | |
| Bribie | D+ | D+ | D+ | D+ | Pumicestone Passage |
| Brisbane Coastal | D+ | D+ | D+ | C- | Bramble Bay |
| Burpengary | D+ | D | C | C+ | Deception Bay |
| Caboolture | D | D- | D+ | D+ | Caboolture River Estuary |
| CIGA | C+ | C | C- | C+ | Caboolture River (Freshwater) |
| Hays | D+ | D | D+ | C- | Bramble Bay |
| Lower Pine | C- | D | D+ | C+ | Pine River Estuary |
| Pumicestone | D+ | D+ | C- | C | Pumicestone Passage |
| Redcliffe | D+ | D+ | C- | N/A | Deception/Bramble Bay |
| Sideling | C- | N/A | C | N/A | Pine River (Freshwater) |
| Stanley | B- | B- | B | N/A | Stanley River |
| Upper Pine | C- | C- | C+ | C+ | Pine River (Freshwater) |

N/A – Scenario not applicable to catchment

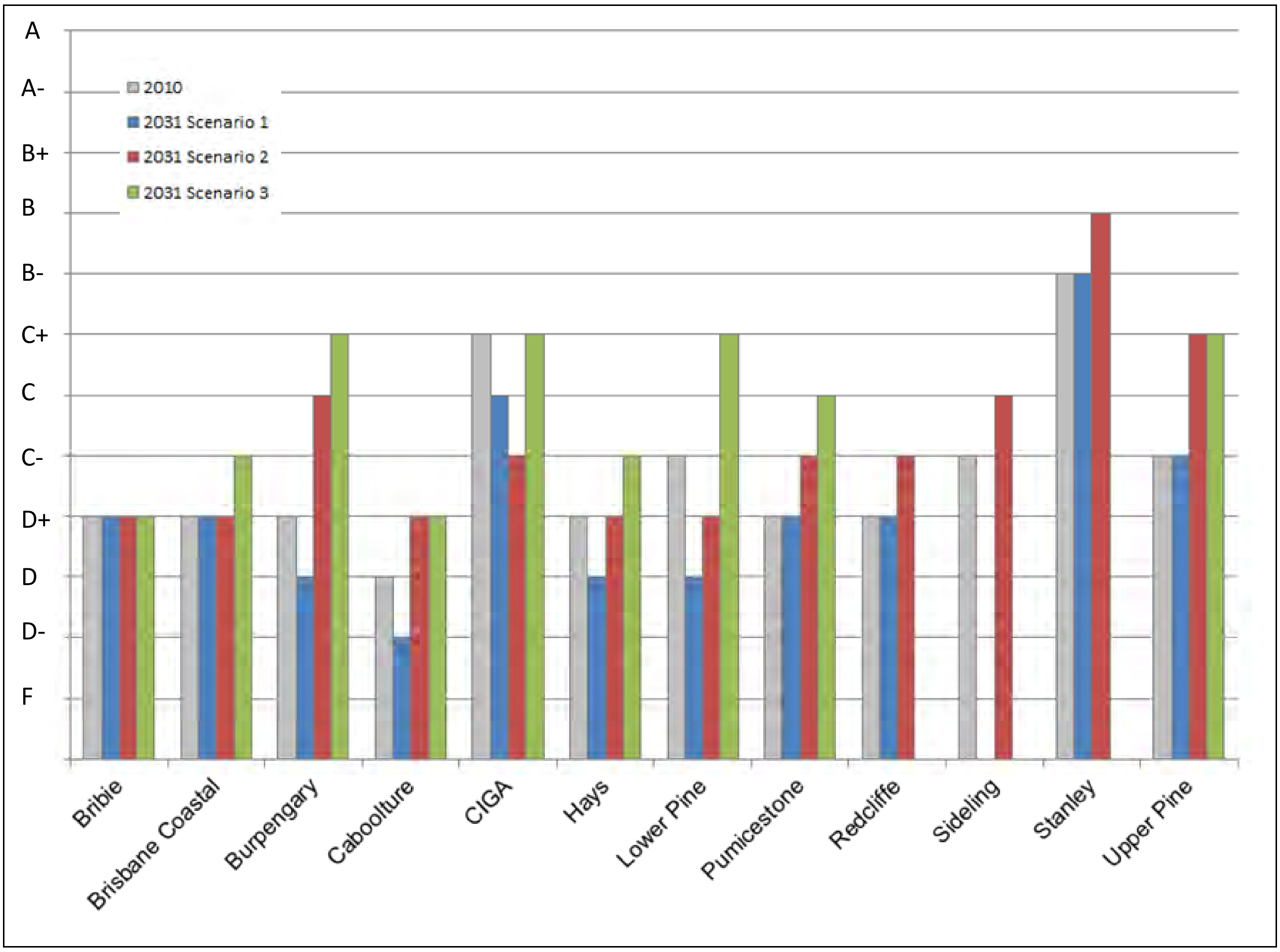



**Figure 6-4 Estimated EHMP Grades for Catchment Management Scenarios**

### 6.1.3 Receiving Water Quality

To assess the impact on pollutant concentrations in receiving waters from implementation of the management scenarios, the receiving water quality modelling software package (RWQM2) was utilised. The modelled catchment and STP loads resulting from implementation of the management scenarios were input into the RWQM2, with results used to indicate level of compliance with WQOs.

Receiving waters assessed include the estuaries of the Caboolture River and Pine River (both North Pine and South Pine Rivers), along with Bramble and Deception Bays which are affected by these rivers as well as direct catchment pollutant loads. Pumicestone Passage was also assessed, however the future BAU condition meets sustainable load targets and was therefore not assessed further in terms of scenario compliance.

The receiving water quality impacts were assessed by:

1. Determining the percentage of reduction in annual median concentrations necessary to meet a 'no worsening' condition and a sustainable load condition;
2. Determining the percentage reduction in annual median concentrations resulting from each management scenario; and
3. Comparing reductions achieved in (2) against the needed reductions in (1) to determine if a given scenario meets either the 'no worsening' or sustainable load condition.

Results for each of the receiving waters were graphed to provide an indication of the impact on water quality achieved through implementation of each management scenario. These graphs are included in Section 4.5.2 of the Source Catchments and Receiving Water Quality Modelling Report in Appendix B.

To provide an example of the receiving water quality modelling results, the graphs for the Caboolture River are presented in Figure 6-5 to Figure 6-7. These graphs illustrate the percent reductions required to meet the sustainable load target and the 'no worsening' target. Scenarios were only considered to achieve these targets if they were achieved along the entire length of the estuary. These graphs indicate the following for the Caboolture River:

- All management scenarios demonstrated compliance with turbidity for a 'no worsening' condition, but not for achieving a sustainable load.
- Management scenarios did not achieve either 'no worsening' or sustainable load for TN or TP.
- TP is close to achieving 'no worsening' along the estuary, but is impacted upstream by STP loads.

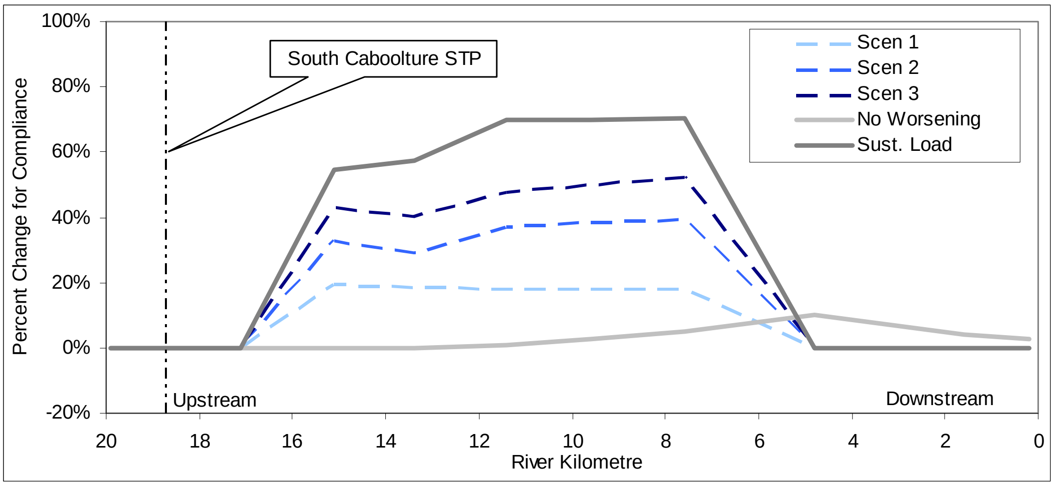



**Figure 6-5 Caboolture River Scenario Compliance - Turbidity**

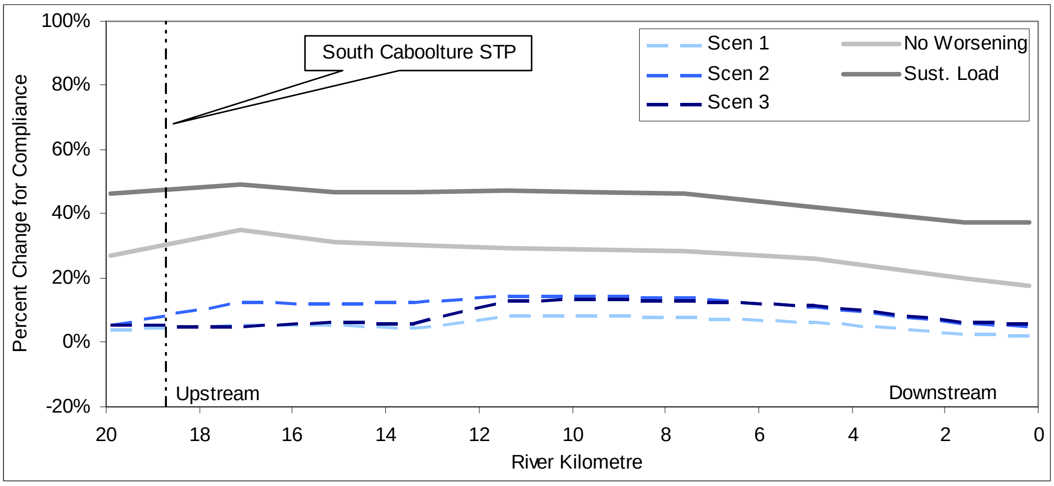



**Figure 6-6 Caboolture River Scenario Compliance – Total Nitrogen**

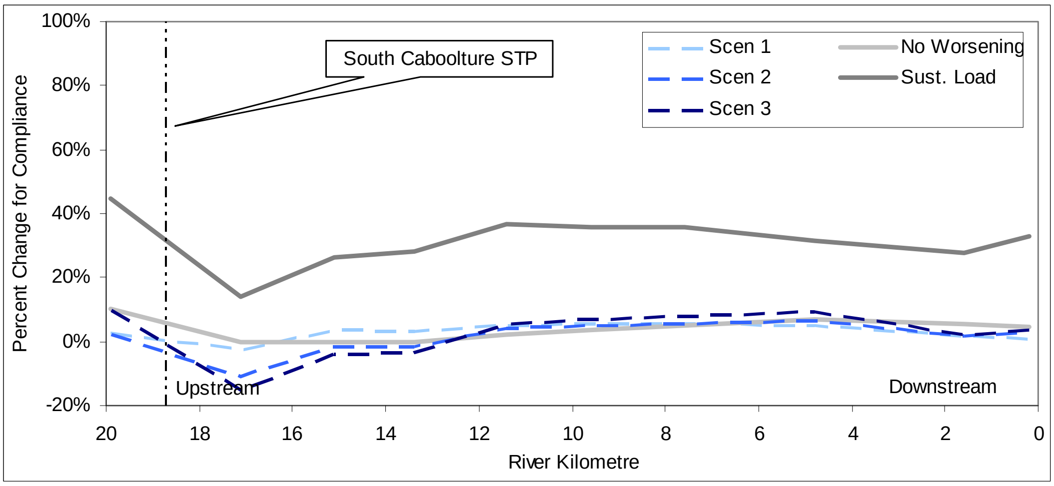



**Figure 6-7 Caboolture River Scenario Compliance – Total Phosphorus**

The general findings of the receiving water quality impacts of the management scenarios can be summarised as follows:

- None of the scenarios for any of the receiving waters achieve sustainable load targets (except Pumicestone Passage).
- For many of the waterways, a 'no worsening' condition for turbidity was achieved by Scenarios 2 and 3 for the entire waterways, and in parts, if not all, of each waterway for Scenario 1.
- In contrast, a 'no worsening' condition was not able to be achieved for all locations in many of the receiving waters for TN and TP. Nevertheless, some locations within each receiving water met the 'no worsening' target, including one site in Bramble bay for TN for scenario 3, and a couple of sites in Bramble Bay for TP for scenario 3.
- Sewage treatment plant operations demonstrated a significant influence on the performance of a given management scenario. Scenarios that incorporated the use of purified recycled water, and associated RO brine discharge, showed increased nutrient concentrations in receiving waters in a few locations, despite overall pollutant loads reducing for these scenarios. For example, Figure 6-7 demonstrates higher annual TN median concentrations near the location of the South Caboolture STP for scenario 3. This is because the concentrations of the RO brine discharge are greater for scenario 3 than for scenarios 1 and 2.

The performance of each scenario for improving water quality was based on combined TSS, TN and TP removal performance. Each parameter was assigned a weighting based on results of the water quality modelling. The importance was determined by the magnitude that each parameter failed to meet the determined sustainable load targets. For example, in the CIGA it was determined that TSS and TP required the largest load reductions to meet sustainable load targets, hence a greater weighting was placed on these parameters in determining the impact of a management scenario on water quality in the MCA.

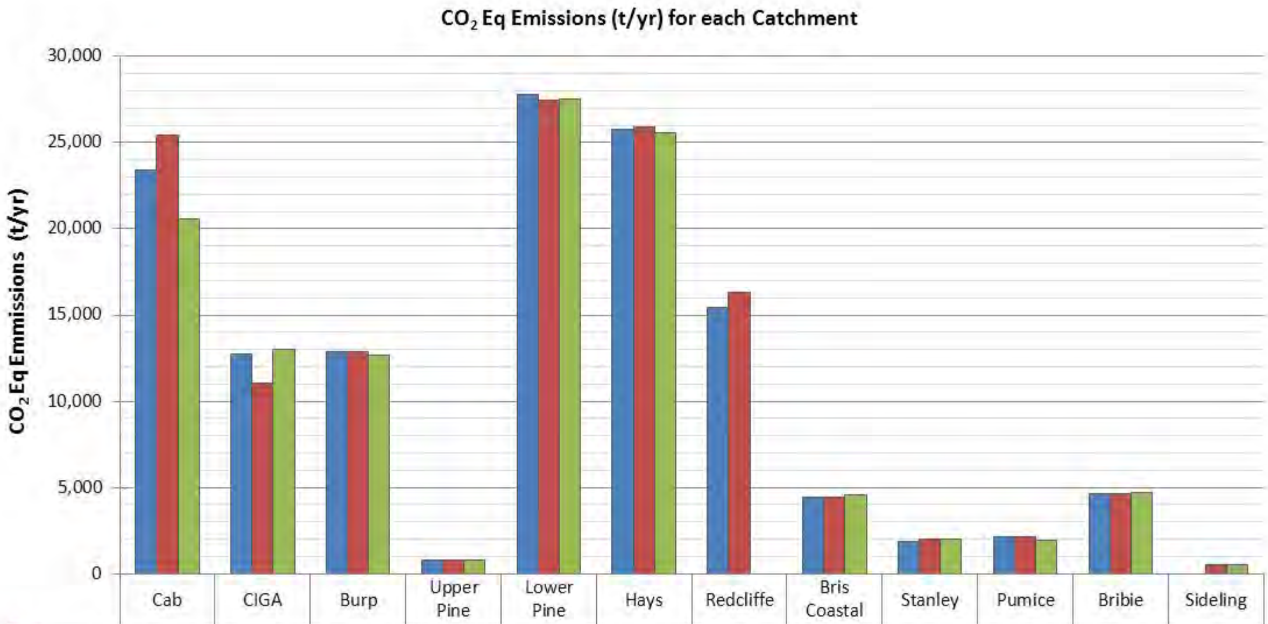
Further modelling results and discussion in regard to the RWQM modelling and associated uncertainty are included in the Source Catchments and Receiving Water Quality Modelling Report in Appendix B.

### 6.1.4 Greenhouse Gas Emissions

Another indicator of the environmental performance of management scenarios was greenhouse gas emissions. Greenhouse gas (GHG) emissions were quantified for each management scenario using the following assumptions for water production, based in information from Hall *et al*. (2009) and DCCEE (2011):

- Energy intensity for using rainwater is 2 MWhr/ML (pumping only)
- Energy intensity for using recycled water is 0.7 MWhr/ML (WTP and pumping)
- Energy intensity for using stormwater is 0.6 MWhr/ML (WTP and pumping)
- Energy intensity for using PRW is 1.7 MWhr/ML (WTP) & and 1,600 MWhr/yr (pumping)
- Energy intensity for using water from the Grid is 1.6 MWhr/ML
- 1 tonne of $CO_2$ produced per kW/hr

The above assumptions were used to broadly estimate the quantity of greenhouse gases emitted by each management scenario in each catchment, with results presented in Figure 6-8. Greenhouse gas emissions are seen to differ between catchments, generally to be commensurate with catchment size and water use. Scenario 1 gives an indication of the typical GHG production for each catchment based on the standard practice of installing rainwater tanks to meet QDC requirements. The assessment found that scenario 3 was expected to produce the most GHG emissions in some catchments (CIGA, Brisbane Coastal, and Bribie), while in other catchments (Caboolture, Burpengary, Pumicestone and Hays) scenario 3 would produce the least emissions as a result of stormwater harvesting replacing rainwater tanks in scenario 3 in these catchments. The high GHG emissions in the CIGA from Scenario 3 are due to the PRW solution, and the energy required to pump water to North Pine Dam. In Upper Pine and Sideling Creek catchments, GHG emissions did not differ between scenarios.




| | Cab | CIGA | Burp | Upper Pine | Lower Pine | Hays | Redcliffe | Bris Coastal | Stanley | Pumice | Bribie | Sideling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario 1 | 23,417 | 12,748 | 12,861 | 783 | 27,779 | 25,793 | 15,422 | 4,451 | 1,891 | 2,160 | 4,612 | - |
| Scenario 2 | 25,461 | 11,075 | 12,861 | 783 | 27,446 | 25,942 | 16,344 | 4,451 | 1,993 | 2,160 | 4,612 | 540 |
| Scenario 3 | 20,575 | 13,041 | 12,676 | 783 | 27,515 | 25,548 | - | 4,587 | 1,993 | 1,915 | 4,715 | 540 |

**Figure 6-8 Greenhouse Gas Emissions from Water Supply for Each Catchment and Scenario**

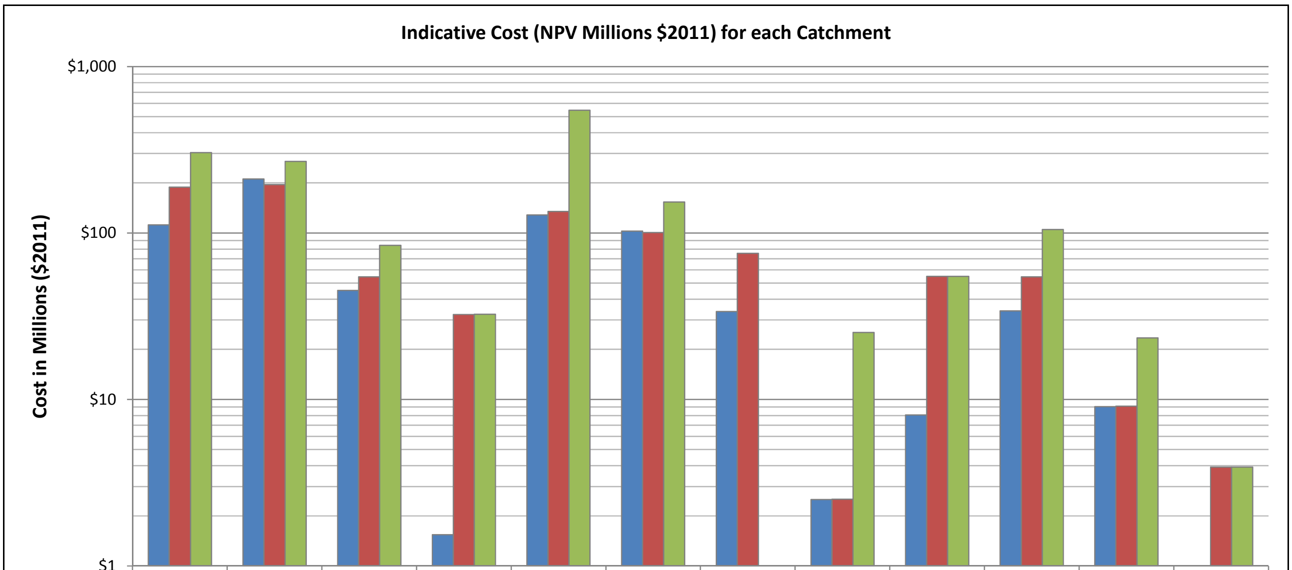
Since the TWCM plan was drafted, Unitywater has undertaken a preliminary assessment of the current GHG emissions for transporting and treating sewage in each major STP catchment. GHG emissions range from 0.4 to 2.0 t $CO_2$ per ML treated (average 1.2), depending on the number of pump stations and the treatment process used. Unitywater expect to finalise their Climate Change Strategy in June 2012 which will document these findings, describe ways of minimising GHG emissions and protecting sewage treatment assets, and will be use when optimising the solution sets presented in this TWCM Plan.

## 6.2 Economic Performance

Indicative costs were investigated to assist in assessing the economic performance of each management scenario. This simply entailed summing the individual cost of the solutions (quantified in Section 5) in each management scenario.

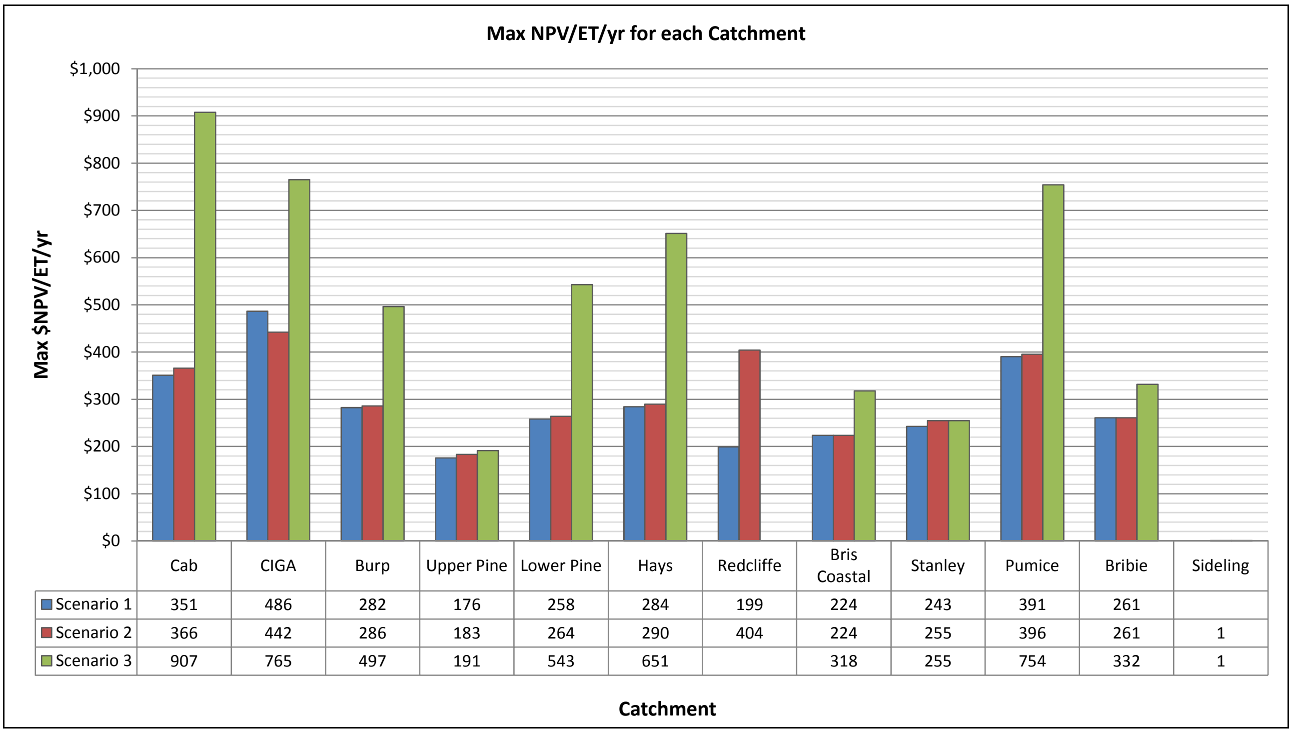
Costs are presented as net present value (NPV), which provides the cost of a solution over a 20 year period in today's dollars ($2011). This allows easy comparison of the management solutions, especially when issues such as ongoing maintenance costs over the 20 year period are inherent in a solution.

The indicative cost for each management solution in each catchment is presented in Figure 6-9. Figure 6-9 shows that in most catchments Scenario 3 has highest capital costs, due to the added outlay to reach stretched performance targets. Of all the catchments, Scenario 3 in the Lower Pine catchment has the highest NPV of approximately $570 Million over the planning period. This is due to the large PRW scheme proposed in this scenario. Figure 6-10 presents the indicative maximum annual cost of each management scenario per ET (i.e. household).




| | Cab | CIGA | Burp | Upper Pine | Lower Pine | Hays | Redcliffe | Bris Coastal | Stanley | Pumice | Bribie | Sideling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario 1 | $111.9 | $210.7 | $45.2 | $1.5 | $128.2 | $102.6 | $33.7 | $2.5 | $8.1 | $34.0 | $9.1 | - |
| Scenario 2 | $188.6 | $194.9 | $54.5 | $32.4 | $134.6 | $100.5 | $75.3 | $2.5 | $54.9 | $54.5 | $9.1 | $3.9 |
| Scenario 3 | $303.4 | $268.8 | $84.3 | $32.5 | $545.5 | $153.4 | - | $25.2 | $54.9 | $105.1 | $23.4 | $3.9 |

**Figure 6-9 Indicative Cost (NPV Millions $2011) for Each Catchment and Scenario**



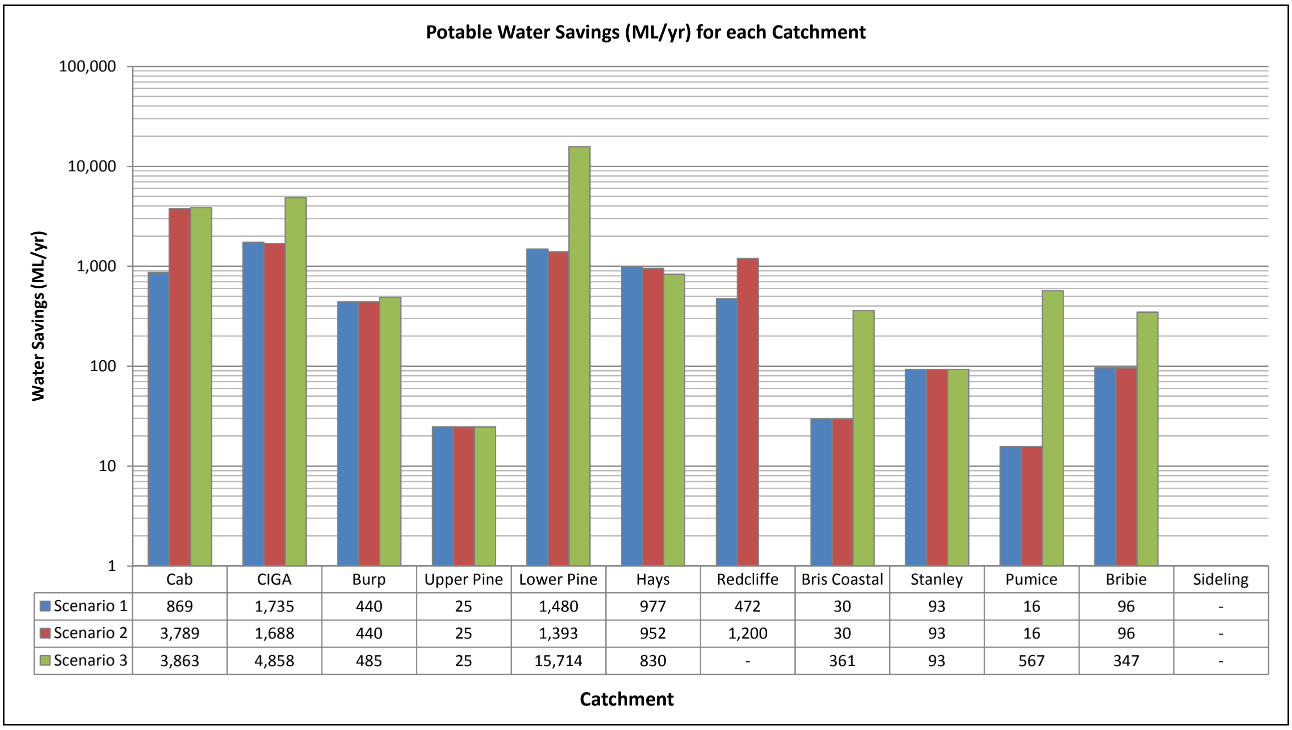

| | Cab | CIGA | Burp | Upper Pine | Lower Pine | Hays | Redcliffe | Bris Coastal | Stanley | Pumice | Bribie | Sideling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario 1 | 351 | 486 | 282 | 176 | 258 | 284 | 199 | 224 | 243 | 391 | 261 | |
| Scenario 2 | 366 | 442 | 286 | 183 | 264 | 290 | 404 | 224 | 255 | 396 | 261 | 1 |
| Scenario 3 | 907 | 765 | 497 | 191 | 543 | 651 | | 318 | 255 | 754 | 332 | 1 |

**Figure 6-10 Indicative Maximum Cost per household ($NPV/yr) for Each Catchment and Scenario**

## 6.3 Social Performance

For each management scenario, the potential potable water savings were quantified to use as a key performance indicator reflecting the ‘social’ criteria category in the MCA. This assessment entailed summing the potable water savings quantified for each individual solution in Section 5, to determine the total potable water savings for each management scenario.

The results are presented in Figure 6-11, which generally shows that for scenarios 1 and 2, the potential water savings are similar. As expected, scenario 3 records the greatest potential water savings due to the stretched performance targets of this scenario. In particular, Scenario 3 in the Lower Pine catchment has the potential to provide approximately 16,000 ML/yr potable water savings with the inclusion of a PRW scheme (which would supply approximately 15,000 ML/yr to North Pine Dam). Another PRW scheme for Scenario 3 in the CIGA catchment accounts for the high potable water savings. In Brisbane Coastal and Bribie Island catchments, the additional water savings from Scenario 3 are due to the retrofit of rainwater tanks to existing properties. Increased water savings in the Pumicestone Catchment from Scenario 3 are due to potential stormwater harvesting schemes in greenfield developments.




| | Cab | CIGA | Burp | Upper Pine | Lower Pine | Hays | Redcliffe | Bris Coastal | Stanley | Pumice | Bribie | Sideling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scenario 1 | 869 | 1,735 | 440 | 25 | 1,480 | 977 | 472 | 30 | 93 | 16 | 96 | - |
| Scenario 2 | 3,789 | 1,688 | 440 | 25 | 1,393 | 952 | 1,200 | 30 | 93 | 16 | 96 | - |
| Scenario 3 | 3,863 | 4,858 | 485 | 25 | 15,714 | 830 | - | 361 | 93 | 567 | 347 | - |

**Figure 6-11 Potable Water Savings (ML/yr) for Each Catchment and Scenario**

## 6.4 Multi Criteria Analysis

To assist in the selection of the preferred management scenario, Multi Criteria Assessment (MCA) was used.

Multi Criteria Assessment 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 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 key steps undertaken in the MCA process included:

1. Identify overarching environmental, social and economic objectives
2. Using the objectives, develop and agree on the list of criteria for evaluating the solutions;
3. Determine the relative importance and weighting of the assessment criteria;
4. Score the impact of the solutions with respect to each criteria;
5. Combine the scores for each criteria with the criteria weighting to provide an overall score for each solution; and
6. Select the preferred management scenario.

Criteria with which to assess the performance of each solution were developed around Triple Bottom Line (TBL) principles and include the following three criteria categories:

- Environment;
- Social; and
- Economic.

The criteria and criteria weighting was originally developed with stakeholders during the Strategy development phase of this project (BMT WBM, 2010). During the detailed planning phase (this study), they were slightly amended, with consensus from stakeholders, to better reflect the information available. The final adopted criteria and criteria weighting is shown in Table 6-4.

**Table 6-4 MCA Criteria and Weighting**

| Criteria Category & Weighting | Criteria | Criteria Weighting |
|---|---|---|
| Environmental<br>Weighting = 33.3% | Changes in water quality in inland water systems, as well as changes to biodiversity, and bed and bank integrity[1] | 10% |
| | Changes in hydrology | 10% |
| | Changes to water quality and biodiversity in estuaries and Moreton Bay[1] | 30% |
| | Changes in water quality and flow and biodiversity of groundwater systems | 5% |
| | Changes in emissions of greenhouse gases[1] | 15% |
| | Impact on environmentally sensitive values[1] | 30% |
| | *Total Environmental Criteria Weighting* | *100%* |
| Social<br>Weighting = 33.3% | Impacts on water supply[1] | 25% |
| | Impacts on human health | 25% |
| | Impacts on public amenity/recreation | 20% |
| | Level of community understanding, engagement and ownership | 10% |
| | Public acceptability | 20% |
| | *Total Social Criteria Weighting* | *100%* |
| Economic<br>Weighting = 33.3% | Financial impacts on MBRC – Outlays, capital and operating expenditure and revenue[1] | 35% |
| | Financial impacts including costs and cost savings on consumers (e.g. infrastructure charges) and other organisations[1] | 35% |
| | Impacts on local industries that rely on the environment (Fisheries, tourism) | 15% |
| | Employment plus local economic sustainability | 15% |
| | *Total Economic Criteria Weighting* | *100%* |

[1] Quantitative assessment undertaken to score criteria

The MCA process had initially been undertaken in the Strategy development phase in late 2010 (BMT WBM, 2010) as a qualitative process through workshops with the following participants:

- Councillors;
- Strategic Coordination Advisory Group (SCAG);
- MBRC representatives; and
- UnityWater representatives.

The scoring was undertaken on a solution/option basis for each catchment in MBRC including the CIGA i.e. each solution was scored for all relevant catchments before moving on to the next solution. The scoring was undertaken using a consensus method. That is, each solution was discussed and debated in terms of how it satisfied each individual criterion, and was scored by the workshop facilitator with the consensus of workshop participants.

With the assessment of individual solution performance (refer to Section 5), a quantitative assessment of the management scenarios could be undertaken (refer to Section 6.1 to 6.3) to more accurately score some of the key MCA criteria. Those criteria scored quantitatively are indicated in Table 6-4. Where quantified results were not available for a particular solution or MCA criterion, the qualitative results from the initial MCA process were utilised. Due to the varying range of information available, a min-max approach was used to standardise and score each management scenario against the criteria. It is noted that there are some limitations to this method in over or understating the results, however it was used to ensure a consistent scoring system with the information available.

Using this combination of a qualitative / quantitative MCA process, an overall score was determined for the three management scenarios in each catchment (refer to Figure 6-12). A sensitivity analysis was also undertaken, by assigning different weightings to environmental, social and economic criteria categories, as detailed in Table 6-5. Results of the sensitivity analysis showed that despite overall scores changing, the preferred scenarios generally remained the same. Hence discussion with Council indicated that an equal weighting for environmental, social and economic criteria categories should be adopted when determining the preferred scenario. The preferred management scenario for each catchment was selected in consultation with Council and Unitywater, and is presented in Section 7. A more detailed overview of the MCA process undertaken can be found in the TWCM Strategy (BMT WBM, 2010).

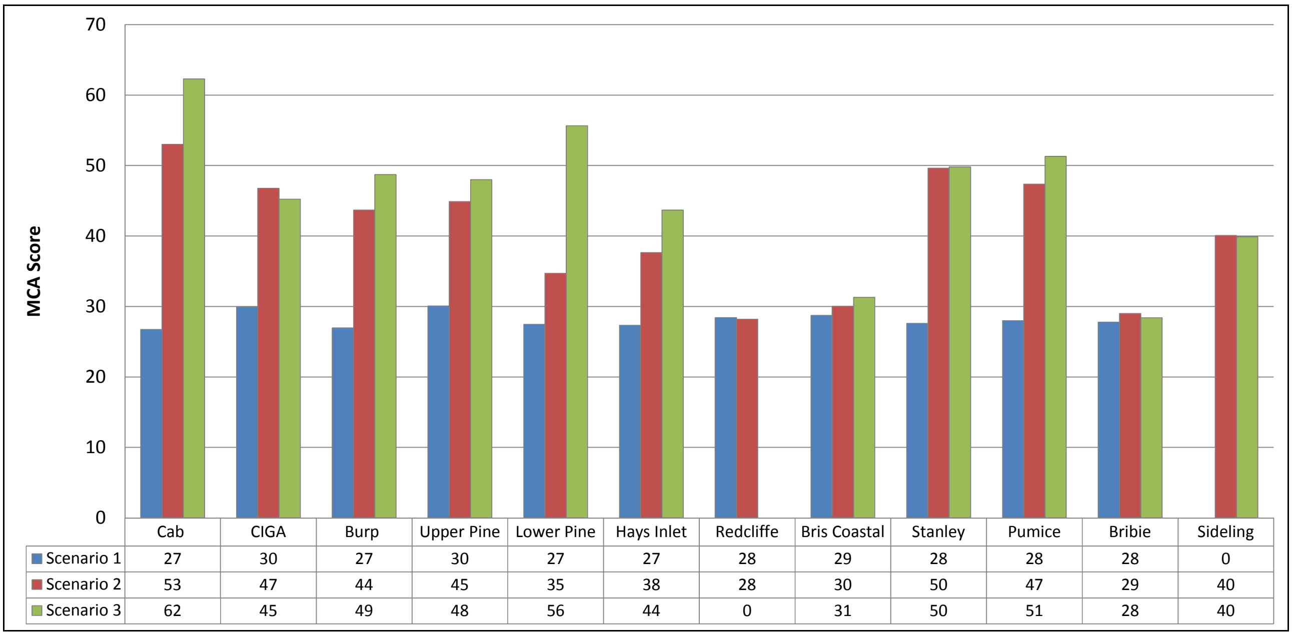



**Figure 6-12 MCA Scores for Management Scenarios in Each Catchment (equal TBL weighting)**

**Table 6-5 Criteria Category Weightings used for Sensitivity Testing**

| Category | Sensitivity Test Weighting 1 | Sensitivity Test Weighting 2 | Sensitivity Test Weighting 3 |
|---|---|---|---|
| Environmental | 30% | 40% | 20% |
| Social | 30% | 40% | 30% |
| Economic | 40% | 20% | 50% |

# 7 PREFERRED SCENARIOS FOR TOTAL WATER CYCLE MANAGEMENT

The preferred management scenarios were initially selected based on the results of the Multi Criteria Analysis. Concept designs were prepared for the preferred scenarios, so that detailed costings (by Project Support) could be undertaken of proposed recycled water schemes. In some instances, the detailed costings substantially differed to those used during the MCA, reducing the economic viability of the preferred management scenario. In these instances, and where significant implementation issues have been identified, alternative management scenarios have been selected and recommended in consultation with key stakeholders. These management scenarios will require further detailed investigations to ensure that they satisfy environmental requirements and are economically feasible.

A summary of the preferred management scenarios initially selected from the MCA, and the final recommended TWCM Planning scenarios for adoption are shown in Table 7-1.

In addition to the solutions presented in the following section, it is noted that Unitywater have recently developed a biosolids strategy that details the preferred management of biosolids for STPs within MBRC. The strategy is to maximise biosolids reuse and ensure all biosolids meet the quality requirements of the reuse market. The current least cost reuse pathway is identified to be agricultural land application. Therefore the strategy endorses the use of biosolids for agricultural land application, eventually aiming to eliminate landfill disposal. It was noted that a number of STPs in the MBRC area (Murrumba Downs, Brendale, South Caboolture, Redcliffe and Bribie Island) will require upgrades to ensure the biosolids meet Grade B stabilisation requirements for agricultural reuse. The Unitywater biosolids strategy should be adopted for the management of biosolids from all STPs within MBRC.

Unitywater is also responsible for the control and management of trade waste discharge into the sewerage network and has recently undertaken a comprehensive review of its Trade Waste Policy. The Policy and the more detailed *Trade Waste Management Plan* (Jan 2012) have evolved from a model trade waste policy released by the State Government in 2002, but have been completely revised to take into account recent legislative change and to move Unitywater towards a best practice wastewater source management philosophy as outlined in the *National Wastewater Source Management Guidelines* (WSAA) 2008.

Unitywater's policy is to accept (subject to conditions) biodegradable waste into the sewerage system, provided that:

- The system has adequate capacity to effectively collect, transport and treat the waste;
- The waste does not hinder the recycling of by-products; and
- In accordance with the principles of ecological sustainability and eco-efficiency, all practicable waste minimisation, recycling and reuse options have been applied by the customer.

Discharge of waste containing substances in amounts liable to be toxic or hazardous to sewerage infrastructure, personnel or the environment is prohibited.

Acceptance of trade waste containing toxic or hazardous substances and non-degradable pollutants to sewer is permitted only after the waste has been pre-treated by appropriate onsite treatment and technology. This ensures that the resulting discharge will not cause harm to the sewage treatment plant process or the environment.

The Trade Waste Management Plan describes the assessment process (including risk assessment), sampling and monitoring programs, modified charging strategies, trade waste admission limits and other issues that may be initiated in response to community needs.

Trade waste makes up a very small proportion of the total wastewater received at all the regions' STP's due to the absence of water intensive heavy industry and the dominance of residential land uses.

Unitywater have advised that there have been no incidents in the Moreton Bay Regional Council area where trade waste discharge has threatened the proper operation of the STP's.

The Policy and Management Plan are available at http://unitywater.com/Sewerage/New-Trade-Waste-Policy-in-2012.aspx

Concept designs for preferred management scenarios as identified from the MCA are presented in Appendix F. Conceptual design of stormwater harvesting systems have only been undertaken at a broad scale, as no lot layout information exists for greenfield sites and a greater level of detail would be pointless at this time due to the many options and the high level of variability in the costs of these options. It is further noted that near to the completion of this project, a number of greenfield sites originally identified as viable for stormwater harvesting, were identified to have been granted Development Approval, and hence were no longer deemed as viable options for stormwater harvesting. The concept design outlines the updated location of viable stormwater harvesting sites, however the performance of this solution will differ slightly from the assessment undertaken in Section 5.10, and summarised below. Revised estimates of the cost and performance of these stormwater harvesting schemes is included in Appendix F.

Similarly, detailed costing of the marginal capital costs of recycled water schemes in the preferred management scenarios (identified during the MCA) has been undertaken by Project Support. These costings are included in Appendix G. As previously noted, these costs are in some instances substantially different to initial estimates for use during the MCA (prior to concept design), and have impacted on the viability of recycled water schemes and the chosen management scenarios. It is recommended that further detailed investigations of the costing and feasibility of recycled water schemes be undertaken prior to any adoption of these schemes.

For all catchments, Unitywater's demand model was used as a basis to estimate future (2031) EPs and water demands over the planning period where appropriate. For CIGA, population predictions were based on information presented in the *Caboolture Identified Growth Area Infrastructure & Staging Report* (Cardno, 2010).

**Table 7-1 Recommended TWCM Planning Scenarios**

| Catchment | Assessment | | Recommended TWCM Plan Scenario | Comments |
|---|---|---|---|---|
| | Multi Criteria Analysis | Additional Financial & Implementation Criteria | | |
| Bribie Island | 2 | 2 | 2 | |
| Burpengary Creek | 3 | 3 | 3 | |
| Brisbane Coastal | 2 | 2 | 2 | |
| Caboolture River | 3 | 2 | 2 | Scenario 3 is not economically viable. Scenario 2 was selected as an acceptable compromise, providing similar water quality outcomes at significantly reduced costs. |
| Caboolture Identified Growth Area (CIGA) | 2 | 1 | 1 | Scenario 2 is not economically viable. Scenario 1 was selected as an acceptable compromise because it provides slightly improved water quality outcomes and is a more affordable option. As all scenarios required zero discharge of effluent, a key difference will be additional land required by the developer for Scenario 1 (for wastewater disposal). |
| Hays Inlet | 3 | 3 | 3 | |
| Lower Pine River | 3 | 2 | 2 | Scenario 3 was identified to have significant implementation barriers, including:<br>i) Political/public palatability<br>ii) Current government policy re Indirect Potable Reuse<br>iii) SEQ Water Strategy preference for desalinisation (over IPR)<br>Scenario 2 was considered the next best alternative if the barriers to Scenario 3 prohibit implementation. However additional measures will be required to meet water quality targets. |
| Pumicestone Passage | 2 | 2 | 2 | |
| Redcliffe | 1 | 1 | 1 | |
| Stanley River | 2 | 2 | 2 | |
| Sideling Creek | 2 | 2 | 2 | |
| Upper Pine River | 3 | 3 | 3 | |

## 7.1 Bribie Island Catchment

A summary of the individual solutions contained in the preferred management scenario for Bribie Island catchment and the overall performance of this management scenario is detailed in Table 7-2. Table 7-3 provides a summary of the capital and operational costs of the solutions, while Table 7-4 includes a distribution of these costs per Equivalent Person (EP).

Although there was not much difference in the MCA score between Scenario 1 and Scenario 2, the small additional costs for Scenario 2 (associated with increased enforcement of E&SC) were considered worthwhile for the adoption of this scenario.

Implementing the preferred management Scenario over the planning period is estimated to contribute towards maintaining the current waterway report card ranking of D+ in Pumicestone Passage over the planning period. It is noted that Bribie Island catchment only has a small contribution towards the overall score EHMP score.

**Key Catchment Characteristics:**

- Area: 10,710 ha
- Existing Population: 17,100
- Future Population: 21,800
- Future Population Growth: 27%
- Future Urban Land Use: 11%
- Water Supply Catchment: Potable water sourced from groundwater aquifer and supplemented by reticulated water network
- Bribie Island STP discharges to groundwater
- EHMP Score 2010: D+ (Pumicestone Passage)

**Table 7-2 Summary of Preferred Management Scenario for Bribie Island**

| Management Scenario 2 - Medium Intensity | | | | | | |
|---|---|---|---|---|---|---|
| **Solution** | **Indicative NPV ($2011)** | **TSS Treatment (kg/yr)** | **TN Treatment (kg/yr)** | **TP Treatment (kg/yr)** | **Potable Water Saving (ML/yr)** | **Land Take (ha)** |
| Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $3,622,000 | 8,080 | 69 | 15 | - | 1.21 |
| Future development meets QDC alternative water supply target | $5,444,000 | 1,911 | 174 | 12 | 96 | - |
| Increased implementation / enforcement of erosion and sediment control (E&SC) on development sites | $45,000 | 13,310 | - | - | - | - |
| Education and capacity building to support implementation of solutions[1] | NA | NA | NA | NA | NA | - |
| **Total for Management Scenario:** | **$9,111,0002** | **23,301** | **243** | **27** | **96** | **1.21** |

[1] Assessment of the cost and performance of this solution has not been undertaken (Not Assessed, NA)

**Table 7-3 Summary of Capital and Operating Expenditures for Bribie Island**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | MBRC | Unitywater | Developer | MBRC | Unitywater | Household |
| Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | - | - | $3,344,257 | $24,172 | - | - |
| Future development meets QDC alternative water supply target | - | - | $5,059,038 | - | - | $33,548 |
| Increased implementation / enforcement of erosion and sediment control (E&SC) on development sites | $3,436 | - | - | $4,995 | - | - |
| ***Sub-Total*** | ***$3,436*** | - | ***$8,403,295*** | ***$29,167*** | - | ***$33,548*** |
| **Total CAPEX / OPEX** | **$8,406,731** | | | **$62,715** | | |

**Table 7-4 Summary of Capital and Operating Expenditures per EP for Bribie Island**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | CAPEX/EP | Contributing EP | Contributing Description | OPEX/EP | Contributing EP | Contributing Description |
| Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $534 | $6,265 | Catchment New | $0.87 | $27,644 | Catchment Total |
| Future development meets QDC alternative water supply target | $1,077 | $4,697 | Serviced only | $7.14 | $4,697 | Serviced only |
| Increased implementation / enforcement of erosion and sediment control (E&SC) on development sites | $0.12 | $27,644 | Catchment Total | $0.18 | $27,644 | Catchment Total |
| **Total (Maximum/EP)** | **$1,611** | | | **$8.20** | | |

A summary of the performance of the preferred management scenario with regards to meeting 'no worsening' or sustainable load reduction targets is shown in Table 7-5. The summary indicates that sustainable load targets are met for all parameters (with water quality modelling indicating WQOs are met now and in the future with no additional management, due to well mixed receiving waters). However 'no worsening' targets are not met for any parameters.

**Table 7-5 Summary of Waterway Health Performance of Management Scenario on Bribie Island Catchment**

| Parameter | Scenario Load Reduction (t/yr) | No Worsening Reduction Target (t/yr) | Meets 'no worsening' Target? | Sustainable Load Reduction Target (t/yr) | Meets Sustainable Load Target? |
|---|---|---|---|---|---|
| TSS | 10[1] | 18 | × | 0 | ✓ |
| TN | 0.2 | 2.4 | × | 0 | ✓ |
| TP | 0.03 | 0.3 | × | 0 | ✓ |

[1]This does not include loads from improved E&SC

The levelised cost of treating pollutants for solutions contained in the preferred management scenario for Bribie Island have been plotted in Figure 7-1 to Figure 7-3 for TSS, TN and TP respectively. These figures show the cumulative predicted annual treatment performance of the management scenario, in order of least cost to implement the solutions. For comparison, annual load reduction targets for the catchment to achieve a 'no worsening' from existing conditions, or 'sustainable load' targets have also been included. It is noted that the EHMP report card (2010) result for receiving waters in Pumicestone Passage is shown to put into context the indicative results that a 'no worsening' scenario may achieve. It should be noted that the results of the 2010 report card (D+) are based on a much larger (external) catchment that was not the focus of this study. The modelling that was undertaken showing WQOs and hence sustainable load targets were met reflects the local area of interest only (lower Pumicestone Passage, adjacent to Bribie Island).

The potential impacts of poor erosion and sediment control during the construction phase have not been accounted for in the catchment modelling or hence the sediment load reduction targets. However it can be seen from Figure 7-1 that the potential benefits from implementing erosion and sediment control are quite significant, and will largely influence sediment generation in the catchment and the ability to achieve 'no worsening' targets.

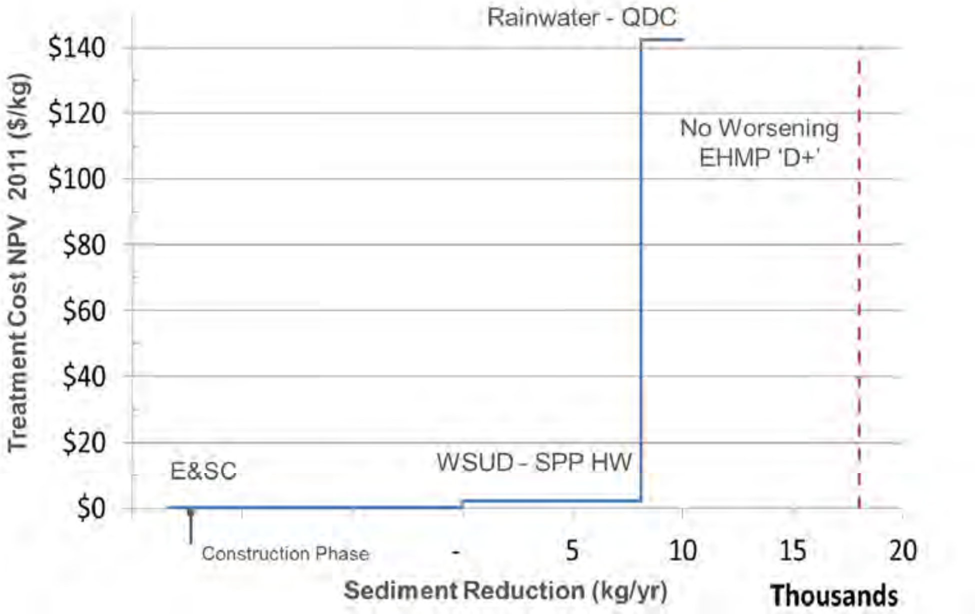



**Figure 7-1 Bribie Island TSS Treatment Cost Curve**

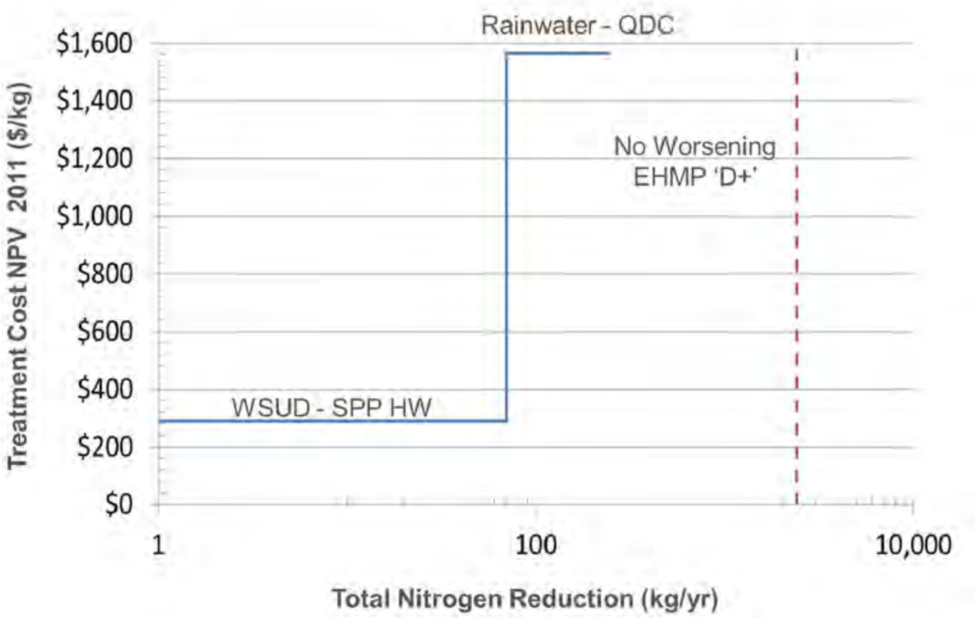



**Figure 7-2 Bribie Island TN Treatment Cost Curve**

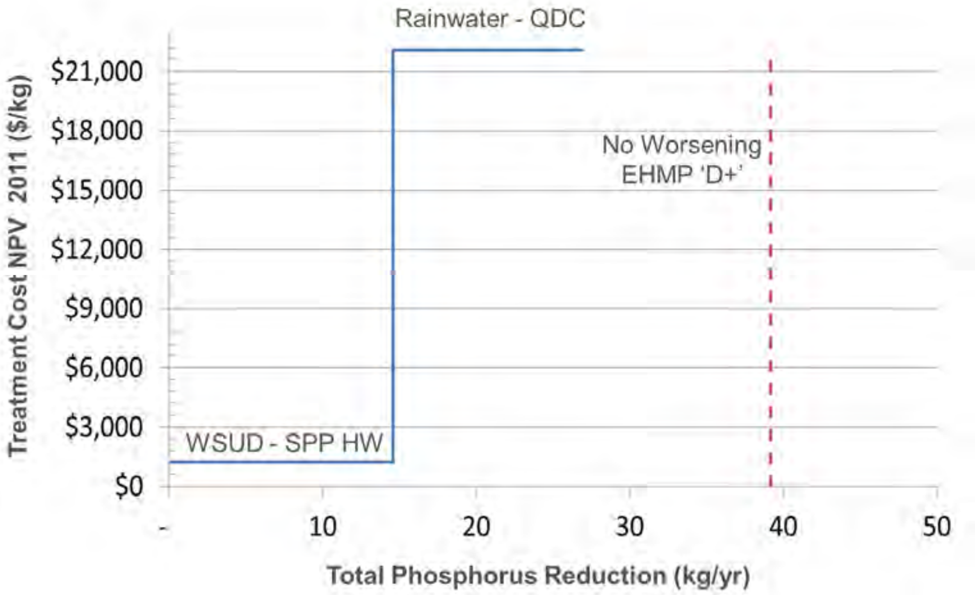



**Figure 7-3 Bribie Island TP Treatment Cost Curve**

## 7.2 Brisbane Coastal Catchment

A summary of the individual solutions contained in the preferred management scenario for Brisbane Coastal Catchment and the overall performance of this management scenario is detailed in Table 7-6. Table 7-7 provides a summary of the capital and operational costs of the solutions, while Table 7-8 includes a distribution of these costs per Equivalent Person (EP).

**Key Catchment Characteristics:**

- Area: 1,530 ha
- Existing Population: 22,600
- Future Population: 24,100
- Future Population Growth: 6%
- Future Urban Land Use: 39%
- Potable water sourced from North Pine Dam
- Wastewater treated at Brendale STP in adjacent Lower Pine River catchment
- Wastewater treated at Luggage Point STP in Brisbane Catchment
- EHMP Score 2010: D+ (Bramble Bay)

Although Scenario 3 actually scored marginally better than Scenario 2 in the MCA, the additional costs associated with Scenario 3 were not considered worthwhile for the adoption of this scenario. Therefore Scenario 2 was adopted as the preferred management scenario.

It is noted that retrofit opportunities in this catchment were only assessed on an end of pipe scale (due to Council's original preference), however as this catchment is largely urbanised, considerable water quality benefits (that have not been accounted) may be gained from retrofitting streetscape WSUD solutions, particularly as the opportunity arises during urban renewal projects (e.g. road upgrades).

Implementing the preferred management Scenario over the planning period is predicted to maintain existing water quality despite future development. However, in receiving waters of Bramble Bay, this maintains a report card ranking of D+. Significant external catchment (outside of Brisbane Coastal catchment) impacts upon this score.

**Table 7-6 Summary of Preferred Management Scenario for Brisbane Coastal Catchment**

| Management Scenario 2 – Medium Intensity | | | | | | |
|---|---|---|---|---|---|---|
| **Solution** | **Indicative NPV ($2011)** | **TSS Treatment (kg/yr)** | **TN Treatment (kg/yr)** | **TP Treatment (kg/yr)** | **Potable Water Saving ML/yr** | **Land Take (ha)** |
| Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $811,000 | 697 | 10 | 2 | - | 0.27 |
| Future development meets QDC alternative water supply target | $1,690,000 | 593 | 54 | 4 | 30 | - |
| Increased implementation / enforcement of erosion and sediment control (E&SC) on development sites | $13,900 | 1,887 | - | - | - | - |
| Education and capacity building to support implementation of solutions[1] | NA | NA | NA | NA | NA | - |
| **Total for Management Scenario:** | **$2,514,900** | **3,177** | **64** | **5** | **30** | **0.27** |

[1] Detailed assessment of the cost and performance of this solution has not been undertaken (Not Assessed NA)

**Table 7-7 Summary of Capital and Operating Expenditures for Brisbane Coastal Catchment**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | MBRC | Unitywater | Developer | MBRC | Unitywater | Household |
| Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | - | - | $748,764 | $5,412 | - | - |
| Future development meets QDC alternative water supply target | - | - | $1,570,420 | - | - | $10,414 |
| Increased implementation / enforcement of erosion and sediment control (E&SC) on development sites | $1,066 | - | - | $1,551 | - | - |
| ***Sub-Total*** | $1,066 | - | $2,319,184 | $6,963 | - | $10,414 |
| **Total CAPEX / OPEX** | **$2,320,251** | | | **$17,377** | | |

**Table 7-8 Summary of Capital and Operating Expenditures per EP for Brisbane Coastal Catchment**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | CAPEX/EP | Contributing EP | Contributing Description | OPEX/EP | Contributing EP | Contributing Description |
| Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $264 | 2,839 | Catchment New | $0.20 | 26,836 | Catchment Total |
| Future development meets QDC alternative water supply target | $1,077 | 1,458 | Serviced only | $7.14 | 1,458 | Serviced only |
| Increased implementation / enforcement of erosion and sediment control (E&SC) on development sites | $0.04 | 26,836 | Catchment Total | $0.06 | 26,836 | Catchment Total |
| **Total (Maximum/EP)** | **$1,341** | | | **$7.40** | | |

A summary of the performance of the preferred management scenario with regards to meeting 'no worsening' or sustainable load reduction targets is shown in Table 7-9.

This summary indicates that while 'no worsening' targets are met for all parameters, sustainable load targets are not.

**Table 7-9 Summary of Waterway Health Performance of Management Scenario in Brisbane Coastal Catchment**

| Parameter | Scenario Load Reduction (t/yr) | No Worsening Reduction Target (t/yr) | Meets 'no worsening' Target? | Sustainable Load Reduction Target (t/yr) | Meets Sustainable Load Target? |
|---|---|---|---|---|---|
| TSS | 1.3[1] | 1.1 | ✓ | 139 | × |
| TN | 0.06 | 0.04 | ✓ | 3.7 | × |
| TP | 0.005 | 0.004 | ✓ | 0.4 | × |

[1]This does not include loads from improved E&SC

The levelised cost of treating pollutants for solutions contained in the preferred management scenario have been plotted in Figure 7-4 to Figure 7-6 for TSS, TN and TP respectively. These figures show the cumulative predicted annual treatment performance of the management scenario, in order of least cost to implement the solutions. For comparison, annual load reduction targets for the catchment to achieve a 'no worsening' from existing conditions have been included. It is noted that the EHMP report card (2010) result from receiving waters of Bramble Bay is shown to put into context the indicative results that a 'no worsening' scenario may achieve. However it should be noted that Brisbane Coastal catchment has a small contribution to total pollutant loads discharged to Bramble Bay. Sustainable load targets are not shown, as they are far beyond the level of treatment achieved (refer to Table 7-9).

The potential impacts of poor erosion and sediment control during the construction phase have not been accounted for in the catchment modelling or hence the sediment load reduction targets. However it can be seen from Figure 7-4 that the potential benefits from implementing erosion and sediment control are quite significant, and will largely influence sediment generation in the catchment and the ability to achieve 'no worsening' targets.

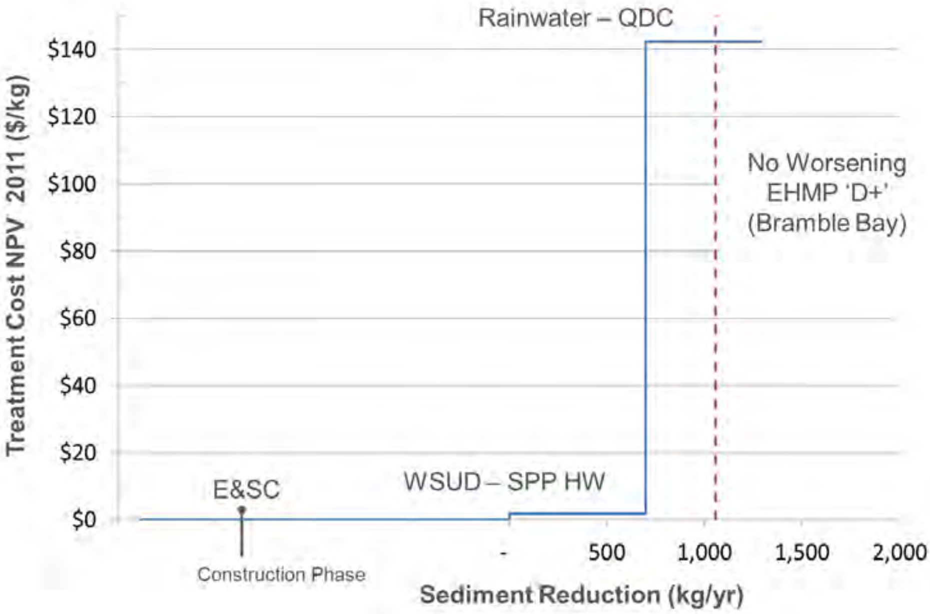



**Figure 7-4 Brisbane Coastal TSS Treatment Cost Curve**

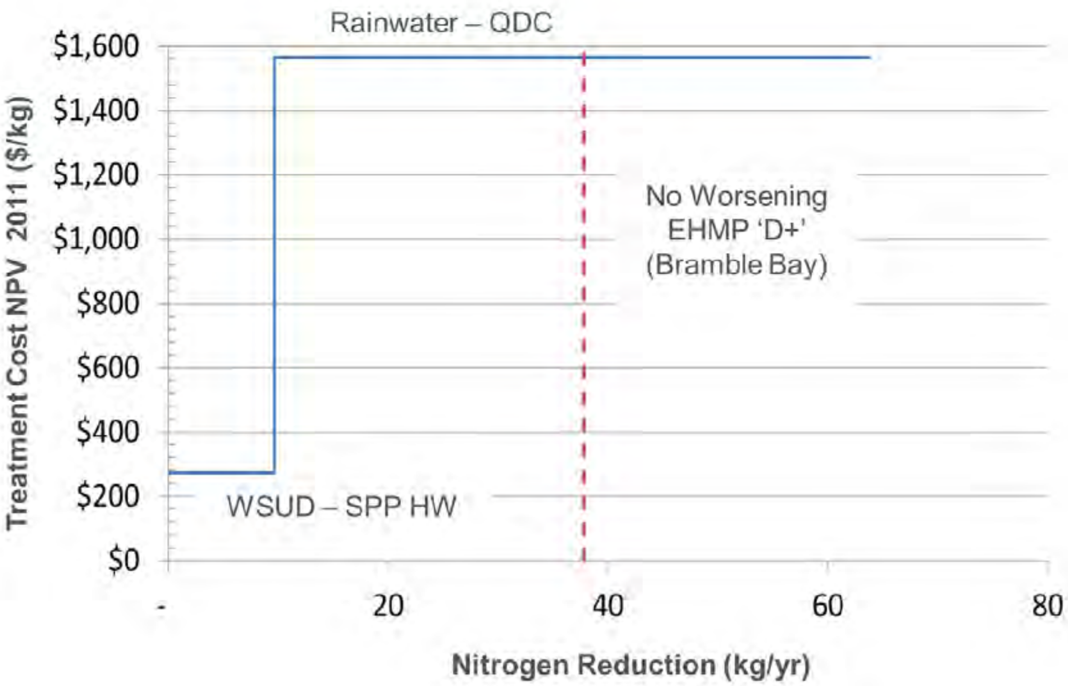



**Figure 7-5 Brisbane Coastal TN Treatment Cost Curve**

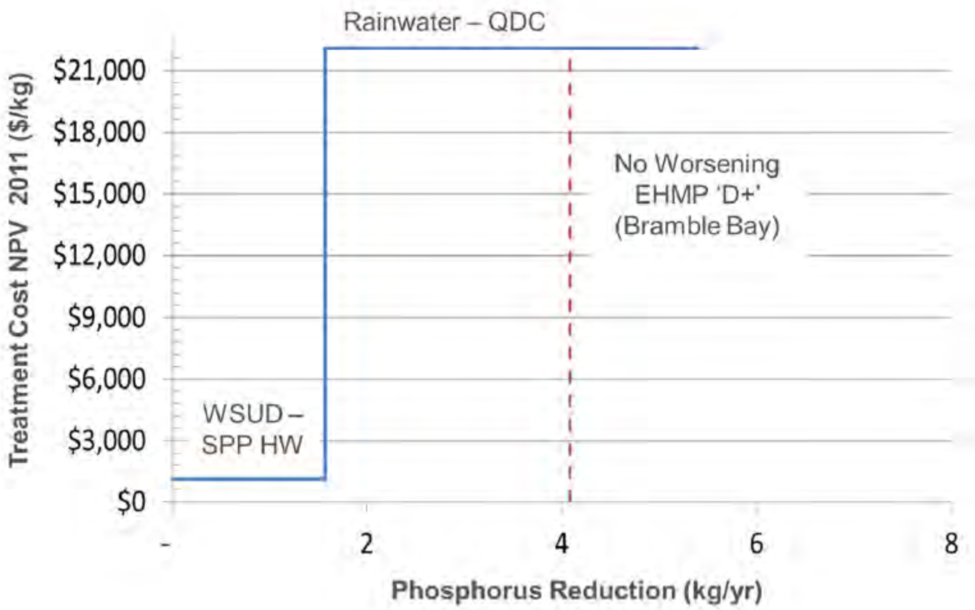



**Figure 7-6 Brisbane Coastal TP Treatment Cost Curve**

## 7.3 Burpengary Creek Catchment

**Key Catchment Characteristics:**

- Area: 8,435 ha
- Existing Population: 42,800
- Future Population: 64,400
- Future Population Growth: 51%
- Future Urban Land Use: 33%
- Potable water sourced from Northern Pipeline Interconnector (NPI) and North Pine Dam
- Wastewater treated at Burpengary East STP and discharged into Caboolture River lower estuary
- EHMP Score 2010:

  D+ (Deception Bay)

A summary of the individual solutions contained in the preferred management scenario for Burpengary Creek Catchment and the overall performance of this management scenario is detailed in Table 7-10. Table 7-11 provides a summary of the capital and operational costs of the solutions, while Table 7-12 includes a distribution of these costs per Equivalent Person (EP).

The stormwater harvesting solution in the preferred management scenario refers to a public open space irrigation and dual reticulation scheme (for toilet and outdoor use). Stormwater harvesting was nominated as part of the stretched management scenario for large (>20ha) greenfield development areas that recycled water schemes were not initially proposed for. Stormwater harvesting will also assist in meeting hydrological objectives for the catchment.

If the preferred Wamuran agricultural irrigation scheme does not proceed (for the Caboolture Catchment), and instead dual reticulation of recycled water is adopted in the Caboolture catchment, the dual reticulation scheme may be extended as an alternative to stormwater harvesting for the above developments. Further assessment of the best option may be required pending the outcomes of the Wamuran irrigation scheme.

Implementing the preferred management Scenario over the planning period is estimated to contribute towards improving waterway health in Deception Bay from a D+ to a C+.

**Table 7-10 Summary of Preferred Management Scenario for Burpengary Creek Catchment**

| Management Scenario 3 – High Intensity | | | | | | |
|---|---|---|---|---|---|---|
| **Solution** | **Indicative NPV ($2011)** | **TSS Treatment (kg/yr)** | **TN Treatment (kg/yr)** | **TP Treatment (kg/yr)** | **Potable Water Saving (ML/yr)** | **Land Take (ha)** |
| Future development meets QDC alternative water supply target | $17,492,000 | 6,142 | 559 | 40 | 307 | - |
| Waterway Riparian Revegetation ($3^{rd}$ & $4^{th}$ order streams) | $8,029,000 | 143,130 | - | - | - | 54 |
| Rural BMP for Grazing - Reveg $1^{st}$ & $2^{nd}$ order streams | $1,060,000 | 195,779 | - | - | - | 43 |
| Increased Implementation/Enforcement of E&SC | $206,000 | 47,790 | - | - | - | - |
| Greenfield WSUD achieves 'No Worsening' | $20,156,000 | 39,461 | 324 | 70 | - | 6.73 |
| Stormwater Harvesting for Non-Potable Use | $15,237,000 | 38,389 | 463 | 86 | 178 | - |
| WSUD Retrofit to Existing Urban Areas | $22,151,000 | 61,030 | 270 | 112 | | 4.30 (B) 7.95 (W) |
| Education and capacity building to support implementation of solutions[1] | NA | NA | NA | NA | NA | - |
| **Total for Management Scenario:** | **$84,331,000** | **531,720** | **1,616** | **308** | **485** | **116** |

[1] Detailed assessment of the cost and performance of this solution has not been undertaken (Not Assessed NA)
(B) – Bioretention surface area (W) Wetland macrophyte zone area

**Table 7-11 Summary of Capital and Operating Expenditures for Burpengary Creek Catchment**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | MBRC | Unitywater | Developer | MBRC | Unitywater | Household |
| Future development meets QDC alternative water supply target | - | - | $16,255,895 | - | - | $107,798 |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $8,028,992 | - | - | - | - | - |
| Rural BMP for Grazing - Reveg 1st & 2nd order streams[1] | $7,632,903 | - | - | $9,808 | - | - |
| Increased Implementation/Enforcement of E&SC | $15,822 | - | - | $23,006 | - | - |
| Greenfield WSUD achieves 'No Worsening' | | - | $18,612,839 | $134,532 | - | - |
| Stormwater Harvesting for Non-Potable Use | $11,147,973 | - | - | $393,745 | - | - |
| WSUD Retrofit to Existing Urban Areas | $19,095,099 | - | - | $245,046 | - | - |
| ***Sub-Total*** | $45,920,788 | - | $34,868,734 | $806,137 | - | $107,798 |
| **Total CAPEX / OPEX** | **$80,789,522** | | | **$913,934** | | |

1 Implementation of this solution and the associated costs are expected to be shared between Council and private landowners. Further investigation of the funding and implementation mechanisms will be undertaken during implementation planning.

**Table 7-12 Summary of Capital and Operating Expenditures per EP for Burpengary Creek Catchment**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | CAPEX/EP | Contributing EP | Contributing Description | OPEX/EP | Contributing EP | Contributing Description |
| Future development meets QDC alternative water supply target | $1,077 | 15,092 | Serviced only | $7.14 | 15,092 | Serviced only |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $105 | 76,669 | Catchment Total | - | 76,669 | Catchment Total |
| Rural BMP for Grazing - Reveg 1st & 2nd order streams | $100 | 76,669 | Catchment Total | $0.13 | 76,669 | Catchment Total |
| Increased Implementation/Enforcement of E&SC | $0.21 | 76,669 | Catchment Total | $0.30 | 76,669 | Catchment Total |
| Greenfield WSUD achieves 'No Worsening' | $657 | 28,346 | Catchment New | $1.75 | 76,669 | Catchment Total |
| Stormwater Harvesting for Non-Potable Use | $1,057 | 10,545 | Serviced only | $5.14 | 76,669 | Catchment Total |
| WSUD Retrofit to Existing Urban Areas | $395 | 48,322 | Catchment Existing | $3.20 | 76,669 | Catchment Total |
| **Total (Maximum/EP)** | **$2,333** | | | **$12.52** | | |

A summary of the performance of the preferred management scenario with regards to meeting 'no worsening' or sustainable load reduction targets is shown in Table 7-13. Table 7-13 indicates that while 'no worsening' targets are easily met for all parameters, sustainable load targets are not.

**Table 7-13 Summary of Waterway Health Performance of Management Scenario in Burpengary Creek Catchment**

| Parameter | Scenario Load Reduction (t/yr) | No Worsening Reduction Target (t/yr) | Meets 'no worsening' Target? | Sustainable Load Reduction Target (t/yr) | Meets Sustainable Load Target? |
|---|---|---|---|---|---|
| TSS | 484[1] | - 42 | ✓ | 687 | × |
| TN | 1.6 | 0.2 | ✓ | 7.9 | × |
| TP | 0.3 | - 0.03 | ✓ | 1.7 | × |

[1]This does not include loads from improved E&SC

The levelised cost for supplying alternative sources of potable water from the solutions that make up the preferred management scenario is shown in Figure 7-7. The cost curve plots the solutions in order of least cost, and shows the cumulative annual potable water savings expected from the preferred management scenario. The current and forecast bulk water cost (from the SEQ Water Grid) has been included on these figures for comparison.

The levelised cost of treating pollutants for solutions contained in the preferred management scenario have been plotted in Figure 7-8 to Figure 7-10 for TSS, TN and TP respectively. These figures show the cumulative predicted annual treatment performance of the management scenario, in order of least cost to implement the solutions. For comparison, annual load reduction targets for the catchment to achieve a 'no worsening' from existing conditions have been included for TN. It is noted that the EHMP report card (2010) result is shown to put into context the indicative results that a 'no worsening' scenario may achieve in receiving waters. Sustainable load targets are not shown, as they are far beyond the level of treatment achieved (refer to Table 7-13).

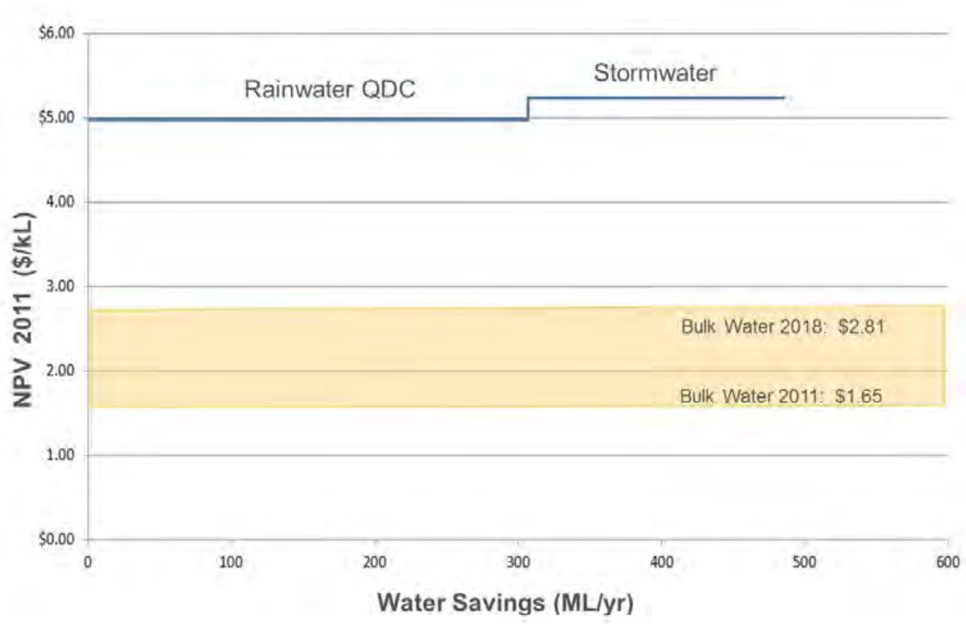



**Figure 7-7 Burpengary Alternative Water Supply Cost Curve**

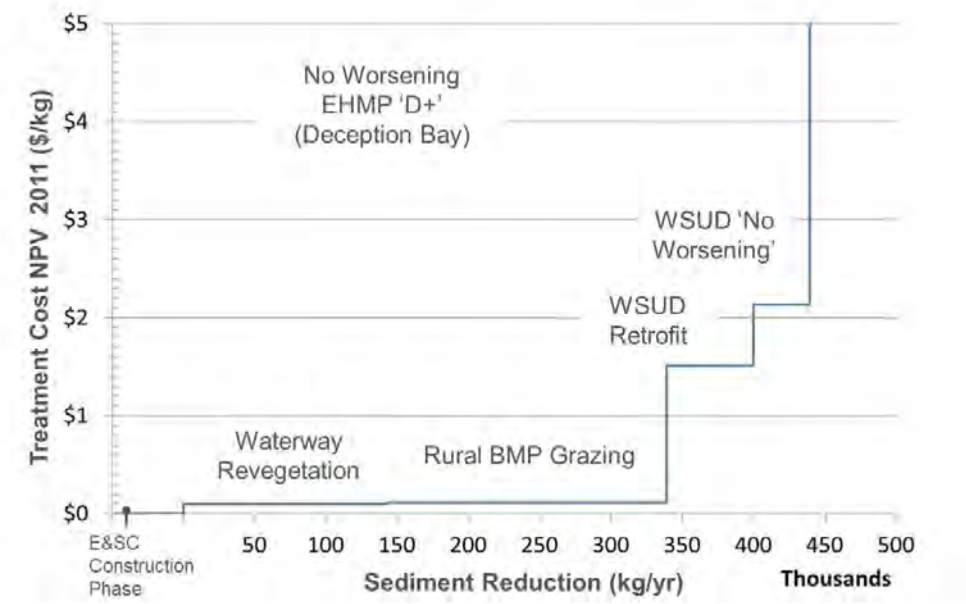



**Figure 7-8 Burpengary TSS Treatment Cost Curve**

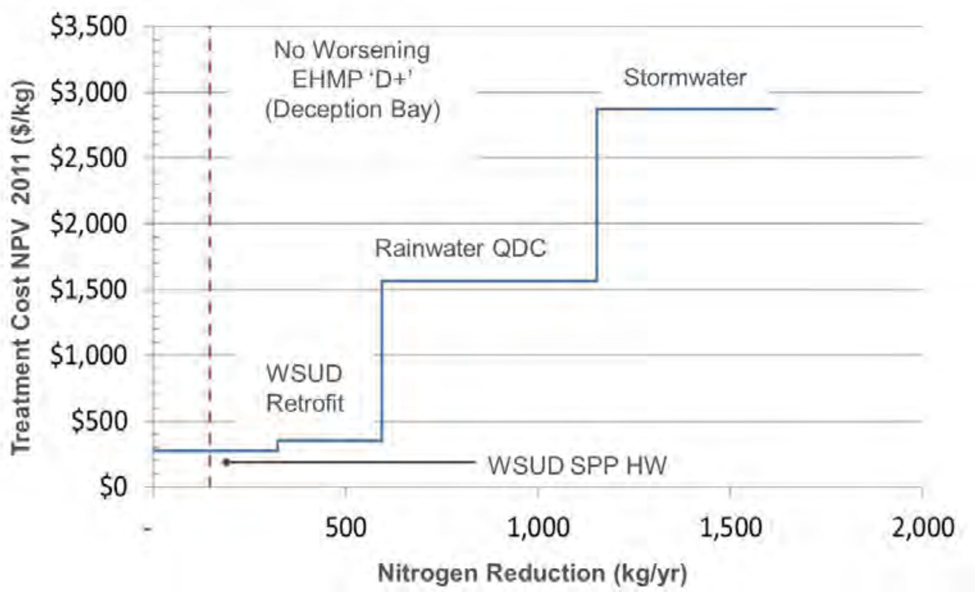



**Figure 7-9 Burpengary TN Treatment Cost Curve**

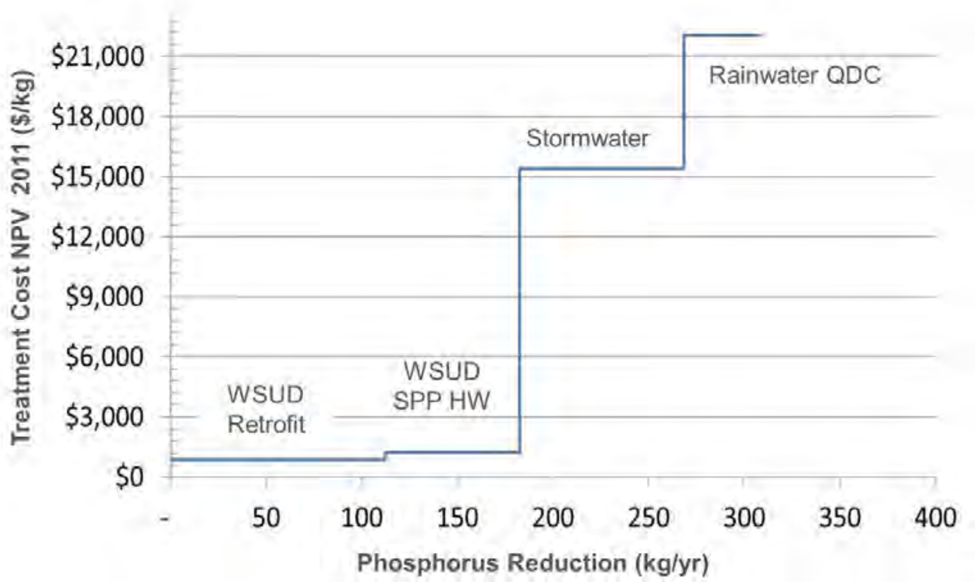



**Figure 7-10 Burpengary TP Treatment Cost Curve**

## 7.4 Caboolture River Catchment

As identified in Table 7-1, Scenario 3 was identified as the preferred scenario for this catchment during the MCA assessment. However, additional detailed costing of the concept design indicated significantly higher costs for the proposed dual reticulation recycled water scheme. Subsequently, the scenario was deemed to be cost prohibitive, and Scenario 2 was selected by key stakeholders as the recommended management scenario. This was identified to be a suitable compromise as the water quality benefits were only slightly less at significantly less cost.

The performance of both management scenarios are documented in the following sections:

- Scenario 3: Preferred Scenario selected using MCA.
- Scenario 2: Recommended Scenario for adoption following additional financial assessment.

Implementing either of the above management Scenario over the planning period is estimated to improve waterway health in the Caboolture River estuary from a D to a D+.

**Key Catchment Characteristics:**

- Area: 34,830 ha
- Existing Population: 69,500
- Future Population: 112,200[1]
- Future Population Growth: 61%[1]
- Future Urban Land Use: 20%
- Potable water sourced from Caboolture Weir, NPI and North Pine Dam
- Wastewater treated within catchment at South Caboolture STP and discharged into Caboolture River upper estuary
- Burpengary East STP discharges into Caboolture River lower estuary
- EHMP Score Caboolture River Catchment 2010:

  C+ (Fresh) D (Estuarine)

[1]Does not include CIGA

### 7.4.1 Scenario 3: Preferred Scenario Using MCA

A summary of the individual solutions contained in Scenario 3, the preferred management scenario for Caboolture River Catchment from the MCA, and the overall performance of this management scenario is detailed in Table 7-14. Table 7-15 provides a summary of the capital and operational costs of the solutions, while Table 7-16 includes a distribution of these costs per Equivalent Person (EP).

It should be noted that Scenario 3 is not the recommended scenario for this catchment.

**Table 7-14 Summary of Management Scenario 3 for Caboolture River Catchment**

| Management Scenario 3 – High Intensity | | | | | | |
|---|---|---|---|---|---|---|
| **Solution** | **Indicative NPV ($2011)** | **TSS Treatment (kg/yr)** | **TN Treatment (kg/yr)** | **TP Treatment (kg/yr)** | **Potable Water Saving (ML/yr)** | **Land Take (ha)** |
| Future development meets QDC alternative water supply target | $24,677,000 | 8,665 | 788 | 56 | 433 | - |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $14,980,000 | 470,332 | - | - | - | 100 |
| Rural BMP for Grazing - Reveg 1st & 2nd order streams | $46,204,000 | 434,195 | - | - | - | 254 |
| Rural BMP for Horticulture - Filter strips | $187,000 | 5,780 | 2,812 | 711 | - | - |
| Increased Implementation/Enforcement of E&SC | $406,000 | 170,628 | - | - | - | - |
| WSUD Retrofit to Existing Urban Areas | $45,705,000 | 137,249 | 635 | 232 | - | 4.94 (B) 26.67 (W) |
| Greenfield WSUD achieves 'No Worsening' | $73,624,000 | 129,443 | 1,104 | 238 | - | 24.57 |
| Recycled Water Supplied to Urban Users[2] | $238,774,000 | 5,932 | 7,689 | 890 | 2,297 | 220[3] |
| Stormwater Harvesting for Non-Potable Use | $16,040,000 | 179,460 | 2,163 | 403 | 184 | - |
| Prevention of illegal stormwater inflow connections to sewer[1] | NA | NA | NA | NA | NA | - |
| Education and capacity building to support implementation of solutions[1] | NA | NA | NA | NA | NA | - |
| Upgrade STP Capacity[1] | NA | NA | NA | NA | NA | - |
| **Total for Management Scenario:** | **$460,597,000** | **1,398,385** | **13,464** | **2,207** | **2,914** | **410** |

[1] Detailed assessment of the cost and performance of this solution has not been undertaken (Not Assessed NA)
[2] This includes detailed capital costing by Project Support. If successful (pending detailed feasibility studies), the Wamuran agricultural reuse scheme would be a preferred alternative.
[3]Land required for disposal of effluent, assuming 0.02 ML/ha/day (Sodosol soils)
(B) – Bioretention surface area (W) Wetland macrophyte zone area

**Table 7-15 Summary of Capital and Operating Expenditures for Caboolture River Catchment (Scenario 3)**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | MBRC | Unitywater | Developer | MBRC | Unitywater | Household |
| Future development meets QDC alternative water supply target | - | - | $22,932,641 | - | - | $152,073 |
| Waterway Riparian Revegetation ($3^{rd}$ & $4^{th}$ order streams) | $14,979,946 | - | - | - | - | - |
| Rural BMP for Grazing - Reveg $1^{st}$ & $2^{nd}$ order streams[1] | $45,475,367 | - | - | $58,432 | - | - |
| Rural BMP for Horticulture - Filter strips[1] | $47,042 | - | - | $11,259 | - | - |
| Increased Implementation/Enforcement of E&SC | $31,220 | - | - | $45,396 | - | - |
| WSUD Retrofit to Existing Urban Areas | $37,821,087 | - | - | $632,160 | - | - |
| Greenfield WSUD achieves 'No Worsening' | - | - | $67,987,249 | $491,406 | | - |
| Recycled Water Supplied to Urban Users | - | $182,853,000 | - | - | $4,875,476 | - |
| Stormwater Harvesting for Non-Potable Use | $12,861,180 | - | - | $471,134 | - | - |
| ***Sub-Total*** | $111,215,842 | $182,853,000 | $90,919,889 | $1,709,786 | $4,875,476 | $152,073 |
| **Total CAPEX / OPEX** | **$384,988,732** | | | **$6,737,336** | | |

[1] Implementation of this solution and the associated costs are expected to be shared between Council and private landowners. Further investigation of the funding and implementation mechanisms will be undertaken during implementation planning

**Table 7-16 Summary of Capital and Operating Expenditures per EP for Caboolture River Catchment (Scenario 3)**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | CAPEX/EP | Contributing EP | Contributing Description | OPEX/EP | Contributing EP | Contributing Description |
| Future development meets QDC alternative water supply target | $1,077 | 21290 | Serviced only | $7.14 | 21290 | Serviced only |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $107 | 139,427 | Catchment Total | - | 139,427 | Catchment Total |
| Rural BMP for Grazing - Reveg 1st & 2nd order streams | $326 | 139,427 | Catchment Total | $0.42 | 139,427 | Catchment Total |
| Rural BMP for Horticulture - Filter strips | $0.34 | 139,427 | Catchment Total | $0.08 | 139,427 | Catchment Total |
| Increased Implementation/Enforcement of E&SC | $0.22 | 139,427 | Catchment Total | $0.33 | 139,427 | Catchment Total |
| WSUD Retrofit to Existing Urban Areas | $452 | 83,623 | Catchment Existing | $4.53 | 139,427 | Catchment Total |
| Greenfield WSUD achieves 'No Worsening' | $1,218 | 55,804 | Catchment New | $3.52 | 139,427 | Catchment Total |
| Recycled Water Supplied to Urban Users | $3,432 | 53,283 | Serviced only | $88.06 | 55,363 | Serviced only |
| Stormwater Harvesting for Non-Potable Use | $1,235 | 10,416 | Serviced only | $3.38 | 139,427 | Catchment Total |
| **Total (Maximum/EP)** | **$6,771** | | | **$100** | | |

A summary of the performance of the preferred management scenario with regards to meeting 'no worsening' or sustainable load reduction targets is shown in Table 7-17. The summary indicates that while 'no worsening' targets are easily met for TSS and TP, they are not meet for TN. Additionally, sustainable load targets are not met for any parameter.

**Table 7-17 Summary of Waterway Health Performance of Management Scenario 3 in Caboolture River Catchment**

| Parameter | Scenario Load Reduction (t/yr) | No Worsening Reduction Target (t/yr) | Meets 'no worsening' Target? | Sustainable Load Reduction Target (t/yr) | Meets Sustainable Load Target? |
|---|---|---|---|---|---|
| TSS | 1,227[1] | -17 | ✓ | 2,845 | × |
| TN | 11.8 | 20.1 | × | 59.8 | × |
| TP | 2.0 | 0.6 | ✓ | 7.2 | × |

[1]This does not include loads from improved E&SC

The levelised cost for supplying alternative sources of potable water from the solutions that make up management scenario 3 is shown in Figure 7-15. The cost curve plots the solutions in order of least cost, and shows the cumulative annual potable water savings expected from the preferred management scenario. The current and forecast bulk water cost (from the SEQ Water Grid) has been included on these figures for comparison.

The levelised cost of treating pollutants for solutions contained in management scenario 3 have been plotted in Figure 7-16 to Figure 7-18 for TSS, TN and TP respectively. These figures show the cumulative predicted annual treatment performance of the management scenario, in order of least cost to implement the solutions. For comparison, annual load reduction targets for the catchment to achieve a 'no worsening' from existing conditions have been included (where applicable). It is noted that the EHMP report card (2010) result for the Caboolture River Estuary is shown to put into context the indicative results that a 'no worsening' scenario may achieve. Sustainable load targets are not shown, as they are far beyond the level of treatment achieved by the management scenario (refer to Table 7-17).

Figure 7-11, Figure 7-17 and Figure 7-14 show the levelised cost to supply water and treat nutrients for the agricultural reuse scheme (Wamuran) as an alternative to providing dual reticulation of recycled water to urban users (dual reticulation is the solution for Scenario 3). If the agricultural reuse project is deemed viable, it can be seen that this solution would be preferred over a recycled water scheme to urban users. The viability of this scheme, however, will depend on the outcome of third party feasibility studies.

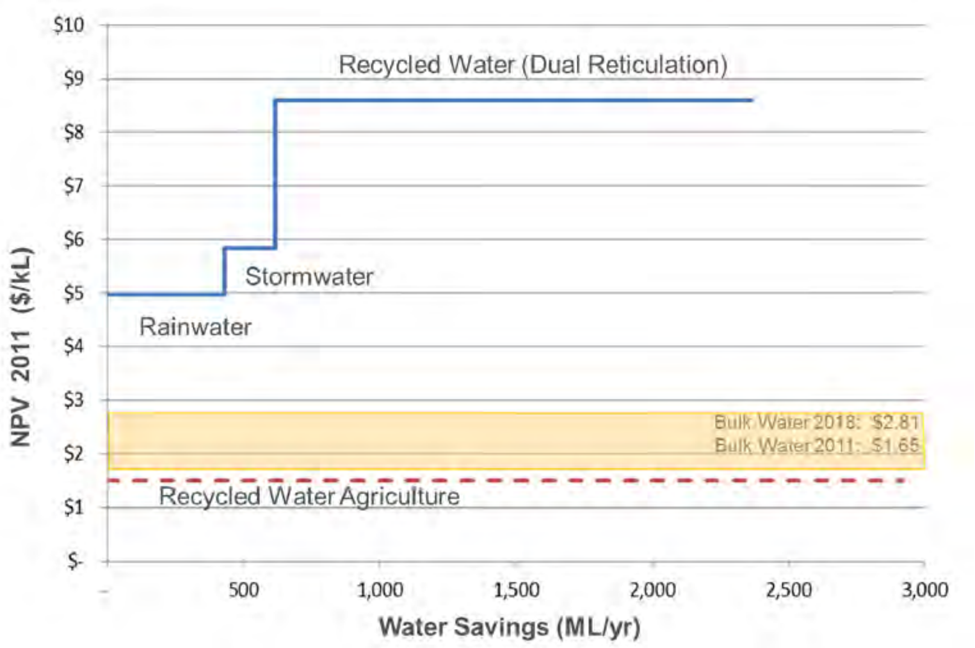



**Figure 7-11 Caboolture River Catchment Alternative Water Supply Cost Curve (Scenario 3)**

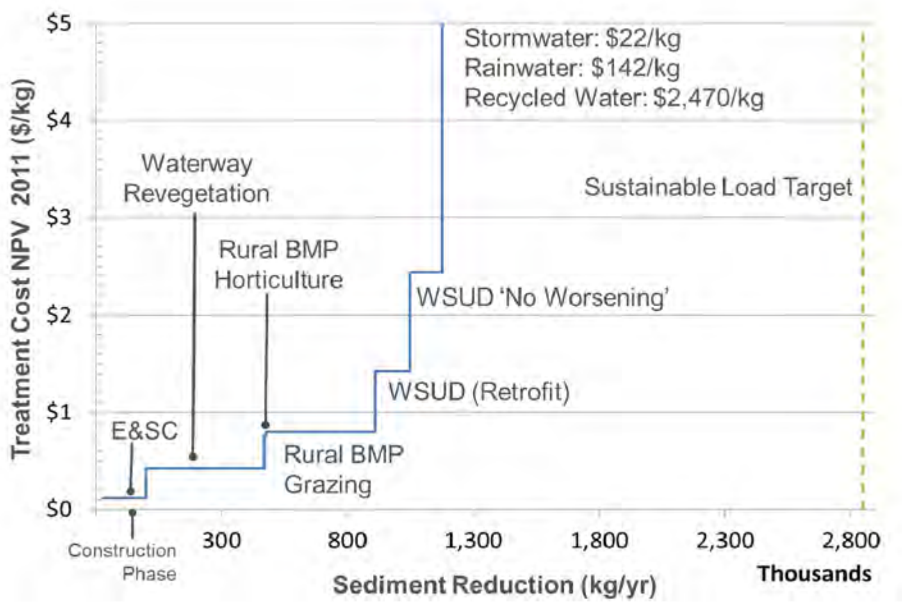



**Figure 7-12 Caboolture River Catchment TSS Treatment Cost Curve (Scenario 3)**

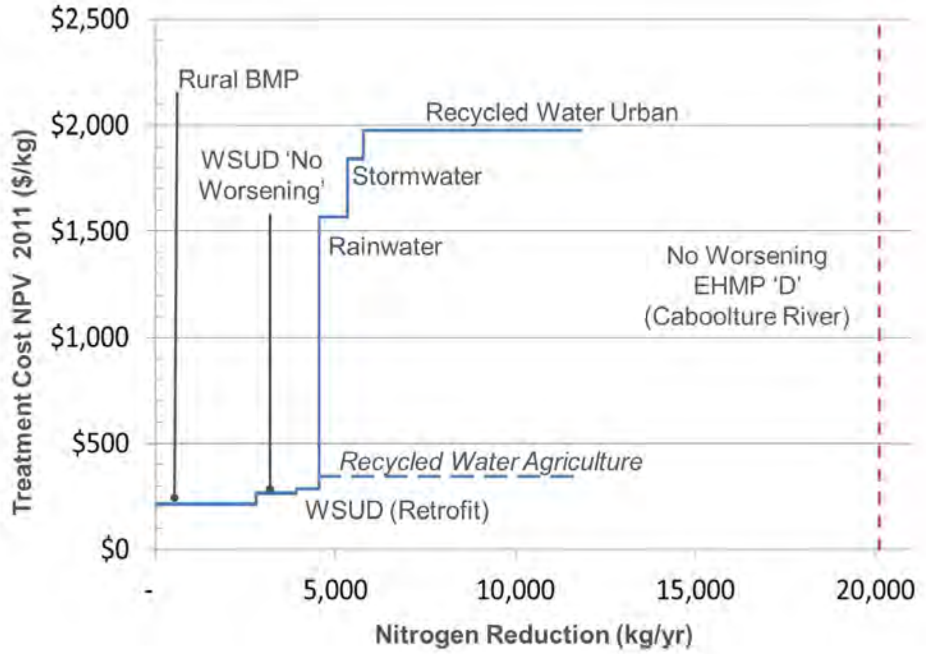



**Figure 7-13 Caboolture River Catchment TN Treatment Cost Curve (Scenario 3)**

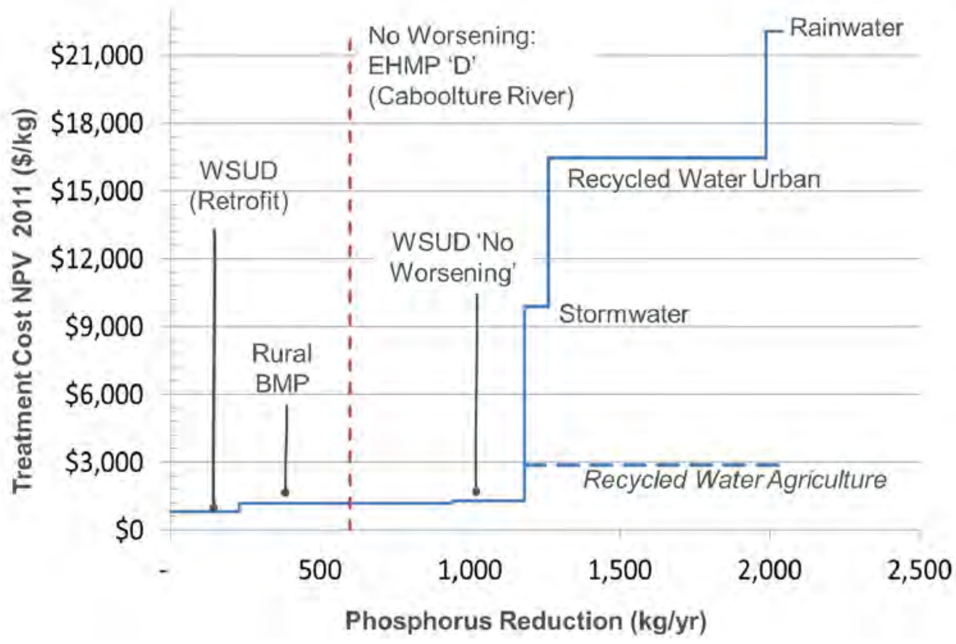



**Figure 7-14 Caboolture River Catchment TP Treatment Cost Curve (Scenario 3)**

### 7.4.2 Scenario 2: Recommended Scenario for TWCM Plan

A summary of the individual solutions contained in Scenario 2, the recommended management scenario for the Caboolture River Catchment and the overall performance of this management scenario is detailed in Table 7-18. Table 7-19 provides a summary of the capital and operational costs of the solutions, while Table 7-20 includes a distribution of these costs per Equivalent Person (EP).

A large component of the cost effectiveness of Scenario 2 is the assumption that the agricultural reuse scheme (Wamuran) will go ahead. This is subject to a detailed feasibility study being undertaken by third party proponents of the proposed scheme, and the likely demand for recycled water. If the scheme is not deemed financially viable by the proponents, it remains a more cost effective solution to implement than dual reticulation, providing demand exists for the water.

The agricultural reuse scheme proposes to provide recycled water from the Caboolture AWTP to a third party proponent who will supply the water to surrounding agricultural users. Moodloo quarry may be used as a storage reservoir, as shown in Figure 5-3. The recycled water proposed for use is currently treated and discharged to the Caboolture River. Although capital and operational costs have been documented for the agricultural reuse scheme, it is likely that the costs will be fully funded by a third party proponent of the scheme, at no cost to Unitywater and ratepayers. It is noted that the water provided by this scheme is not considered to be a potable water saving, however by substituting waterway extractions, the scheme would assist to protect environmental flows.

Implementing the preferred management Scenario over the planning period is estimated to improve waterway health in the Caboolture River estuary from a D+ to a C.

**Table 7-18 Summary of Management Scenario 2 (Recommended) for Caboolture River Catchment**

| Management Scenario 2 –Medium Intensity | | | | | | |
|---|---|---|---|---|---|---|
| **Solution** | **Indicative NPV ($2011)** | **TSS Treatment (kg/yr)** | **TN Treatment (kg/yr)** | **TP Treatment (kg/yr)** | **Potable Water Saving (ML/yr)** | **Land Take (ha)** |
| Future development meets QDC alternative water supply target | $49,470,000 | 17,370 | 1,581 | 112 | 869 | - |
| Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $62,474,000 | 124,522 | 1,013 | 226 | - | 21 |
| Recycled Water Supplied to Agricultural Users (Wamuran Scheme)[1] | $50,248,000[1] | - | - | - | (2,920[3]) | - |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $14,980,000 | 470,332 | - | - | - | 100 |
| Rural BMP for Grazing - Reveg 1st & 2nd order streams | $46,204,000 | 434,195 | - | - | - | 254 |
| Rural BMP for Horticulture - Filter strips | $187,000 | 5,780 | 2,812 | 711 | - | - |
| Increased Implementation/Enforcement of E&SC | $406,000 | 170,628 | - | - | - | - |
| Prevention of illegal stormwater inflow connections to sewer[2] | NA | NA | NA | NA | NA | - |
| Education and capacity building to support implementation of solutions[2] | NA | NA | NA | NA | NA | - |
| Upgrade STP Capacity[2] | NA | NA | NA | NA | NA | - |
| **Total for Management Scenario:** | **$ 223,969,000** | **1,228,666** | **12,705** | **1,924** | **869** | **375** |

[1] This scheme is dependent upon feasibility studies being undertaken by the proposed proponent of the scheme. The documented costs to Unitywater to implement this scheme should be recovered from the project proponent and through the price of water sold to the propponent
[2] Detailed assessment of the cost and performance of this solution has not been undertaken (Not Assessed NA)
[3] Substituted water is not a reticulated potable water saving

**Table 7-19 Summary of Capital and Operating Expenditures for Caboolture River Catchment (Scenario 2)**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | MBRC | Unitywater | Developer | MBRC | Unitywater | Household |
| Future development meets QDC alternative water supply target | - | - | $57,691,332 | $416,988 | - | - |
| Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | - | - | $45,973,610 | - | - | $304,865 |
| Recycled Water Supplied to Agricultural Users (Wamuran Scheme) | - | $35,000,000 | - | - | $1,599,400 | - |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $14,979,946 | - | - | - | - | - |
| Rural BMP for Grazing - Reveg 1st & 2nd order streams[1] | $45,475,367 | - | - | $58,432 | - | - |
| Rural BMP for Horticulture - Filter strips | $47,042 | - | - | $11,259 | - | - |
| Increased Implementation/Enforcement of E&SC | $31,220 | - | - | $45,396 | - | - |
| ***Sub-Total*** | $60,533,575 | $35,000,000 | $103,664,942 | $532,075 | $1,599,400 | $304,865 |
| **Total CAPEX / OPEX** | **$199,198,517** | | | **$2,436,340** | | |

[1] Implementation of this solution and the associated costs are expected to be shared between Council and private landowners. Further investigation of the funding and implementation mechanisms will be undertaken during implementation planning

**Table 7-20 Summary of Capital and Operating Expenditures per EP for Caboolture River Catchment (Scenario 2)**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | CAPEX/EP | Contributing EP | Contributing Description | OPEX/EP | Contributing EP | Contributing Description |
| Future development meets QDC alternative water supply target | $1,034 | 55,804 | Catchment New | $7.47 | 55,804 | Catchment Total |
| Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $1,077 | 42,681 | Serviced only | $7.14 | 42,681 | Serviced only |
| Recycled Water Supplied to Agricultural Users (Wamuran Scheme) | $657 | 53,283 | Catchment New | $28.89 | 55,363 | Catchment new & currently serviced |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $107 | 139,427 | Catchment Total | - | 139,427 | Catchment Total |
| Rural BMP for Grazing - Reveg 1st & 2nd order streams | $326 | 139,427 | Catchment Total | $0.42 | 139,427 | Catchment Total |
| Rural BMP for Horticulture - Filter strips | $0.34 | 139,427 | Catchment Total | $0.08 | 139,427 | Catchment Total |
| Increased Implementation/Enforcement of E&SC | $0.22 | 139,427 | Catchment Total | $0.33 | 139,427 | Catchment Total |
| **Total (Maximum/EP)** | **$3,202** | | | **$44.33** | | |

A summary of the performance of the preferred management scenario with regards to meeting 'no worsening' or sustainable load reduction targets is shown in Table 7-21. The summary indicates that while 'no worsening' targets are easily met for TSS and TP, sustainable load targets are not. Furthermore, although the preferred scenario results in substantial annual TN reduction, it does not meet 'no worsening' or sustainable load targets.

**Table 7-21 Summary of Waterway Health Performance of Management Scenario in Caboolture River Catchment**

| Parameter | Scenario Load Reduction (t/yr) | No Worsening Reduction Target (t/yr) | Meets 'no worsening' Target? | Sustainable Load Reduction Target (t/yr) | Meets Sustainable Load Target? |
|---|---|---|---|---|---|
| TSS | 1,058[1] | -17 | ✓ | 2,845 | × |
| TN | 12.7 | 20.1 | × | 59.8 | × |
| TP | 1.9 | 0.6 | ✓ | 7.2 | × |

[1]This does not include loads from improved E&SC

The levelised cost for supplying alternative sources of potable water from the solutions that make up the preferred management scenario is shown in Figure 7-15. The cost curve plots the solutions in order of least cost, and shows the cumulative annual water savings expected from the preferred management scenario. It is noted that recycled water used for the agricultural re-use scheme does not substitute a potable supply source. The current and forecast bulk water cost (from the SEQ Water Grid) has been included on this figure for comparison.

The levelised cost of treating pollutants for solutions contained in the preferred management scenario have been plotted in Figure 7-16 to Figure 7-18 for TSS, TN and TP respectively. These figures show the cumulative predicted annual treatment performance of the management scenario, in order of least cost to implement the solutions. For comparison, annual load reduction targets for the catchment to achieve a 'no worsening' from existing conditions have been included (where applicable). It is noted that the EHMP report card (2010) result for the Caboolture River estuary is shown to put into context the indicative results that a 'no worsening' scenario may achieve. Sustainable load targets are not shown, as they are far beyond the level of treatment achieved by the management scenario (refer to Table 7-21).

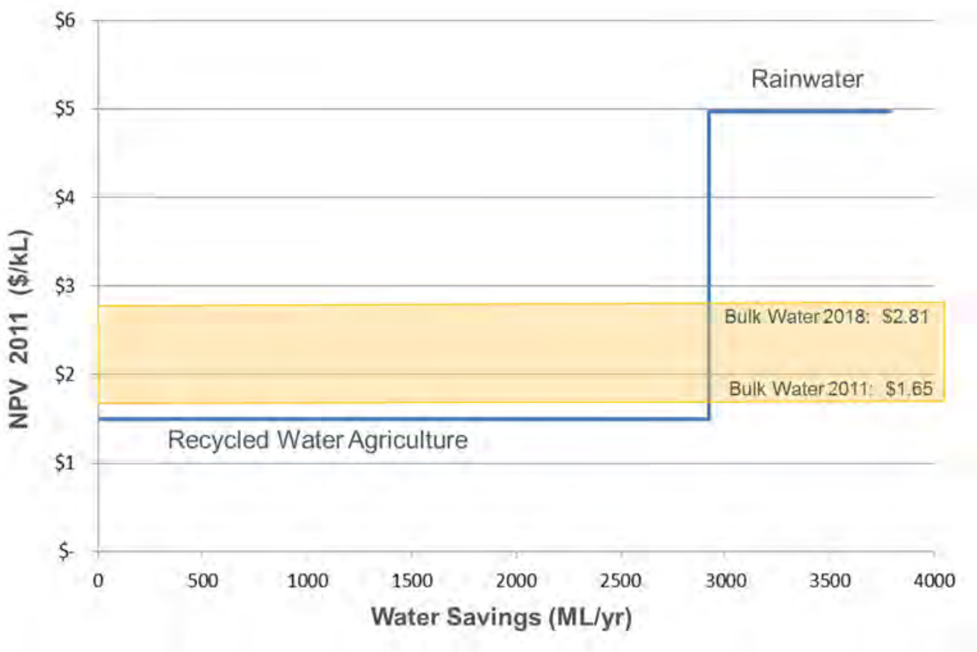



**Figure 7-15 Caboolture River Catchment Alternative Water Supply Cost Curve (Scenario 2)**

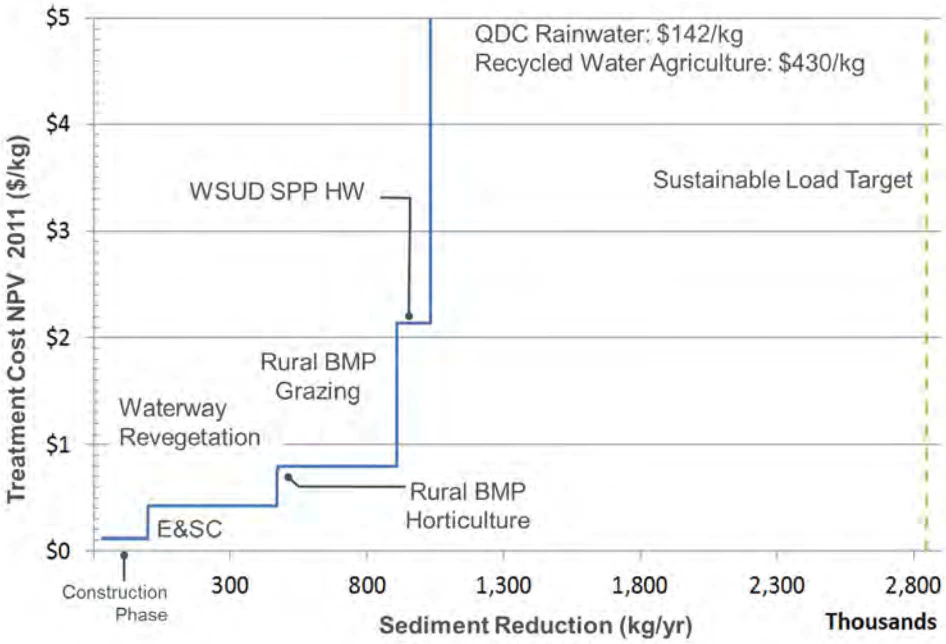



**Figure 7-16 Caboolture River Catchment TSS Treatment Cost Curve (Scenario 2)**

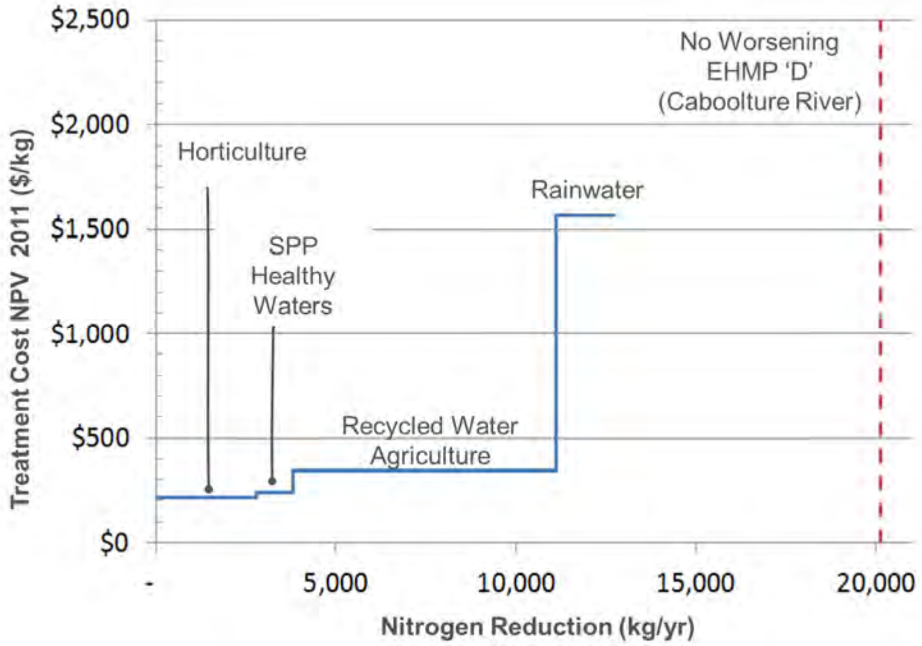



**Figure 7-17 Caboolture River Catchment TN Treatment Cost Curve (Scenario 2)**

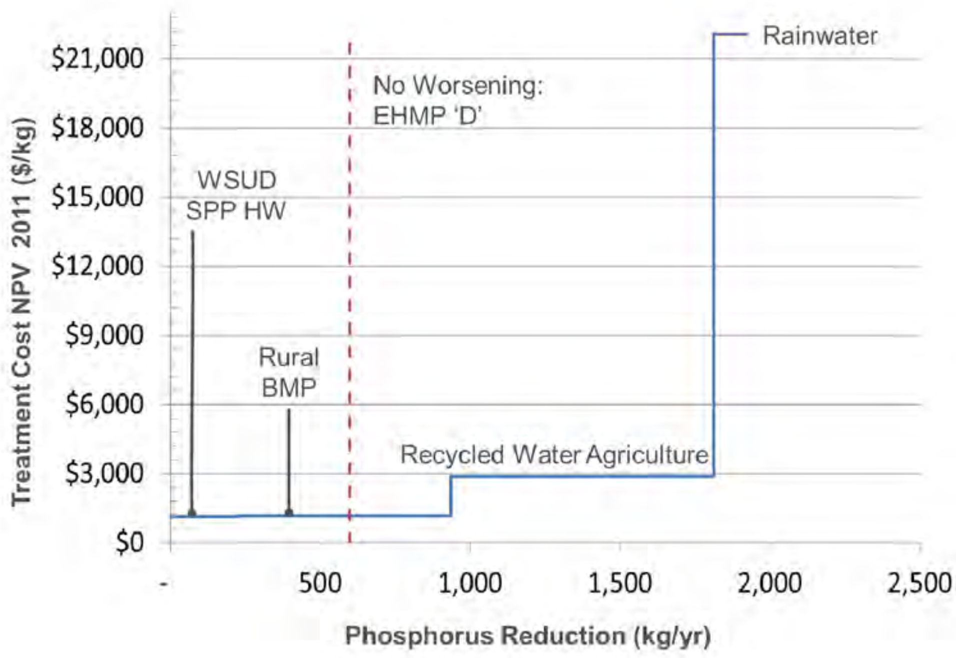



**Figure 7-18 Caboolture River Catchment TP Treatment Cost Curve**

The implementation of the recommended management Scenario over the planning period is estimated to improve waterway health in the Caboolture River estuary from a D to a D+. However, it is noted that Total Nitrogen from the proposed management scenario does not meet 'no worsening' target load reductions. Furthermore, implementing additional solutions proposed in Scenario 3 would still not meet the 'no worsening' targets for TN.

To meet the legislative intent of the EPP Water (2009), at minimum a 'no worsening' in water quality is required. To achieve a 'no worsening' in water quality for TN, it is recommended that the following additional treatment measures be investigated to progressively work towards meeting this target:

- WSUD retrofit at a streetscape scale, particularly as opportunities arise through urban renewal and road upgrade projects, as well as implementation of end of pipe opportunities identified for Scenario 3 (refer to Appendix F)
- Stormwater harvesting in greenfield developments (as identified in Scenario 3).
- Upgrade of effluent nitrogen treatment process at Burpengary and Caboolture South STPs
- Potential cap on population growth.

Furthermore, if the proposed agricultural reuse scheme does not proceed, other opportunities to use recycled water (such as those identified in Scenario 3) should be considered.

## 7.5 CIGA Catchment

**Key Catchment Characteristics:**

- Area: 4,160 ha
- Existing Population: 0
- Future Population: 52,500
- Future Population Growth: 100%
- Future Urban Land Use: 73%
- Potable water to be sourced from NPI and North Pine Dam
- Water supply catchment (Caboolture Weir)
- New STP required, with zero discharge to Caboolture River
- EHMP Score Caboolture River Catchment 2010:

C+ (Fresh) D (Estuarine)

As identified in Table 7-1, Scenario 2 was identified as the preferred scenario for this catchment during the MCA assessment. However, additional detailed costing of the concept design indicated significantly higher costs for the proposed dual reticulation recycled water scheme. Subsequently, the scenario was deemed to be cost prohibitive, and Scenario 1 was selected by key stakeholders as the recommended management scenario. This was identified to be a suitable compromise as Scenario 1 also provides slightly improved nutrient reduction benefits, at significantly less cost.

The performance of both management scenarios are documented in the following sections:

- Scenario 2: Preferred Scenario selected using MCA.
- Scenario 1: Recommended Scenario for adoption following additional financial assessment.

Implementing Scenario 1 (recommended) over the planning period is estimated to assist to maintain waterway health in the Caboolture River (freshwater), with the EHMP grade estimated to lower slightly from a C+ to a C.

### 7.5.1 Scenario 2: Preferred Scenario Using MCA

A summary of the individual solutions contained in Scenario 2, the preferred management scenario for the CIGA Catchment from the MCA, and the overall performance of this management scenario is detailed in Table 7-22. Table 7-23 provides a summary of the capital and operational costs of the solutions, while Table 7-24 includes a distribution of these costs per Equivalent Person (EP).

It should be noted that Scenario 2 is not the recommended scenario for this catchment.

The solution to use recycled water for dual reticulation and POS irrigation includes additional pollutant reduction from land disposal to meet zero discharge environmental constraints in the catchment.

**Table 7-22 Summary of Management Scenario 2 for CIGA Catchment**

| Management Scenario 2 – Medium Intensity | | | | | | |
|---|---|---|---|---|---|---|
| **Solution** | **Indicative NPV ($2011)** | **TSS Treatment (kg/yr)** | **TN Treatment (kg/yr)** | **TP Treatment (kg/yr)** | **Potable Water Saving (ML/yr)** | **Land Take (ha)** |
| Future development meets SPP Healthy Waters target | $153,764,000 | 200,000 | 2,378 | 537 | - | 51.32 |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $3,600,000 | 87,000 | - | - | - | 24 |
| Increased Implementation/Enforcement of E&SC | $500,000 | 312,582 | - | - | - | - |
| Recycled Water for Dual Reticulation & Public Open Space irrigation, with remainder discharged to land | $184,753,000 [2] | 9,066 (3,218)[3] | 11,333 (4,024)[3] | 1,360 (483)[3] | 1,688 | 220 |
| Prevention of illegal stormwater inflow connections to sewer[1] | NA | NA | NA | NA | NA | - |
| Education and capacity building to support implementation of solutions[1] | NA | NA | NA | NA | NA | - |
| New STP[1] | NA | NA | NA | NA | NA | - |
| **Total for Management Scenario:** | **$342,617,000** | **608,648** | **13,711** | **1,897** | **1,688** | **295** |

[1] Detailed assessment of the cost and performance of this solution has not been undertaken (Not Assessed NA)
[2] This includes detailed capital costing by Project Support
[3] This is the proportion of pollutant load assumed removed via disposal to land

**Table 7-23 Summary of Capital and Operating Expenditures for CIGA Catchment (Scenario 2)**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | MBRC | Unitywater | Developer | MBRC | Unitywater | Household |
| Future development meets SPP Healthy Waters target | - | - | $141,992,001 | $1,026,306 | - | - |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $3,600,000 | - | - | - | - | - |
| Increased Implementation/Enforcement of E&SC | $38,414 | - | - | $55,855 | - | - |
| Recycled Water for Dual Reticulation & Public Open Space irrigation, with remainder discharged to land | - | $193,621,000 | - | - | $5,545,473 | - |
| ***Sub-Total*** | $3,638,414 | $193,621,000 | $141,992,001 | $1,082,161 | $5,545,473 | - |
| **Total CAPEX / OPEX** | **$339,251,415** | | | **$6,627,635** | | |

**Table 7-24 Summary of Capital and Operating Expenditures per EP for CIGA Catchment (Scenario 2)**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | CAPEX/EP | Contributing EP | Contributing Description | OPEX/EP | Contributing EP | Contributing Description |
| Future development meets SPP Healthy Waters target | $2,566 | 55,345 | Catchment New | $18.54 | 55,345 | Catchment Total |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $65 | 55,345 | Catchment Total | 0 | 55,345 | Catchment Total |
| Increased Implementation/Enforcement of E&SC | $0.69 | 55,345 | Catchment Total | $1.01 | 55,345 | Catchment Total |
| Recycled Water for Dual Reticulation & Public Open Space irrigation, with remainder discharged to land | $3,498 | 55,345 | Serviced only | $100 | 55,345 | Serviced only |
| **Total (Maximum/EP)** | **$6,130** | | | **$120** | | |

A summary of the performance of the Scenario 2 with regards to meeting 'no worsening' or sustainable load reduction targets is shown in Table 7-25. The summary indicates that 'no worsening' targets are met for TSS only. Sustainable load targets are not met for any parameters.

**Table 7-25 Summary of Waterway Health Performance of Management Scenario 2 in CIGA Catchment**

| Parameter | Scenario Load Reduction (t/yr) | No Worsening Reduction Target (t/yr) | Meets 'no worsening' Target? | Sustainable Load Reduction Target (t/yr) | Meets Sustainable Load Target? |
|---|---|---|---|---|---|
| TSS | 296[1] | 168 | ✓ | 435 | × |
| TN | 13.7 | 18.4 | × | 17.5 | × |
| TP | 1.9 | 2.2 | × | 2.5 | × |

[1]This does not include loads from improved E&SC

It should be noted that existing TN loads (in predominantly grazing and agricultural land) are less than Green Space loads (in forested catchment), resulting in 'no worsening' target reductions being greater than 'sustainable load' target reductions. While this would typically not be expected, this anomaly is the result of the 'typical year' used in the catchment / receiving water quality model framework. 2005/2006 was used as the typical year (out of necessity), which was a relatively dry year compared to the average year, resulting in higher than normal baseflow contributing to loads from the forested catchment. Nevertheless, the results are within the typical modelling standard of error, and are still useful as a guide to decision making.

Figure 7-19 shows the performance of recycled water for supply of dual reticulation and POS (the solution contained in this management scenario), in comparison to the other alternative water supply solutions investigated in other scenarios. Although it should be noted there are competing demands with the supply sources, this illustrates the approximate levelised cost and yield of alternative water supply solutions investigated in each management scenario. It should also be noted, that conceptual design and costing by Project Support was only undertaken for recycled water for dual reticulation and POS irrigation. It shows that recycled water for dual reticulation isan unaffordable option at approximately $35/kL. All alternative water supply solutions are predicted to cost more than the Grid's future predicted bulk water supply cost in 2018 (approximately $2.81/kL).

The levelised cost of treating pollutants for solutions contained in Scenario 2 have been plotted in Figure 7-20 to Figure 7-22 for TSS, TN and TP respectively. These figures show the cumulative predicted annual treatment performance of the management scenario, in order of least cost to implement the solutions. For comparison, annual load reduction targets for the catchment to achieve a ‘no worsening’ from existing conditions have been included (where applicable). It is noted that the EHMP report card (2010) result for freshwater reaches of the Caboolture River is shown to put into context the indicative results that a ‘no worsening’ scenario may achieve. However this score relates to freshwaters within the whole of the Caboolture River catchment (and Burpengary), not just the CIGA. Sustainable load targets are also shown on the below figures.

Figure 7-20 to Figure 7-22. show that TSS is the only parameter to meet ‘no worsening’ targets, and indicates that no parameter meets sustainable load targets. The potential impacts of poor erosion and sediment control during the construction phase have not been accounted for in the catchment modelling or hence the sediment load reduction targets. However it can be seen from Figure 7-20 that the potential benefits from implementing erosion and sediment control are quite significant (due to the large developable area in this catchment) and will largely influence sediment generation in the catchment and the ability to achieve sustainable load targets.

It is noted that original modelling in MUSIC suggested that the treatment performance of compliance with the State Planning Policy for Healthy Waters (SPP HW), would achieve a ‘no worsening’ in pollutant loads. However, modelling in Source Catchments indicates that this was not the case, and thus the management scenario does not meet ‘no worsening’ objectives for TN or TP.

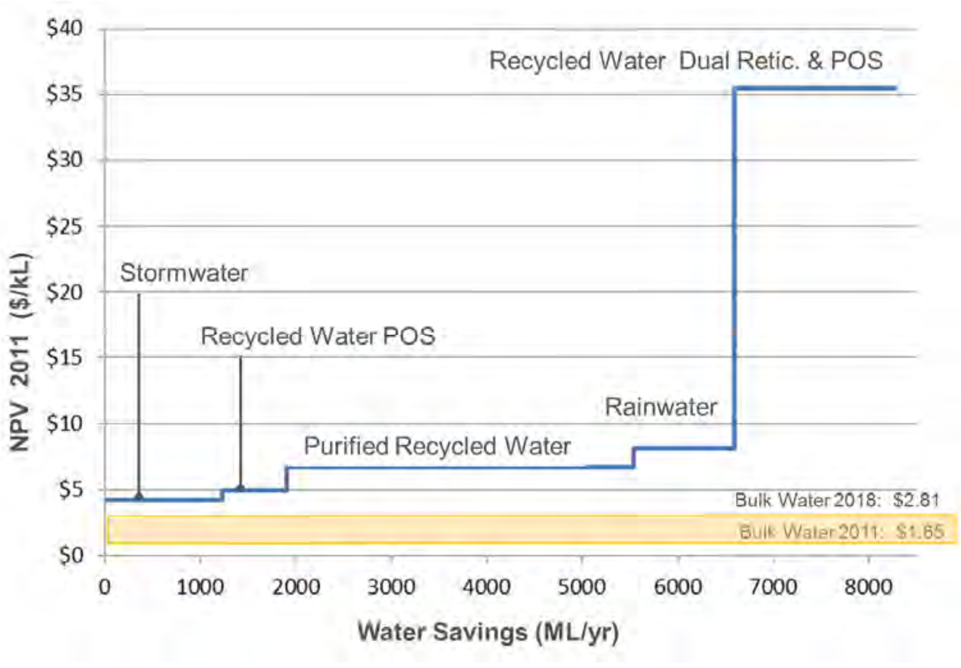



**Figure 7-19 CIGA Catchment Alternative Water Supply Cost Curve (all Scenarios)**

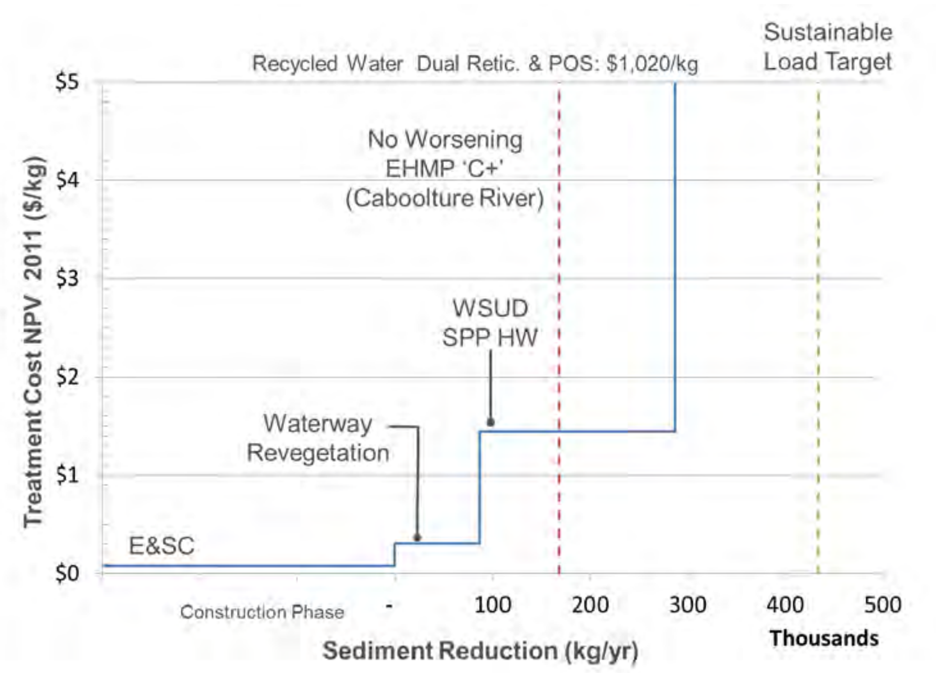



**Figure 7-20 CIGA Catchment TSS Treatment Cost Curve (Scenario 2)**

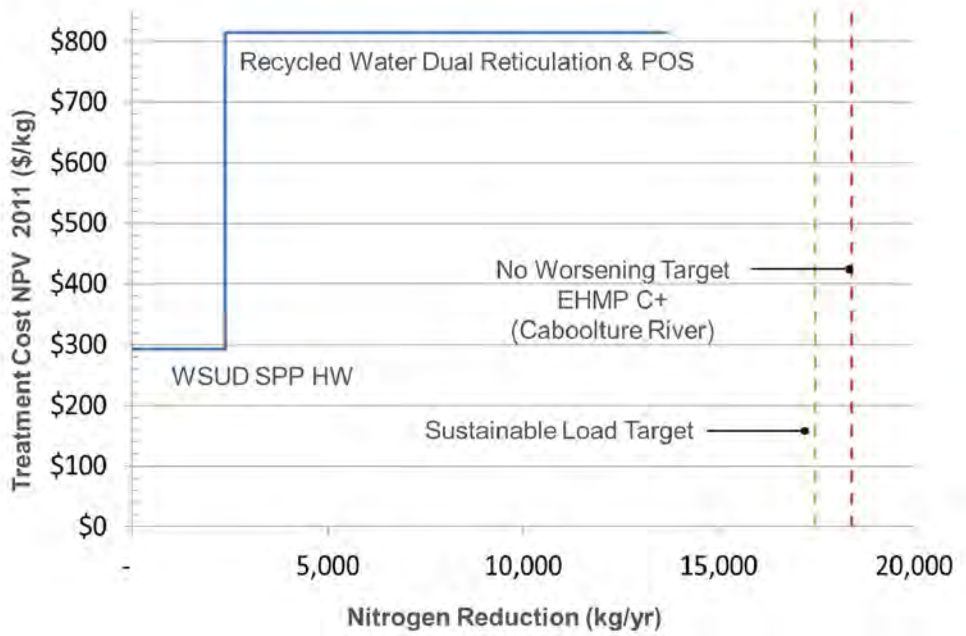



**Figure 7-21 CIGA Catchment TN Treatment Cost Curve (Scenario 2)**

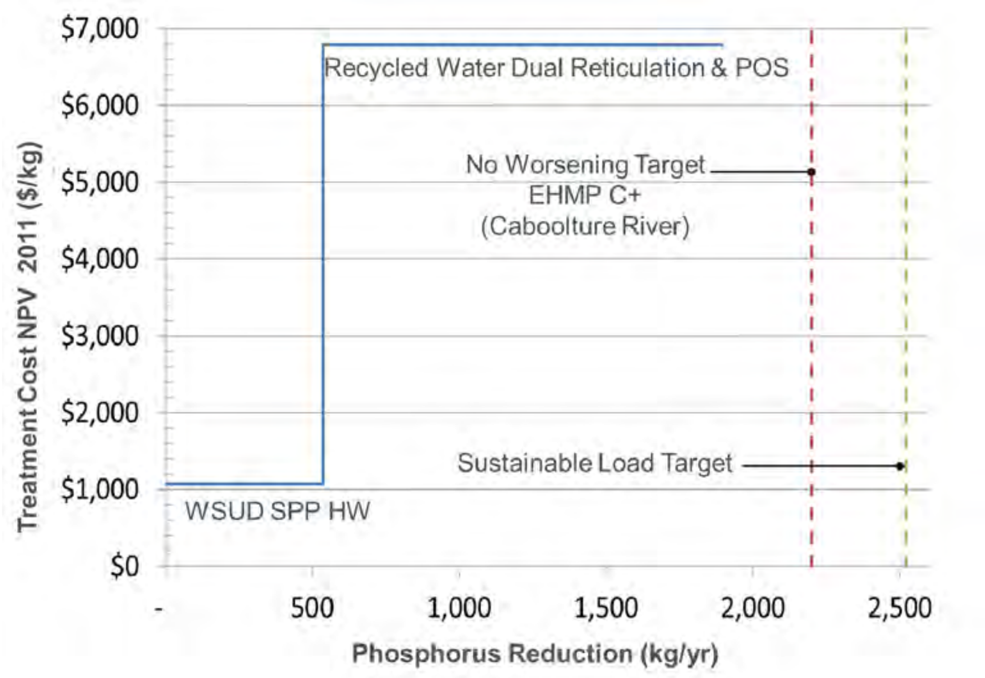



**Figure 7-22 CIGA Catchment TP Treatment Cost Curve (Scenario 2)**

### 7.5.2 Scenario 1: Recommended Scenario for TWCM Plan

A summary of the individual solutions contained in Scenario 1, the recommended management scenario for the Caboolture River Catchment and the overall performance of this management scenario is detailed in Table 7-26. Table 7-27 provides a summary of the capital and operational costs of the solutions, while Table 7-28 includes a distribution of these costs per Equivalent Person (EP).

Scenario 1 includes the use of recycled water for POS irrigation only, and includes additional pollutant reduction from land disposal to meet zero discharge environmental constraints in the catchment.

**Table 7-26 Summary of Recommended Management Scenario for CIGA Catchment**

| Management Scenario 1 – Low Intensity | | | | | | |
|---|---|---|---|---|---|---|
| **Solution** | **Indicative NPV ($2011)** | **TSS Treatment (kg/yr)** | **TN Treatment (kg/yr)** | **TP Treatment (kg/yr)** | **Potable Water Saving (ML/yr)** | **Land Take (ha)** |
| Future development meets SPP Healthy Waters target | $153,764,000 | 200,000 | 2,378 | 537 | - | 51.32 |
| Future development meets QDC alternative water supply target (using rainwater) | $28,342,000 | 21,280 | 1,936 | 137 | 1,064 | - |
| Recycled Water for Public Open Space irrigation, with remainder discharged to land | $28,629,000[2] | 9,066 (5,251)[3] | 11,333 (6,564)[3] | 1,360 (572)[3] | 671 | 360 |
| New STP[1] | NA | NA | NA | NA | NA | NA |
| **Total for Management Scenario:** | $210,735,000 | 230,346 | 15,647 | 2,034 | 1,735 | 411 |

[1] Detailed assessment of the cost and performance of this solution has not been undertaken (Not Assessed NA)
[2]Costed assuming a Class A+ plant. Significant savings could be made by building a Class A plant. To be further analysed in a RW options study for CIGA.
[3] This is the proportion of pollutant load assumed removed via disposal to land

**Table 7-27 Summary of Capital and Operating Expenditures for CIGA Catchment (Scenario 1)**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | MBRC | Unitywater | Developer | MBRC | Unitywater | Household |
| Future development meets SPP Healthy Waters target | - | - | $141,992,001 | $1,026,306 | - | - |
| Future development meets QDC alternative water supply target (using rainwater) | - | - | $56,566,157 | - | - | $375,107 |
| Recycled Water for Public Open Space irrigation, with remainder discharged to land | - | $74,616,910 | - | - | $3,201,768 | - |
| ***Sub-Total*** | - | $74,616,910 | $198,558,158 | $1,026,306 | $3,201,768 | $375,107 |
| **Total CAPEX / OPEX** | **$273,175,068** | | | **$4,603,181** | | |

**Table 7-28 Summary of Capital and Operating Expenditures per EP for CIGA Catchment (Scenario 1)**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | CAPEX/EP | Contributing EP | Contributing Description | OPEX/EP | Contributing EP | Contributing Description |
| Future development meets SPP Healthy Waters target | $2,566 | 55,345 | Catchment New | $19 | 55,345 | Catchment Total |
| Future development meets QDC alternative water supply target (using rainwater) | $1,077 | 52,515 | Serviced only | $7 | 52,515 | Serviced only |
| Recycled Water for Public Open Space irrigation, with remainder discharged to land | $1,348 | 55,345 | Serviced catchment | $58 | 55,345 | Serviced catchment |
| **Total (Maximum/EP)** | **$4,991** | | | **$84** | | |

A summary of the performance of the recommended management scenario with regards to meeting ‘no worsening’ or sustainable load reduction targets is shown in Table 7-29. The summary indicates that ‘no worsening’ targets are met for TSS only. Sustainable load targets are not met for any parameters.

**Table 7-29 Summary of Waterway Health Performance of Management Scenario 1 in CIGA Catchment**

| Parameter | Scenario Load Reduction (t/yr) | No Worsening Reduction Target (t/yr) | Meets ‘no worsening’ Target? | Sustainable Load Reduction Target (t/yr) | Meets Sustainable Load Target? |
|---|---|---|---|---|---|
| TSS | 230[1] | 168 | ✓ | 435 | × |
| TN | 15.6 | 18.4 | × | 17.5 | × |
| TP | 2.0 | 2.2 | × | 2.5 | × |

[1]This does not include loads from improved E&SC

Figure 7-19 shows the performance of recycled water for POS irrigation provides one of the least cost alternative water supply solutions, along with stormwater harvesting. The recycled water scheme was costed assuming Class A+ water, therefore cost savings may be provided by the use of a Class A scheme instead, It is noted that concept design and costing of this scenario has not been undertaken, and further detailed investigations should be undertaken prior to implementing this management scenario.

The levelised cost of treating pollutants for solutions contained in the recommended management scenario have been plotted in Figure 7-23 to Figure 7-25 for TSS, TN and TP respectively. These figures show the cumulative predicted annual treatment performance of the management scenario, in order of least cost to implement the solutions. For comparison, annual load reduction targets for the catchment to achieve a ‘no worsening’ from existing conditions have been included (where applicable). It is noted that the EHMP report card (2010) result for freshwater reaches of the Caboolture River is shown to put into context the indicative results that a ‘no worsening’ scenario may achieve. However this score relates to freshwaters within the whole of the Caboolture River catchment (and Burpengary), not just the CIGA. Sustainable load targets are also shown on the below figures.

Figure 7-23 to Figure 7-25 show that TSS is the only parameter to meet ‘no worsening’ targets, and indicates that no parameter meets sustainable load targets. The potential impacts of poor erosion and sediment control during the construction phase have not been accounted for in the catchment modelling or hence the sediment load reduction targets. However it can be seen from Figure 7-23 that the potential benefits from implementing erosion and sediment control are quite significant (due to the large developable area in this catchment) and will largely influence sediment generation in the catchment and the ability to achieve sustainable load targets.

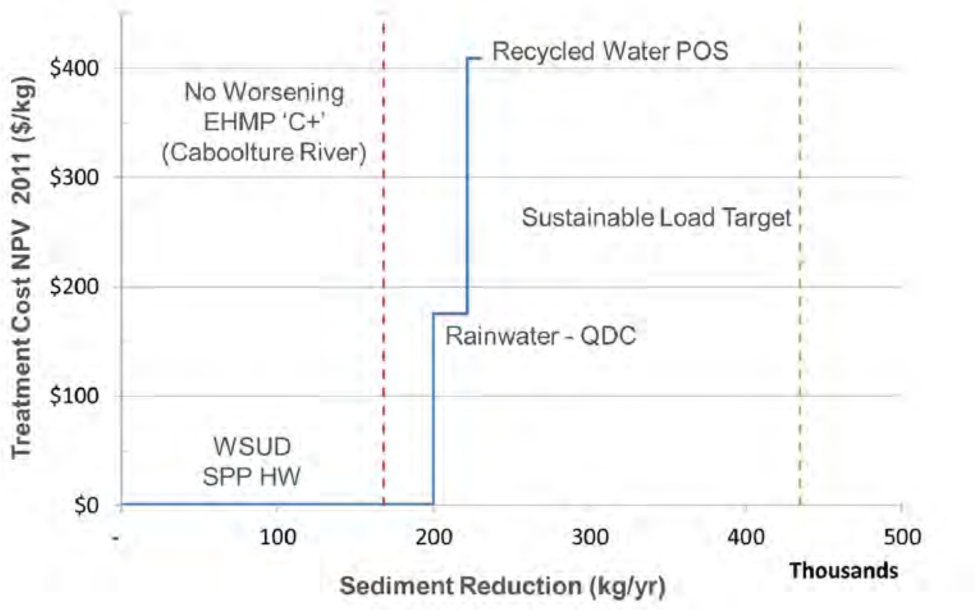



**Figure 7-23 CIGA Catchment TSS Treatment Cost Curve (Scenario 1)**

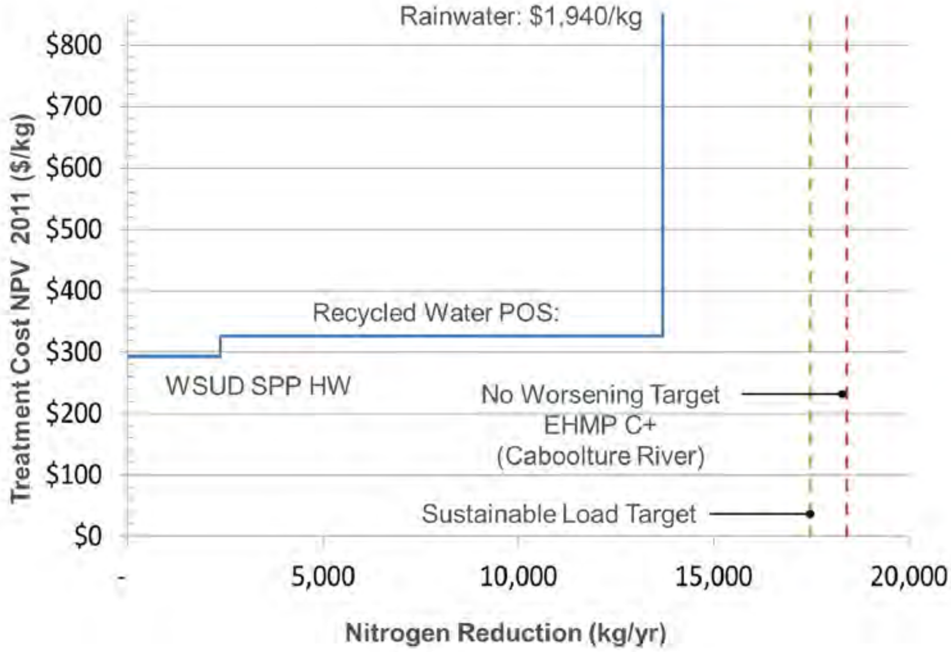



**Figure 7-24 CIGA Catchment TN Treatment Cost Curve (Scenario 1)**

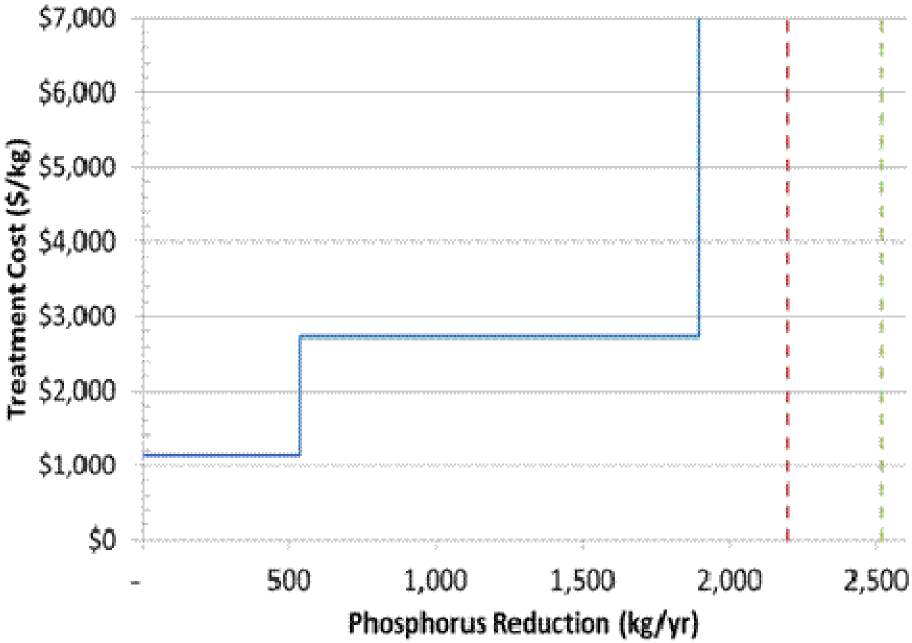



**Figure 7-25 CIGA Catchment TP Treatment Cost Curve (Scenario 1)**

Implementing the preferred management Scenario over the planning period will assist to maintain waterway health in the Caboolture River (freshwater), with the existing (2010) EHMP grade of C+ estimated to be C in 2031. However, it is noted that TN and TP from the proposed management scenario does not meet 'no worsening' target load reductions. Furthermore, implementing additional solutions proposed in Scenario 2 would still not meet the 'no worsening' targets for TN.

To meet the legislative intent of the EPP Water (2009), at minimum a 'no worsening' in water quality is required. To achieve a 'no worsening' in water quality for nutrients, it is recommended that the following additional management measures be investigated to progressively work towards meeting this target:

- Implementation of WSUD to achieve 'no worsening' in catchment pollutant loads
- Potential cap on population growth.

## 7.6 Hays Inlet Catchment

A summary of the individual solutions contained in the preferred management scenario for Hays Inlet Catchment and the overall performance of this management scenario is detailed in Table 7-30. Table 7-33 provides a summary of the capital and operational costs of the solutions, while

Table 7-32 includes a distribution of these costs per Equivalent Person (EP).

**Key Catchment Characteristics:**

- Area: 7,599 ha
- Existing Population: 63,600
- Future Population: 111,600
- Future Population Growth: 76%
- Future Urban Land Use: 56%
- Potable water sourced from North Pine Dam and Lake Kurwongbah
- Wastewater from southern catchment is treated at Murrumba Downs STP
- Wastewater from northern catchment is treated at Burpengary East STP
- Redcliffe STP located in this catchment & discharges wastewater from Redcliffe

The stormwater harvesting solution in the preferred management scenario refers to a dual reticulation scheme only (for toilet and outdoor use). This was based on the premise that recycled water may be used for public open space irrigation only (as part of Lower Pine Scenario 2). As such, stormwater harvesting was nominated as part of the stretched management scenario for large (>20 ha) greenfield development areas that recycled water schemes were not servicing. Stormwater harvesting would also assist in meeting hydrological objectives for the catchment.

It is noted that an alternative to this would be extending the recycled water scheme proposed for the Northern Growth Corridor Scenario 2 (from Murrumba Downs) to service this area for dual reticulation (in addition to POS irrigation). However if the preferred management scenario for Lower Pine Catchment is adopted (Purified Recycled Water), then the urban recycled water scheme may not go ahead. In this case, opportunity exists to extend stormwater harvesting to service POS irrigation in this catchment too. Further detailed assessment will be required prior to implementing this scenario.

Implementing the preferred management scenario over the planning period is estimated to assist protect and improve waterway health in Bramble Bay from an EHMP score of D+ to C-.

**Table 7-30 Summary of Preferred Management Scenario for Hays Inlet Catchment**

| Management Scenario 3 – High Intensity | | | | | | |
|---|---|---|---|---|---|---|
| **Solution** | **Indicative NPV ($2011)** | **TSS Treatment (kg/yr)** | **TN Treatment (kg/yr)** | **TP Treatment (kg/yr)** | **Potable Water Saving (ML/yr)** | **Land Take** |
| Future development meets QDC alternative water supply target | $24,516,000 | 8,608 | 783 | 56 | 430 | - |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $1,797,000 | 129,440 | - | - | - | 12 |
| Increased Implementation/Enforcement of E&SC | $457,000 | 117,174 | - | - | - | - |
| Recycled Water Supplied to Urban Users (Redcliffe STP)[1] | $39,273,000 | 1,333 | 3,334 | 67 | 154 | - |
| Greenfield WSUD achieves 'No Worsening' | $82,822,000 | 341,179 | 2,594 | 567 | | 27.64 |
| Stormwater Harvesting for Non-Potable Use | $15,498,000 | 37,099 | 447 | 83 | 246 | - |
| WSUD Retrofit to Existing Urban Areas | $8,841,000 | 69,679 | 261 | 97 | | 2.93 (B) |
| Prevention of illegal stormwater inflow connections to sewer[2] | NA | NA | NA | NA | NA | - |
| Education and capacity building to support implementation of solutions[2] | NA | NA | NA | NA | NA | - |
| Upgrade STP Design Capacity[2] | NA | NA | NA | NA | NA | - |
| **Total for Management Scenario:** | **$173,204,000** | **704,513** | **7,420** | **870** | **830** | **42.6** |

[1] This includes capital cost estimates by Project Support. An alternative that may be further investigated by Unitywater is the upgrade of treatment processes at Redcliffe STP to improve effluent quality.
[2] Detailed assessment of the cost and performance of this solution has not been undertaken (Not Assessed NA)
(B) – Bioretention surface area

**Table 7-31 Summary of Capital and Operating Expenditures for Hays Catchment**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | MBRC | Unitywater | Developer | MBRC | Unitywater | Household |
| Future development meets QDC alternative water supply target | - | - | $22,783,090 | - | - | $151,082 |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $1,796,987 | - | - | - | - | - |
| Increased Implementation/Enforcement of E&SC | $35,132 | - | - | $51,083 | - | - |
| Recycled Water Supplied to Urban Users (Redcliffe STP) | - | $26,438,000 | - | | $1,119,056 | - |
| Greenfield WSUD achieves 'No Worsening' | - | - | $76,481,262 | $552,800 | - | - |
| Stormwater Harvesting for Non-Potable Use | $11,153,736 | - | - | $421,029 | - | - |
| WSUD Retrofit to Existing Urban Areas | $8,110,224 | - | | $58,620 | - | - |
| ***Sub-Total*** | $21,096,078 | $26,438,000 | $99,264,352 | $1,083,533 | $1,119,056 | $151,082 |
| **Total CAPEX / OPEX** | **$146,798,431** | | | **$2,353,670** | | |

**Table 7-32 Summary of Capital and Operating Expenditures per EP for Hays Catchment**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | CAPEX/EP | Contributing EP | Contributing Description | OPEX/EP | Contributing EP | Contributing Description |
| Future development meets QDC alternative water supply target | $1,077.14 | 21,151 | Serviced only | 21,151 | Serviced only | $7.14 |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $12 | 153,521 | Catchment Total | 153,521 | Catchment Total | - |
| Increased Implementation/Enforcement of E&SC | $0.23 | 153,521 | Catchment Total | 153,521 | Catchment Total | $0.33 |
| Recycled Water Supplied to Urban Users (Redcliffe STP) | $172 | 153,521 | Serviced catchment | 153,521 | Serviced catchment | 7.29 |
| Greenfield WSUD achieves 'No Worsening' | $1,114 | 68,651 | Catchment New | 68,651 | Catchment New | $3.60 |
| Stormwater Harvesting for Non-Potable Use | $743 | 15,009 | Serviced only | 15,009 | Serviced only | $2.74 |
| WSUD Retrofit to Existing Urban Areas | $96 | 84,870 | Catchment Existing | 84,870 | Catchment Existing | $0.38 |
| **Total (Maximum/EP)** | **$2,471** | | | **$19** | | |

A summary of the performance of the preferred management scenario with regards to meeting 'no worsening' or sustainable load reduction targets is shown in Table 7-33. The summary indicates that 'no worsening' targets are met for TSS and TP, however sustainable load targets are not met for any parameter.

**Table 7-33 Summary of Waterway Health Performance of Management Scenario in Hays Inlet Catchment**

| Parameter | Scenario Load Reduction (t/yr) | No Worsening Reduction Target (t/yr) | Meets 'no worsening' Target? | Sustainable Load Reduction Target (t/yr) | Meets Sustainable Load Target? |
|---|---|---|---|---|---|
| TSS | 587[1] | 126 | ✓ | 914 | × |
| TN | 7.4 | 9.6 | × | 45.4 | × |
| TP | 0.9 | 0.8 | ✓ | 3.7 | × |

[1]This does not include loads from improved E&SC

The levelised cost for supplying alternative sources of potable water from the solutions that make up the preferred management scenario is shown in Figure 7-26. The cost curve plots the solutions in order of least cost, and shows the cumulative annual potable water savings expected from the preferred management scenario. The current and forecast bulk water cost (from the SEQ Water Grid) has been included on these figures for comparison.

The levelised cost of treating pollutants for solutions contained in the preferred management scenario have been plotted in Figure 7-27 to Figure 7-29 for TSS, TN and TP respectively. These figures show the cumulative predicted annual treatment performance of the management scenario, in order of least cost to implement the solutions. For comparison, annual load reduction targets for the catchment to achieve a 'no worsening' from existing conditions have been included (where applicable). It is noted that the EHMP report card (2010) result is shown to put into context the indicative results that a 'no worsening' scenario may achieve. Sustainable load targets are not shown, as they are far beyond the level of treatment achieved by the management scenario (refer to Table 7-33). It is noted that TN does not meet the 'no worsening' objectives set, likely due to the increase in loads to Hays Inlet from the Redcliff STP.

To meet the legislative intent of the EPP Water (2009), at minimum a 'no worsening' in water quality is required. To achieve a 'no worsening' in water quality for TN, it is recommended that the following additional treatment measures be investigated:

- Upgrade of effluent nitrogen treatment process at Redcliffe STP;
- Increased implementation of WSUD retrofit at a streetscape scale; and
- Potential cap on population growth.

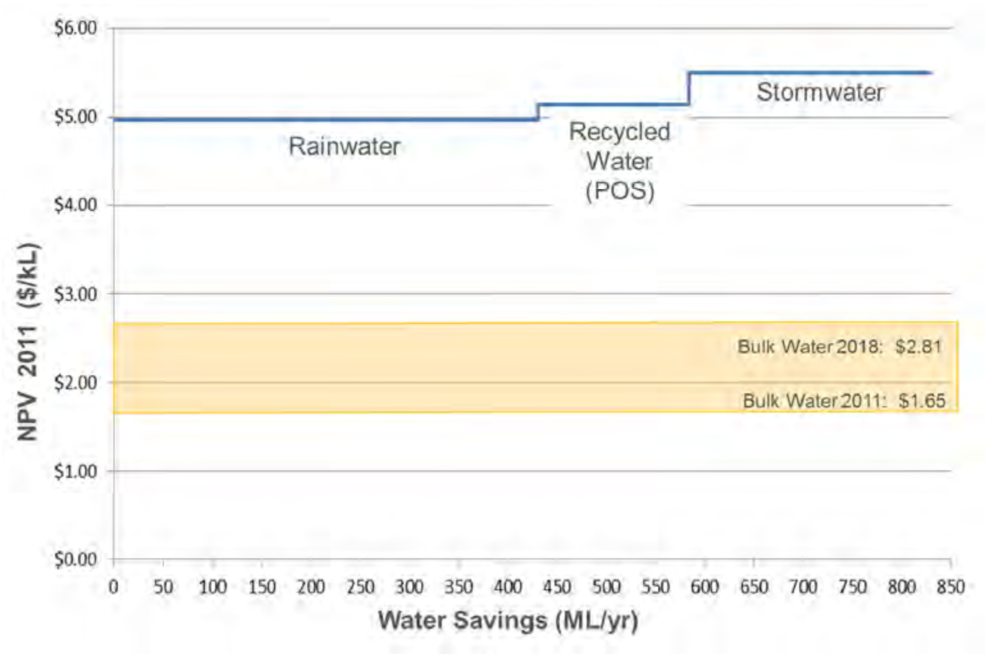



**Figure 7-26 Hays Inlet Catchment Alternative Water Supply Cost Curve**

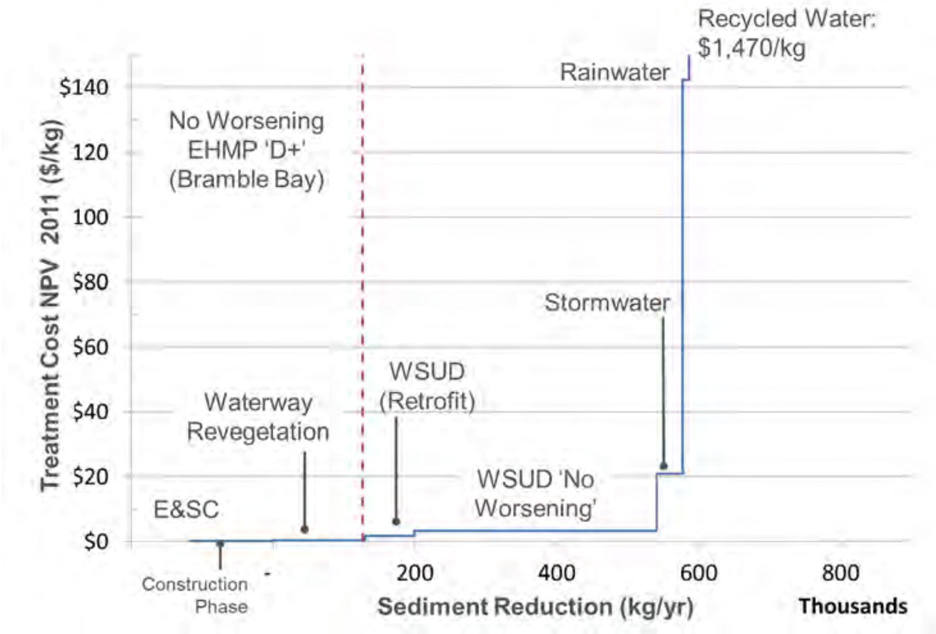



**Figure 7-27 Hays Inlet Catchment TSS Treatment Cost Curve**

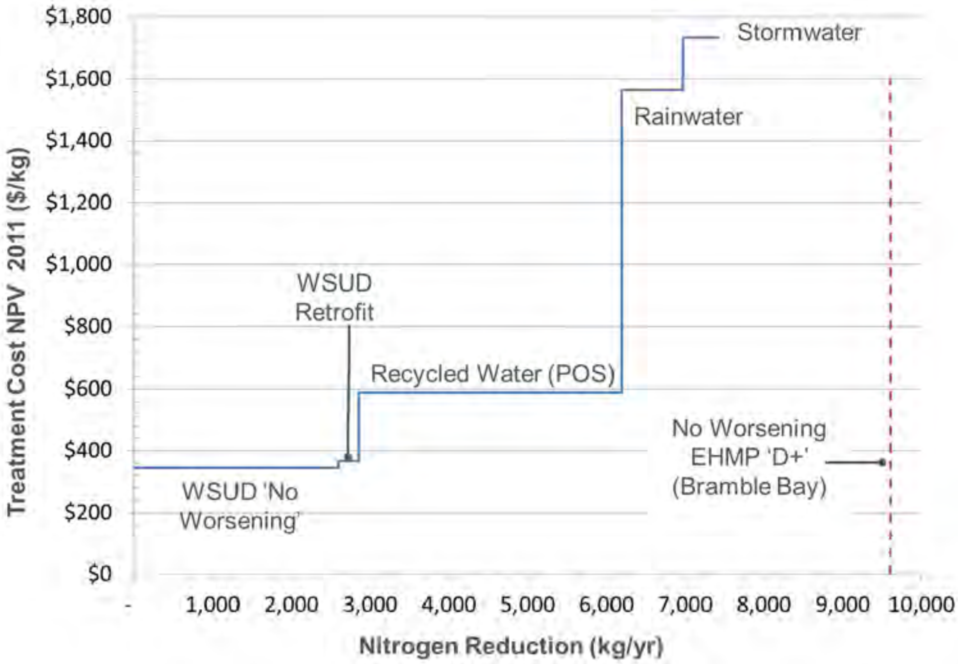



**Figure 7-28 Hays Inlet Catchment TN Treatment Cost Curve**

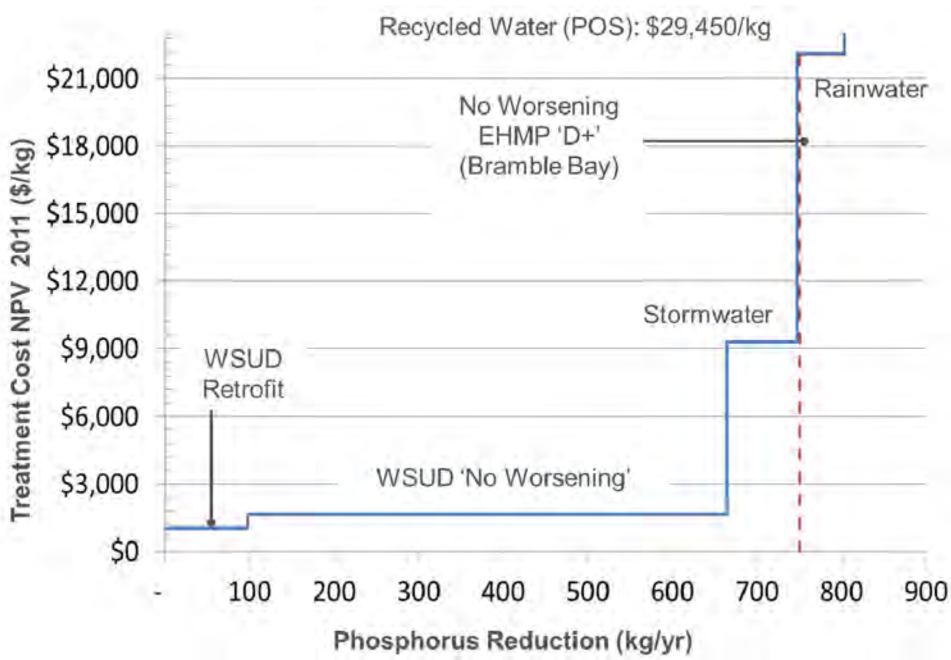



**Figure 7-29 Hays Inlet Catchment TP Treatment Cost Curve**

## 7.7 Lower Pine River Catchment

As identified in Table 7-1, Scenario 3 was identified as the preferred scenario for this catchment during the MCA assessment. However, Scenario 3 was identified to have significant implementation barriers associated with indirect potable reuse of purified recycled water (PRW), including:

- Political / public palatability: the 'yuck' factor associated with indirect potable reuse of purified recycled water needs to be overcome to gain political and public acceptance.
- Current government policy: Currently schemes are not operated unless dam capacity is below 40%
- SEQ Water Strategy: Current preference is for desalinisation as a water supply source over indirect potable reuse of PRW.

Scenario 3 also requires significant capital investment. As such, Scenario 2 was considered the next best alternative if the barriers to Scenario 3 prohibit implementation. However additional management measures will be required for Scenario 2 to meet water quality targets.

**Key Catchment Characteristics:**

- Area: 28,280 ha
- Existing Population: 90,700
- Future Population: 133,000
- Future Population Growth: 47%
- Future Urban Land Use: 21%
- Potable water sourced from North Pine Dam and Lake Kurwongbah
- Wastewater treated at Murrumba Downs and Brendale STPs, discharge to Pine River & South Pine River
- EHMP Score 2010: C- (Fresh) C- (Estuarine)

The performance of both management scenarios are documented in the following sections:

- Scenario 3: Preferred Scenario selected using MCA.
- Scenario 2: Recommended alternative scenario for adoption if Scenario 3 is not feasible (due to implementation barriers)

### 7.7.1 Scenario 3: Preferred Scenario Using MCA

A summary of the individual solutions contained in the preferred management scenario for Lower Pine River Catchment and the overall performance of this management scenario is detailed in Table 7-34. Table 7-35 provides a summary of the capital and operational costs of the solutions, while Table 7-36 includes a distribution of these costs per Equivalent Person (EP).

Implementing the preferred management scenario (Scenario 3) is predicted to protect and improve waterway health in the Lower Pine River estuary from an EHMP grade of C- to C+ over the planning period.

**Table 7-34 Summary of Preferred Management Scenario for Lower Pine River Catchment**

| **Management Scenario 3 – High Intensity** | | | | | | |
|---|---|---|---|---|---|---|
| **Solution** | **Indicative NPV ($2011)** | **TSS Treatment (kg/yr)** | **TN Treatment (kg/yr)** | **TP Treatment (kg/yr)** | **Potable Water Saving (ML/yr)** | **Land Take (ha)** |
| Future development meets QDC alternative water supply target | $18,258,000 | 6,411 | 583 | 41 | 321 | - |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $9,817,000 | 120,148 | - | - | - | 65 |
| Increased Implementation/Enforcement of E&SC | $402,000 | 64,782 | - | - | - | - |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams) | $1,519,000 | 158,438 | - | - | - | 8 |
| Rural BMP for Horticulture - Filter strips | $1,297,000 | 70,747 | 805 | 112 | - | - |
| Greenfield WSUD achieves 'No Worsening' | $27,683,000 | 36,006 | 331 | 68 | - | 9.24 |
| WSUD Retrofit to Existing Urban Areas | $38,332,000 | 73,388 | 345 | 119 | - | 7.20 (B) 14.38 (W) |
| Stormwater Harvesting for Non-Potable Use | $15,413,000 | 38,776 | 467 | 87 | 197 | - |
| Indirect Potable Reuse of Purified Recycled Water (PRW)[1] | $471,359,000 | 32,479 | 26,898 | 7,712 | 15,197 | - |
| Prevention of illegal stormwater inflow connections to sewer[2] | NA | NA | NA | NA | NA | - |
| Education and capacity building to support implementation of solutions[2] | NA | NA | NA | NA | NA | - |
| Upgrade WTP Infrastructure[3] | NA | NA | NA | NA | NA | - |
| Upgrade STP Design Capacity (Murrumba & Brendale)[2] | NA | NA | NA | NA | NA | - |
| **Total for Management Scenario:** | **$584,080,000** | **601,176** | **29,429** | **8,140** | **15,714** | **104** |

[1] Assumes that Murrumba Downs licence requirements for POS irrigation (Northern Growth Corridor) are satisfied using PRW. Includes capital costing by Project Support.
[2] Detailed assessment of the cost and performance of this solution has not been undertaken (Not Assessed NA)
[3] Capacity issues identified from Clear Mountain to Samford
(B) – Bioretention surface area (W) Wetland macrophyte zone area

**Table 7-35 Summary of Capital and Operating Expenditures for Lower Pine River Catchment (Scenario 3)**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | MBRC | Unitywater | Developer | MBRC | Unitywater | Household |
| Future development meets QDC alternative water supply target | - | - | $16,967,542 | - | - | $112,517 |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $9,816,923 | - | - | - | - | - |
| Increased Implementation/Enforcement of E&SC | $30,926 | - | - | $44,968 | - | - |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams)[1] | $1,495,317 | - | - | $1,921 | - | - |
| Rural BMP for Horticulture - Filter strips[1] | $325,392 | - | - | $77,877 | - | - |
| Greenfield WSUD achieves 'No Worsening' | - | - | $25,563,668 | $184,772 | - | - |
| WSUD Retrofit to Existing Urban Areas | $32,948,726 | - | - | $431,682 | - | - |
| Stormwater Harvesting for Non-Potable Use | $11,231,724 | - | - | $402,663 | - | - |
| Indirect Potable Reuse of Purified Recycled Water (PRW) | - | $277,603,783 | - | - | $22,795,200 | |
| ***Sub-Total*** | $55,849,008 | $277,603,783 | $42,531,210 | $1,143,884 | $22,795,200 | $112,517 |
| **Total CAPEX / OPEX** | **$375,984,001** | | | **$24,051,601** | | |

[1] Implementation of this solution and the associated costs are expected to be shared between Council and private landowners. Further investigation of the funding and implementation mechanisms will be undertaken during implementation planning.

**Table 7-36 Summary of Capital and Operating Expenditures per EP for Lower Pine River Catchment (Scenario 3)**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | CAPEX/EP | Contributing EP | Contributing Description | OPEX/EP | Contributing EP | Contributing Description |
| Future development meets QDC alternative water supply target | $1,077 | 15,752 | Serviced only | $7.14 | 15,752 | Serviced only |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $59 | 165,599 | Catchment Total | | 165,599 | Catchment Total |
| Increased Implementation/Enforcement of E&SC | $0.19 | 165,599 | Catchment Total | $0.27 | 165,599 | Catchment Total |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams) | $9 | 165,599 | Catchment Total | $0.01 | 165,599 | Catchment Total |
| Rural BMP for Horticulture - Filter strips | $1.96 | 165,599 | Catchment Total | $0.47 | 165,599 | Catchment Total |
| Greenfield WSUD achieves 'No Worsening' | $440 | 58,059 | Catchment New | $1.12 | 165,599 | Catchment Total |
| WSUD Retrofit to Existing Urban Areas | $306 | 107,539 | Catchment Existing | $2.61 | 165,599 | Catchment Total |
| Stormwater Harvesting for Non-Potable Use | $872 | 12,886 | Serviced only | $2.43 | 165,599 | Catchment Total |
| Indirect Potable Reuse of Purified Recycled Water (PRW) | $361 | 769,274 | Serviced All MBRC | $30 | 769,274 | Serviced All MBRC |
| **Total (Maximum/EP)** | **$2,255** | | | **$41** | | |

A summary of the performance of the preferred management scenario with regards to meeting 'no worsening' or sustainable load reduction targets is shown in Table 7-37.

The summary indicates that 'no worsening' targets are met for all parameters (TSS, TN and TP), however sustainable load targets are not met for any parameter.

Table 7-34 shows that indirect potable reuse of Purified Recycled Water contributes to a significant proportion of the pollutant load reduction required to meet the 'no worsening' targets in Table 7-15. The pollutant reduction from this solution alone meets 'no worsening' target load reductions for TN and TP. The most cost effective option for reducing TSS is rural BMPs for horticulture. This solution, together with implementing PRW (and increased enforcement of E&SC measures during the construction phase) would ensure that no-worsening targets are met in the Lower Pine catchment. However it is noted that a no-worsening in this catchment is equivalent to an EHMP report card grade of C-, and therefore additional solutions may be warrant to improve waterway health.

**Table 7-37 Summary of Waterway Health Performance of Management Scenario in Lower Pine River Catchment**

| Parameter | Scenario Load Reduction (t/yr) | No Worsening Reduction Target (t/yr) | Meets 'no worsening' Target? | Sustainable Load Reduction Target (t/yr) | Meets Sustainable Load Target? |
|---|---|---|---|---|---|
| TSS | 536[1] | 65 | ✓ | 1,408 | × |
| TN | 29.4 | 22.3 | ✓ | 71.2 | × |
| TP | 8.1 | 4.9 | ✓ | 12.9 | × |

[1]This does not include loads from improved E&SC

The levelised cost for supplying alternative sources of potable water from the solutions that make up the preferred management scenario is shown in Figure 7-30. The cost curve plots the solutions in order of least cost, and shows the cumulative annual potable water savings expected from the preferred management scenario. The current and forecast bulk water cost (from the SEQ Water Grid) has been included on these figures for comparison.

The levelised cost of treating pollutants for solutions contained in the preferred management scenario have been plotted in Figure 7-31 to Figure 7-33 for TSS, TN and TP respectively. These figures show the cumulative predicted annual treatment performance of the management scenario, in order of least cost to implement the solutions. For comparison, annual load reduction targets for the catchment to achieve a 'no worsening' from existing conditions have been included (where applicable). It is noted that the EHMP report card (2010) result for the Pine River Estuary is shown to put into context the indicative results that a 'no worsening' scenario may achieve. Sustainable load targets are not shown, as they are far beyond the level of treatment achieved by the management scenario (refer to Table 7-37).

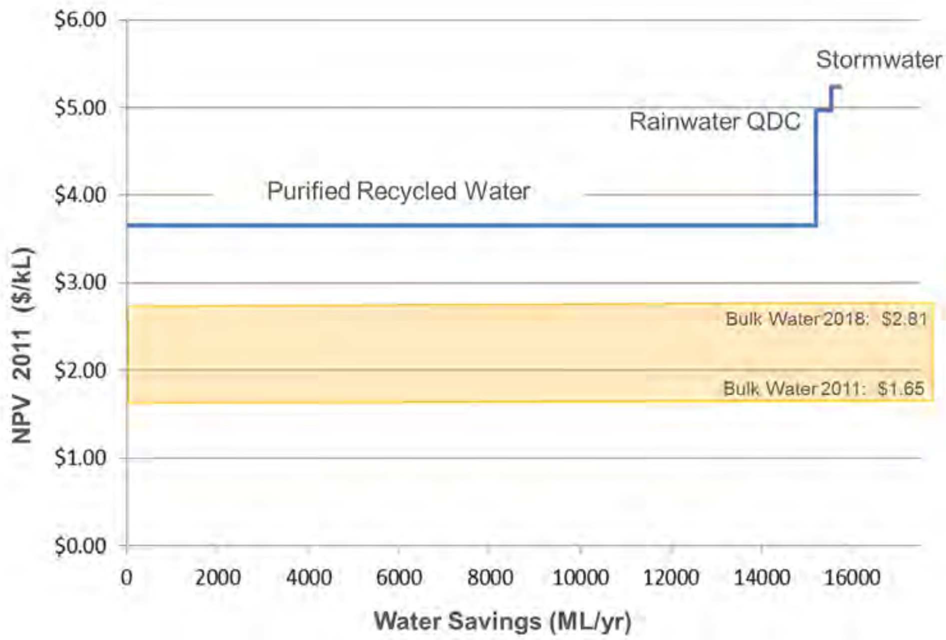



**Figure 7-30 Lower Pine River Catchment Alternative Water Supply Cost Curve (Scenario 3)**

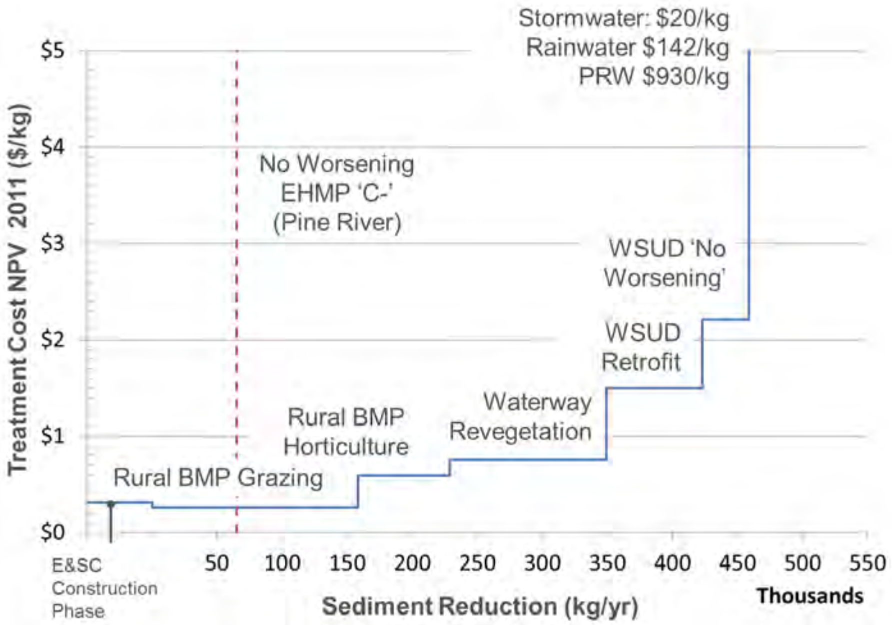



**Figure 7-31 Lower Pine River Catchment TSS Treatment Cost Curve (Scenario 3)**

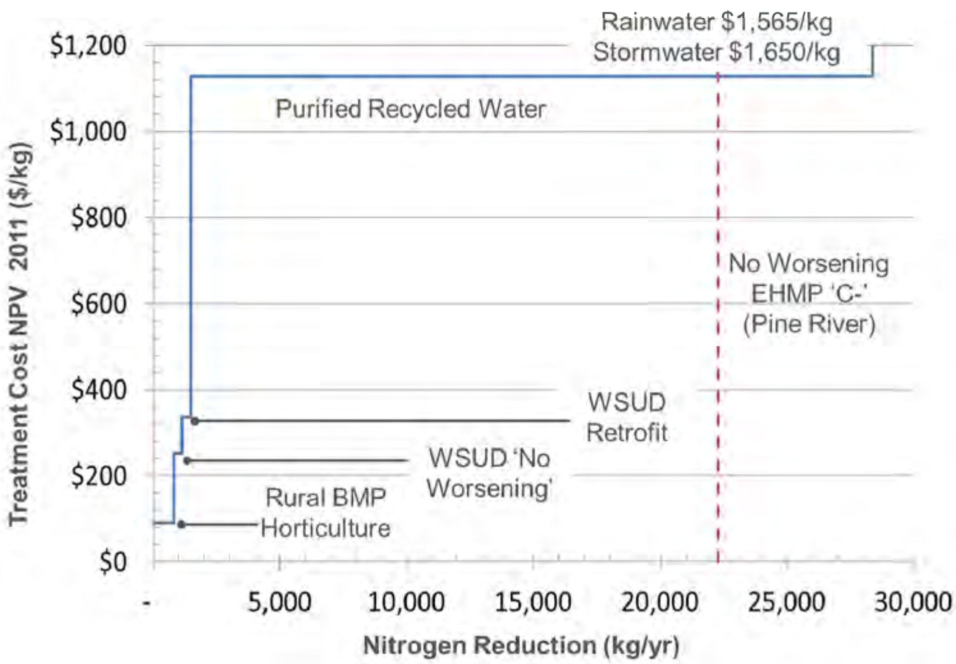



**Figure 7-32 Lower Pine River Catchment TN Treatment Cost Curve (Scenario 3)**

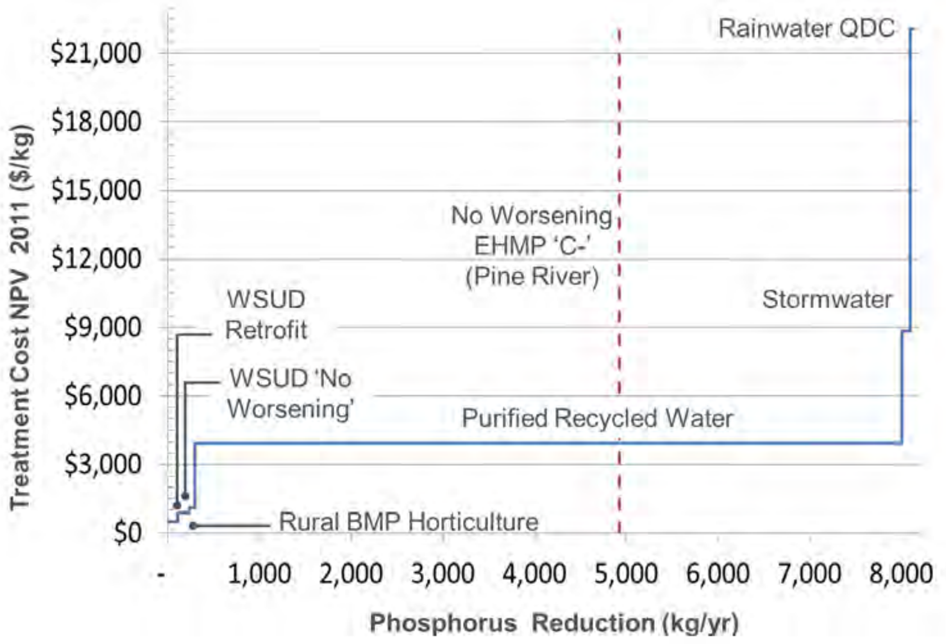



**Figure 7-33 Lower Pine River Catchment TP Treatment Cost Curve (Scenario 3)**

As the preferred solution outlined above includes a Purified Recycled Water scheme for indirect potable reuse, the following barriers to implementation have been identified:

- public and political acceptance of a Purified Recycled Water Scheme; and
- current restrictions to PRW schemes to operate only when dam capacity is less than 40%

It is recommended that community consultation and a targeted campaign to market and educate the community about Purified Recycled Water will be required to ensure successful implementation of this solution. Guidance could be gained from Singapore's experience and its campaign to drink PRW (branded 'Newater'), including a visitor centre aimed at increasing public education and acceptance. The Newater scheme in Singapore has been operational since late 2002, and has been successful in shaping community attitudes towards its acceptance through an innovative communication and education campaign, and a proactive media strategy. A survey in 2007 indicated eight in ten people are proud of Singapore's water management and see it as a role model for other countries. The key to the campaigns success was building trust and social acceptability (Chee Hean 2008). Singapore's Public Utilities Board was responsible for developing the successful communication campaign that promoted water conservation and water recycling, and was awarded the Grand Prize for Corporate communications at the Golden World Awards (2008) from the International Public Relations Association.

Investigation and review of the current operating policy that restricts use of PRW schemes to when dam capacity is <40% is also recommended.

### 7.7.2 Scenario 2: Recommended Alternative for TWCM Plan

In the event that the preferred solution is not acceptable, a second preference has been identified. The second preference, from results of the MCA, is Scenario 2. The key performance differences between the preferred solutions (Scenario 3) and Scenario 2 are outlined in Table 7-38.

Should Scenario 2 be adopted as the preferred management scenario, waterway health in the Pine River estuary is anticipated to decline from an EHMP grade of C- to D+ over the planning period. This is a worsening to current waterway health, whereas if Scenario 3 is implemented, waterway health is estimated to improve to a C+.

**Table 7-38 Summary of Performance Differences between Lower Pine Scenario 3 and Scenario 2**

| Performance Indicator | Scenario 3 (Preferred) | Scenario 2 (Second Preference) | Performance Implications of Adopting Scenario 2 |
|---|---|---|---|
| Net Present Value ($2011) | $584,080,000 | $134,616,000 | -$449,464,000 |
| TSS Load Generation (t/yr) | 995 | 1,133 | + 139 (14%) |
| TN Load Generation (t/yr) | 50.4 | 71.9 | + 21.5 (43%) |
| TP Load Generation (t/yr) | 5.2 | 12.1 | + 6.9 (132%) |
| Potable Water Saving (ML/yr) | 15,714 | 1,393 | - 14,321 (91%) |

A summary of the performance of the second preference management scenario with regards to meeting 'no worsening' or sustainable load reduction targets is shown in Table 7-39. The summary indicates that 'no worsening' targets are met for TSS only, and sustainable load targets are not met for any parameter.

**Table 7-39 Summary of Waterway Health Performance of Recommended Alternative Management Scenario in Lower Pine River Catchment**

| Parameter | Scenario Load Reduction (t/yr) | No Worsening Reduction Target (t/yr) | Meets 'no worsening' Target? | Sustainable Load Reduction Target (t/yr) | Meets Sustainable Load Target? |
|---|---|---|---|---|---|
| TSS | 398[1] | 65 | ✓ | 1,408 | × |
| TN | 7.9 | 22.3 | × | 71.2 | × |
| TP | 1.3 | 4.9 | × | 12.9 | × |

[1]This does not include loads from improved E&SC

A summary of the individual solutions contained in the second preference, Scenario 2, for the Lower Pine Catchment and the overall performance of this management scenario is further detailed in Table 7-40. Table 7-41 provides a summary of the capital and operational costs of the solutions, while Table 7-42 includes a distribution of these costs per Equivalent Person (EP).

**Table 7-40 Summary of Alternative Management Scenario for Lower Pine River Catchment**

| Alternative Management Scenario 2 – Medium Intensity | | | | | | |
|---|---|---|---|---|---|---|
| **Solution** | **Indicative NPV ($2011)** | **TSS Treatment (kg/yr)** | **TN Treatment (kg/yr)** | **TP Treatment (kg/yr)** | **Potable Water Saving (ML/yr)** | **Land Take (ha)** |
| Future development meets SPP Healthy Waters target | $27,683,000 | 36,006 | 331 | 68 | - | 9 |
| Future development meets QDC alternative water supply target | $23,209,000 | 8,149 | 742 | 53 | 407 | - |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $9,817,000 | 120,148 | - | - | - | 65 |
| Increased Implementation/Enforcement of E&SC | $402,000 | 64,782 | - | - | - | - |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams) | $1,519,000 | 158,438 | - | - | - | 8 |
| Rural BMP for Horticulture - Filter strips | $1,297,000 | 70,747 | 805 | 112 | - | - |
| Recycled Water to Urban Users | $70,689,000 | 4,161 | 6,059 | 1,040 | 986 | - |
| Prevention of illegal stormwater inflow connections to sewer[1] | NA | NA | NA | NA | NA | - |
| Education and capacity building to support implementation of solutions[1] | NA | NA | NA | NA | NA | - |
| Upgrade WTP Infrastructure[2] | NA | NA | NA | NA | NA | - |
| Upgrade STP Design Capacity (Murrumba & Brendale)[1] | NA | NA | NA | NA | NA | - |
| **Total for Management Scenario:** | **$134,616,000** | **462,431** | **7,936** | **1,273** | **1,393** | **82** |

[1] Detailed assessment of the cost and performance of this solution has not been undertaken (Not Assessed NA)
[2] Capacity issues identified from Clear Mountain to Samford

**Table 7-41 Summary of Capital and Operating Expenditures for Lower Pine River Catchment (Scenario 2)**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | MBRC | Unitywater | Developer | MBRC | Unitywater | Household |
| Future development meets SPP Healthy Waters target | - | - | $25,563,668 | $184,772 | | - |
| Future development meets QDC alternative water supply target | - | - | $21,568,838 | - | - | $143,029 |
| Waterway Riparian Revegetation ($3^{rd}$ & $4^{th}$ order streams) | $9,816,923 | - | - | - | - | |
| Increased Implementation/Enforcement of E&SC | $30,926 | - | - | $44,968 | - | - |
| Rural BMP for Grazing (Revegetation $1^{st}$ & $2^{nd}$ order streams)[1] | $1,495,317 | - | - | $1,921 | - | - |
| Rural BMP for Horticulture - Filter strips[1] | $325,392 | - | - | $77,877 | - | - |
| Recycled Water – Northern Growth Corridor | - | $24,795,500 | - | - | $2,879,281 | - |
| Recycled Water - Brendale | - | $4,526,875 | - | - | $727,249 | - |
| ***Sub-Total*** | $11,668,558 | $29,322,375 | $47,132,506 | $309,539 | $3,606,530 | $143,029 |
| **Total CAPEX / OPEX** | **$88,123,439** | | | **$4,059,098** | | |

[1] Implementation of this solution and the associated costs are expected to be shared between Council and private landowners. Further investigation of the funding and implementation mechanisms will be undertaken during implementation planning.

**Table 7-42 Summary of Capital and Operating Expenditures per EP for Lower Pine River Catchment (Scenario 2)**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | CAPEX/EP | Contributing EP | Contributing Description | OPEX/EP | Contributing EP | Contributing Description |
| Future development meets SPP Healthy Waters target | $440 | 58,059 | Catchment New | $1.12 | 165,599 | Catchment Total |
| Future development meets QDC alternative water supply target | $1,077 | 20,024 | Serviced only | $7.14 | 20,024 | Serviced only |
| Waterway Riparian Revegetation (3rd & 4th order streams) | $59 | 165,599 | Catchment Total | - | 165,599 | Catchment Total |
| Increased Implementation/Enforcement of E&SC | $0.19 | 165,599 | Catchment Total | $0.27 | 165,599 | Catchment Total |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams) | $9 | 165,599 | Catchment Total | $0.01 | 165,599 | Catchment Total |
| Rural BMP for Horticulture - Filter strips | $1.96 | 165,599 | Catchment Total | $0.47 | 165,599 | Catchment Total |
| Recycled Water – Northern Growth Corridor | $381 | 65,000 | Serviced only | $44 | 65,000 | Serviced only |
| Recycled Water - Brendale | $27.34 | 165,599 | Serviced catchment | $4.39 | 165,599 | Serviced catchment |
| **Total (Maximum/EP)** | **1,997** | | | **58** | | |

The levelised cost for supplying alternative sources of potable water from the solutions that make up the preferred management scenario is shown in Figure 7-34. The cost curve plots the solutions in order of least cost, and shows the cumulative annual potable water savings expected from the preferred management scenario. The current and forecast bulk water cost (from the SEQ Water Grid) has been included on these figures for comparison.

The levelised cost of treating pollutants for solutions contained in the preferred management scenario have been plotted in

Figure 7-35 to Figure 7-37 for TSS, TN and TP respectively. These figures show the cumulative predicted annual treatment performance of the management scenario, in order of least cost to implement the solutions. For comparison, annual load reduction targets for the catchment to achieve a 'no worsening' from existing conditions have been included (where applicable). It is noted that the EHMP report card (2010) result for the Pine River Estuary is shown to put into context the indicative results that a 'no worsening' scenario may achieve. Sustainable load targets are not shown, as they are far beyond the level of treatment achieved by the management scenario (refer to Table 7-39). It is noted that the alternative scenario is predicted to result in a D+, which is a decline in the current EHMP report card rating for the Pine River Estuary. The preferred scenario (including PRW) is likely to result in an improvement in waterway health, and an EHMP score around C+.

If the preferred scenario is not adopted, it is evident that the second preference will need additional solutions investigated to achieve 'no worsening' in pollutant loads for TN and TP. The following solutions in Scenario 3 that target nutrient reduction may be added:

- WSUD retrofit to existing urban areas (end of pipe bioretention basins and wetlands); and
- Stormwater harvesting for non-potable reuse.

However it is noted that the above solutions investigated will still not result in a 'no-worsening' in nutrient pollutant loads. Therefore additional solutions will need to be investigated to achieve 'no worsening', including:

- Greater implementation of WSUD in existing areas (i.e. streetscape);
- Improved effluent treatment performance processes at Brendale and Murrumba STP; and
- Cap on population growth.

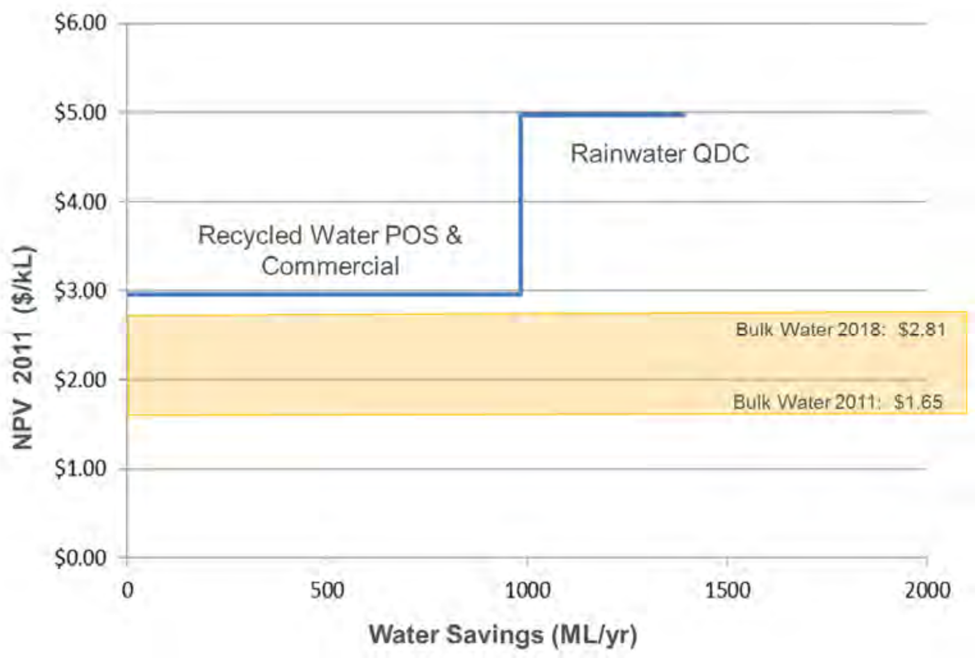



**Figure 7-34 Lower Pine River Catchment Alternative Water Supply Cost Curve (Scenario 2)**

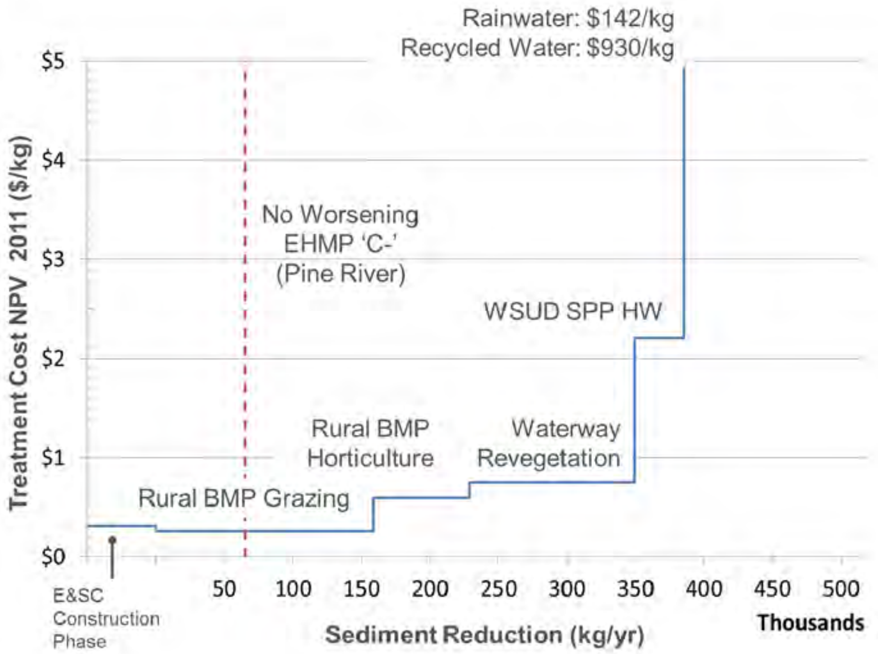



**Figure 7-35 Lower Pine River Catchment TSS Treatment Cost Curve (Scenario 2)**

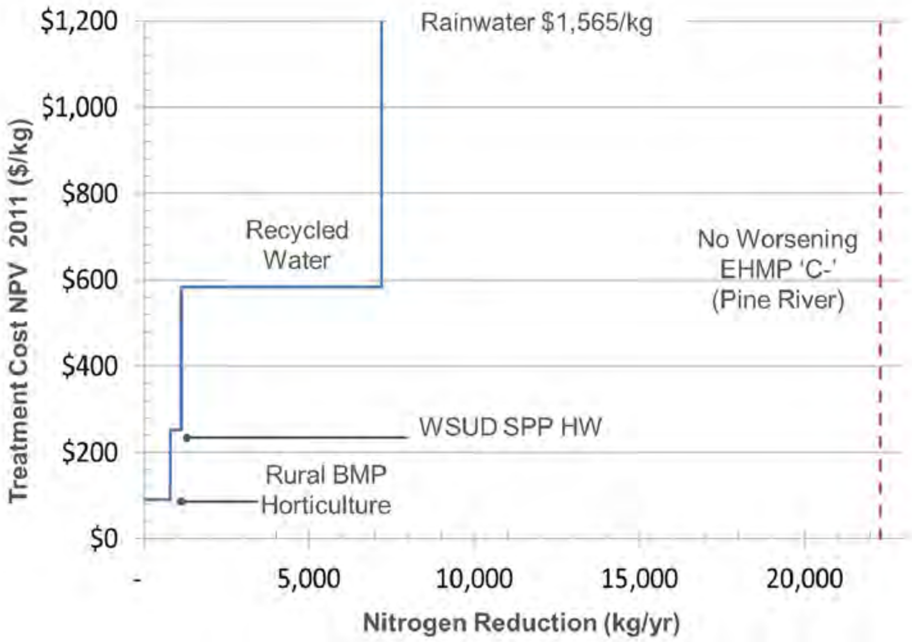



**Figure 7-36 Lower Pine River Catchment TN Treatment Cost Curve (Scenario 2)**

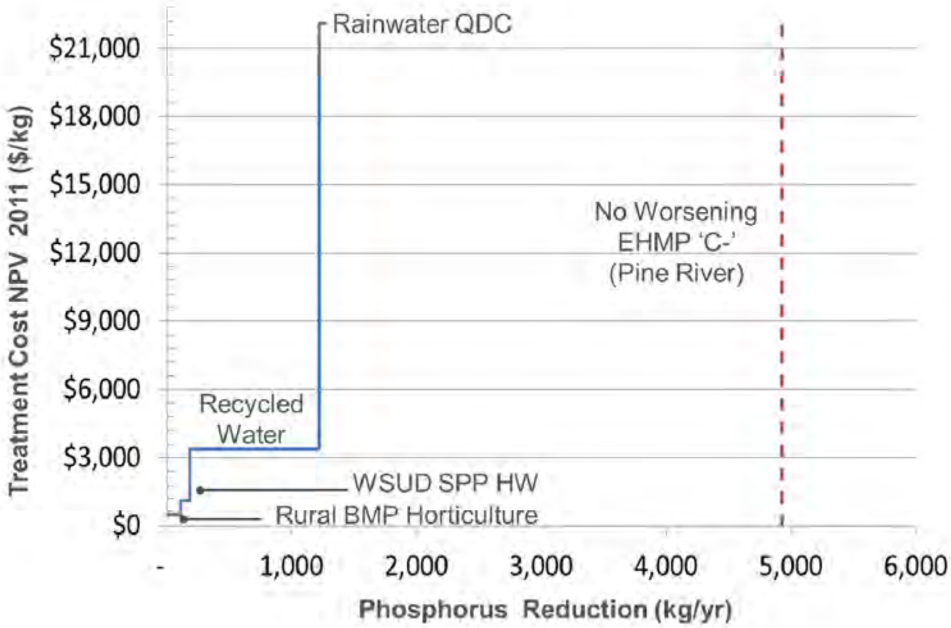



**Figure 7-37 Lower Pine River Catchment TP Treatment Cost Curve (Scenario 2)**

## 7.8 Pumicestone Catchment

A summary of the individual solutions contained in the preferred management scenario for Pumicestone Catchment and the overall performance of this management scenario is detailed in Table 7-43. Table 7-44 provides a summary of the capital and operational costs of the solutions, while Table 7-45 includes a distribution of these costs per Equivalent Person (EP).

Although Scenario 3 actually scored marginally better than Scenario 2 (refer to Figure 6-12), the additional costs associated with Scenario 3 were not considered worthwhile for the adoption of this scenario, considering the minor difference in score and results of water quality modelling which indicate that water quality objectives are currently being met in receiving waters of the lower Pumicestone Passage (at adjacent monitoring site), and will be in the future (due to well mixed waters). Therefore Scenario 2 was adopted as the preferred management scenario.

Implementing Scenario 2 is predicted to contribute to improving waterway health in Pumicestone Passage estuary from a D+ to a C- over the planning period

**Key Catchment Characteristics:**

- Area: 18,480 ha
- Existing Population: 11,400
- Future Population: 12,200
- Future Population Growth: 7%
- Future Urban Land Use: 9%
- Potable water sourced from Caboolture Catchment
- Wastewater from central catchment treated at Caboolture STP
- Wastewater from eastern catchment treated at Bribie Island STP
- EHMP Score 2010: D+ (Pumicestone Estuary)

**Table 7-43 Summary of Preferred Management Scenario for Pumicestone Catchment**

| Management Scenario 2 – Medium Intensity | | | | | | |
|---|---|---|---|---|---|---|
| **Solution** | **Indicative NPV ($2011)** | **TSS Treatment (kg/yr)** | **TN Treatment (kg/yr)** | **TP Treatment (kg/yr)** | **Potable Water Saving (ML/yr)** | **Land Take (ha)** |
| Future Development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $33,118,000 | 65,054 | 527 | 114 | - | 11.05 |
| Future development meets QDC alternative water supply target | $890,000 | 313 | 28 | 2 | 16 | - |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams) | $15,141,000 | 320,676 | - | - | - | 83 |
| Rural BMP for Horticulture - Filter strips | $521,000 | 16,803 | 585 | 120 | - | - |
| Waterway riparian revegetation on 3rd & 4th order streams | $4,806,000 | 126,212 | - | - | - | 32 |
| Increased Implementation/Enforcement of E&SC | $7,300 | 76,464 | - | - | - | - |
| Education and capacity building to support implementation of solutions[1] | NA | NA | NA | NA | NA | - |
| **Total for Management Scenario:** | **$ 54,483,300** | **605,523** | **1,140** | **235** | **16** | **126** |

[1] Detailed assessment of the cost and performance of this solution has not been undertaken (Not Assessed NA)

**Table 7-44 Summary of Capital and Operating Expenditures for Pumicestone Catchment**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | MBRC | Unitywater | Developer | MBRC | Unitywater | Household |
| Future Development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | - | - | $30,582,820 | $221,050 | - | - |
| Future development meets QDC alternative water supply target | - | - | $827,170 | | - | $5,485 |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams)[1] | $14,901,953 | - | - | $19,148 | - | |
| Rural BMP for Horticulture - Filter strips[1] | $130,799 | - | - | $31,305 | - | - |
| Waterway riparian revegetation on 3rd & 4th order streams | $4,806,233 | - | - | | - | - |
| Increased Implementation/Enforcement of E&SC | $562 | - | - | $817 | - | - |
| ***Sub-Total*** | $19,839,547 | - | $31,409,990 | $272,319 | - | $5,485 |
| **Total CAPEX / OPEX** | **$51,249,538** | | | **$277,804** | | |

[1] Implementation of this solution and the associated costs are expected to be shared between Council and private landowners.

Further investigation of the funding and implementation mechanisms will be undertaken during implementation planning.

**Table 7-45 Summary of Capital and Operating Expenditures per EP for Pumicestone Catchment**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | CAPEX/EP | Contributing EP | Contributing Description | OPEX/EP | Contributing EP | Contributing Description |
| Future Development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $28,369 | 1,078 | Catchment New | $16.98 | $28,369 | Catchment Total |
| Future development meets QDC alternative water supply target | $1,077.14 | 768 | Serviced only | $7.14 | 768 | Serviced only |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams) | $1,145 | 13,019 | Catchment Total | $1.47 | 13,019 | Catchment Total |
| Rural BMP for Horticulture - Filter strips | $10.05 | 13,019 | Catchment Total | $2.40 | 13,019 | Catchment Total |
| Waterway riparian revegetation on 3rd & 4th order streams | $369 | 13,019 | Catchment Total | 0 | 13,019 | Catchment Total |
| Increased Implementation/Enforcement of E&SC | $0.04 | 13,019 | Catchment Total | $0.06 | 13,019 | Catchment Total |
| **Total (Maximum/EP)** | $2,601[1] | | | **$28** | | |

[1]Does not include WSUD to meet SPP HW, as it is unusually high - thought to be due to large areas of industrial land use

A summary of the performance of the preferred management scenario with regards to meeting 'no worsening' or sustainable load reduction targets is shown in Table 7-46. The summary indicates that sustainable load targets are met for all parameters (with water quality modelling indicating WQOs are met now and in the future with no additional management, due to well mixed receiving waters). However 'no worsening' targets are met for TSS and TP only. From Table 7-43 it can be seen that rural BMP for grazing has a high NPV ($15 million). As this solution targets sediment only, it could be removed from the preferred management scenario and sediment reduction would still meet 'no worsening' targets (achieving 208 t/yr TSS reduction), while significantly reducing the cost of the preferred scenario.

**Table 7-46 Summary of Waterway Health Performance of Management Scenario in Pumicestone Catchment**

| Parameter | Scenario Load Reduction (t/yr) | No Worsening Reduction Target (t/yr) | Meets 'no worsening' Target? | Sustainable Load Reduction Target (t/yr) | Meets Sustainable Load Target? |
|---|---|---|---|---|---|
| TSS | 529[1] | - 19 | ✓ | 0 | ✓ |
| TN | 1.1 | 1.2 | × | 0 | ✓ |
| TP | 0.2 | 0.1 | ✓ | 0 | ✓ |

[1]This does not include loads from improved E&SC

The levelised cost of treating pollutants for solutions contained in the preferred management scenario have been plotted in Figure 7-38 to Figure 7-40 for TSS, TN and TP respectively. These figures show the cumulative predicted annual treatment performance of the management scenario, in order of least cost to implement the solutions. For comparison, annual load reduction targets for the catchment to achieve a 'no worsening' from existing conditions have been included (where applicable). It is noted that the EHMP report card (2010) result for Pumicestone Passage is shown to put into context the indicative results that a 'no worsening' scenario may achieve. It should be noted that the results of the 2010 report card (C-) are based on a much larger (external) catchment that was not the focus of this study. The modelling that was undertaken showing WQOs and hence sustainable load targets were met reflects the local area interest only (lower Pumicestone Passage).

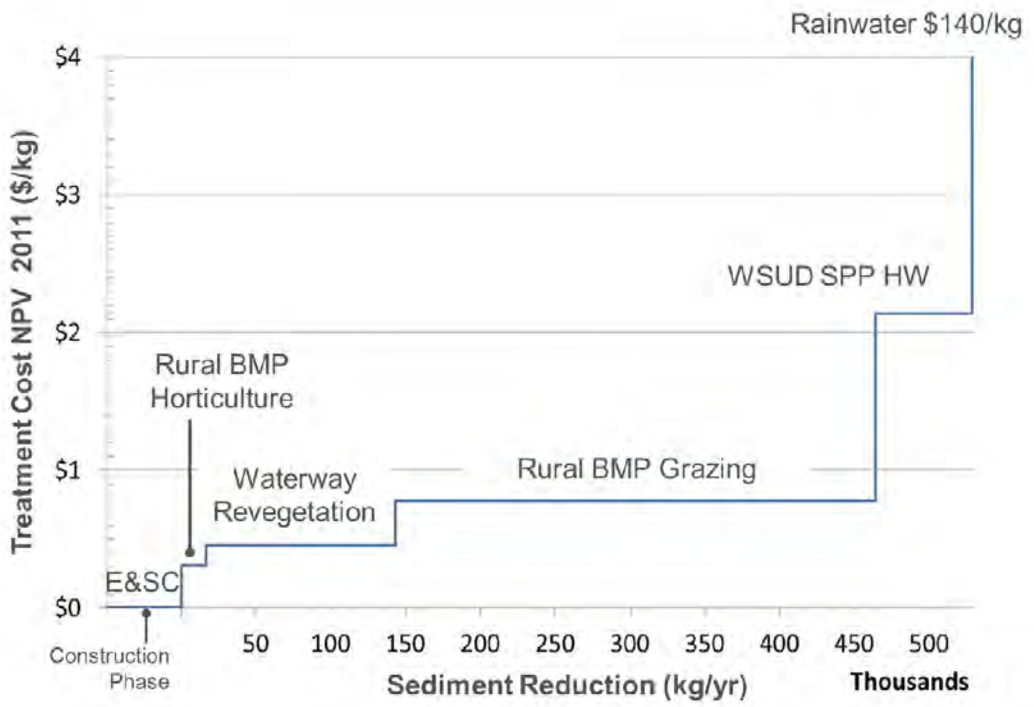



**Figure 7-38 Pumicestone Catchment TSS Treatment Cost Curve**

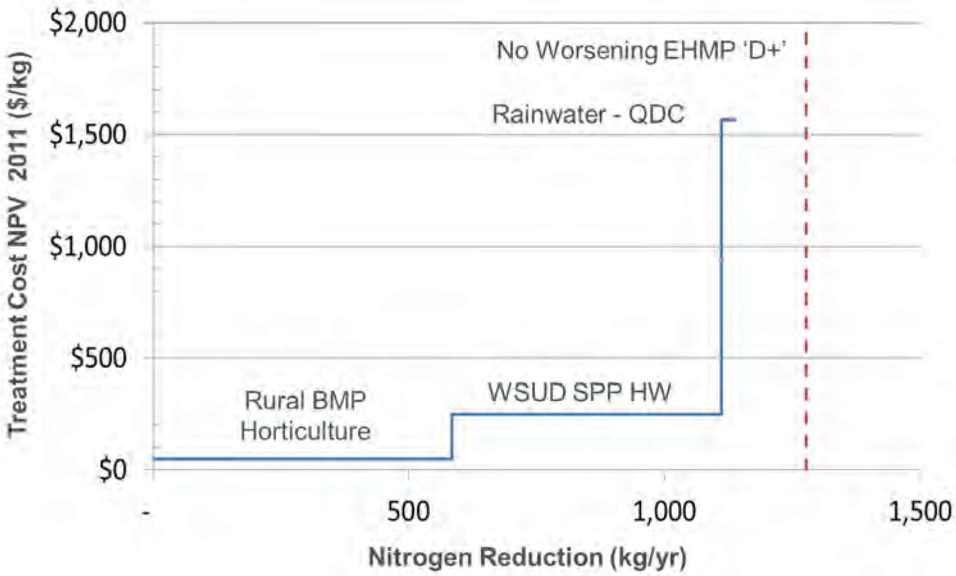



**Figure 7-39 Pumicestone Catchment TN Treatment Cost Curve**

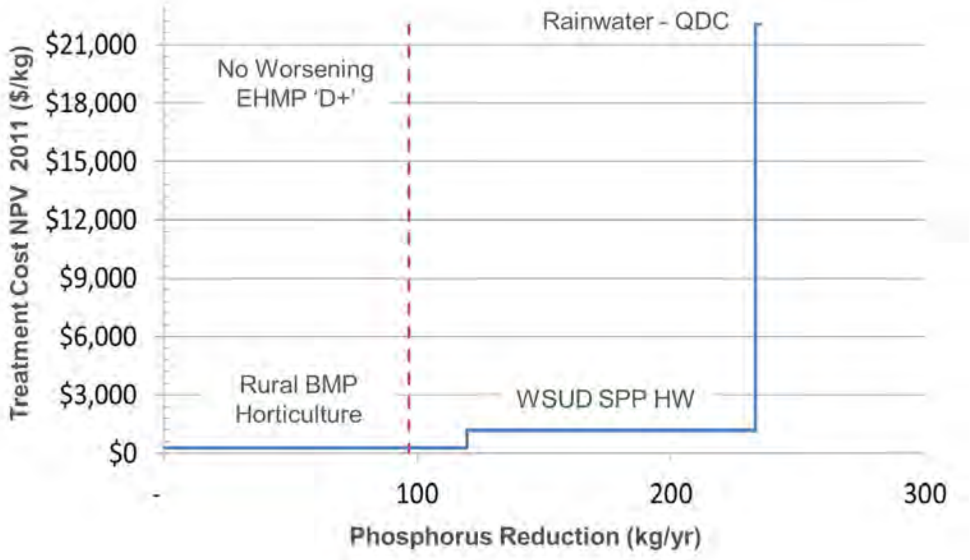



**Figure 7-40 Pumicestone Catchment TP Treatment Cost Curve**

## 7.9 Redcliffe Catchment

A summary of the individual solutions contained in the preferred management scenario for Redcliffe catchment and the overall performance of this management scenario is detailed in Table 7-47. Table 7-48 provides a summary of the capital and operational costs of the solutions, while Table 7-49 includes a distribution of these costs per Equivalent Person (EP).

It is noted that part of the Redcliffe peninsula is located within Hays catchment, including the Redcliffe STP. Therefore more complex TWCM solutions (e.g. investigating recycled water from the Redcliffe STP) are examined within Hays catchment.

The results of the MCA indicated similar results for Scenario 1 and 2, with the latter scoring marginally higher. Due to the high additional costs for Scenario 2 and negligible difference in score, Scenario 1 was adopted as the preferred scenario.

**Key Catchment Characteristics:**

- Area: 2,662 ha
- Existing Population: 49,600
- Future Population: 72,900
- Future Population Growth: 47%
- Future Urban Land Use: 73%
- Potable water sourced from North Pine Dam and Lake Kurwongbah
- Wastewater treated at Redcliffe STP in Hays Inlet catchment
- EHMP Score 2010: D+ (Bramble & Deception Bays

Implementing the preferred management scenario is anticipated to contribute towards maintaining existing water quality over the planning period, which is equivalent to a grade of D+ in both Bramble and Deception Bay. Other external catchments influence these grades.

**Table 7-47 Summary of Preferred Management Scenario for Redcliffe**

| Management Scenario 1 – Low Intensity | | | | | | |
|---|---|---|---|---|---|---|
| **Solution** | **Indicative NPV ($2011)** | **TSS Treatment (kg/yr)** | **TN Treatment (kg/yr)** | **TP Treatment (kg/yr)** | **Potable Water Saving (ML/yr)** | **Land Take (ha)** |
| Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $6,788,000 | 22,903 | 196 | 42 | - | 2.27 |
| Future development meets QDC alternative water supply target | $26,914,000 | 9,450 | 860 | 61 | 472 | - |
| **Total for Management Scenario:** | **$33,702,000** | **32,353** | **1,056** | **103** | **472** | **2.27** |

**Table 7-48 Summary of Capital and Operating Expenditures for Redcliffe**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | MBRC | Unitywater | Developer | MBRC | Unitywater | Household |
| Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | - | - | $6,268,475 | $45,308 | - | - |
| Future development meets QDC alternative water supply target | - | - | $25,011,236 | - | - | $165,857 |
| ***Sub-Total*** | **-** | **-** | $31,279,711 | $45,308 | **-** | $165,857 |
| **Total CAPEX / OPEX** | **$31,279,711** | | | **$211,165** | | |

**Table 7-49 Summary of Capital and Operating Expenditures per EP for Redcliffe**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | CAPEX/EP | Contributing EP | Contributing Description | OPEX/EP | Contributing EP | Contributing Description |
| Future development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $197 | 31,816 | Catchment New | $0.49 | 92,071 | Catchment Total |
| Future development meets QDC alternative water supply target | $1,077.14 | 23,220 | Serviced only | $7.14 | 23,220 | Serviced only |
| **Total (Maximum/EP)** | **$1,274** | | | **$7.63** | | |

It is noted that retrofit opportunities in this catchment were only assessed on an end of pipe scale (due to Council's original preference), however as this catchment is largely urbanised, considerable water quality benefits may be gained from retrofitting streetscape WSUD solutions, particularly as the opportunity arises during urban renewal projects (e.g. road upgrades).

A summary of the performance of the preferred management scenario with regards to meeting 'no worsening' or sustainable load reduction targets is shown in Table 7-50. The summary indicates that 'no worsening' targets are met for all parameters; however sustainable load targets are not met for any of the water quality parameters.

**Table 7-50 Summary of Waterway Health Performance of Management Scenario in Redcliffe**

| Parameter | Scenario Load Reduction (t/yr) | No Worsening Reduction Target (t/yr) | Meets 'no worsening' Target? | Sustainable Load Reduction Target (t/yr) | Meets Sustainable Load Target? |
|---|---|---|---|---|---|
| TSS | 32 | 32 | ✓ | 381 | × |
| TN | 1.1 | 0.8 | ✓ | 9.1 | × |
| TP | 0.1 | 0.1 | ✓ | 1.1 | × |

The levelised cost of treating pollutants for solutions contained in the preferred management scenario for Redcliffe have been plotted in Figure 7-41 to Figure 7-43 for TSS, TN and TP respectively. These figures show the cumulative predicted annual treatment performance of the management scenario, in order of least cost to implement the solutions. For comparison, annual load reduction targets for the catchment to achieve a 'no worsening' from existing conditions, have also been included. The EHMP report card (2010) result is shown to put into context the indicative results only that a 'no worsening' scenario may achieve in receiving waters. It should be noted that this EHMP report (D+) is for receiving waters in Bramble and Deception Bay, which are also influenced by catchments other than Redcliffe.

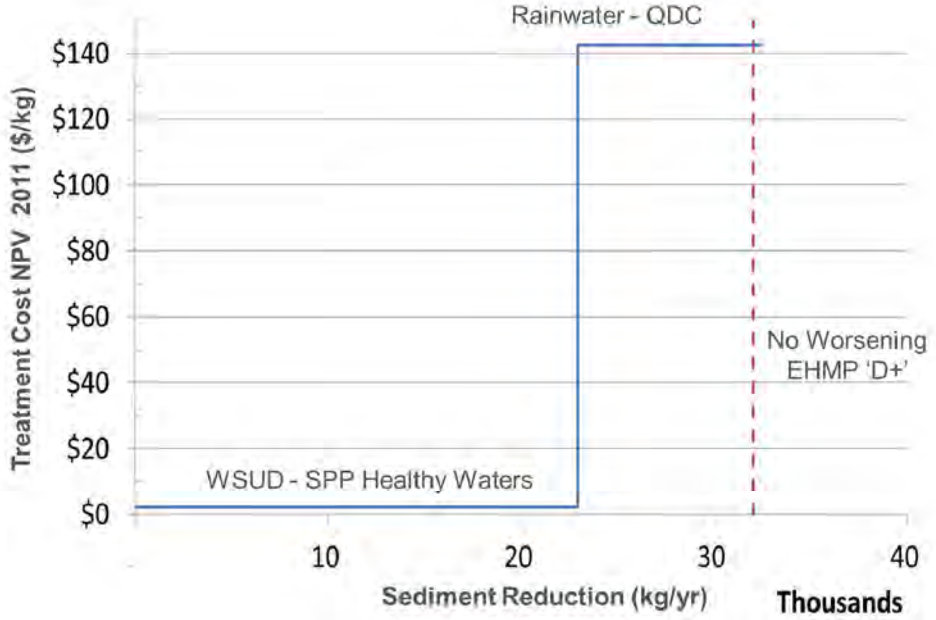



**Figure 7-41 Redcliffe Catchment TSS Treatment Cost Curve**

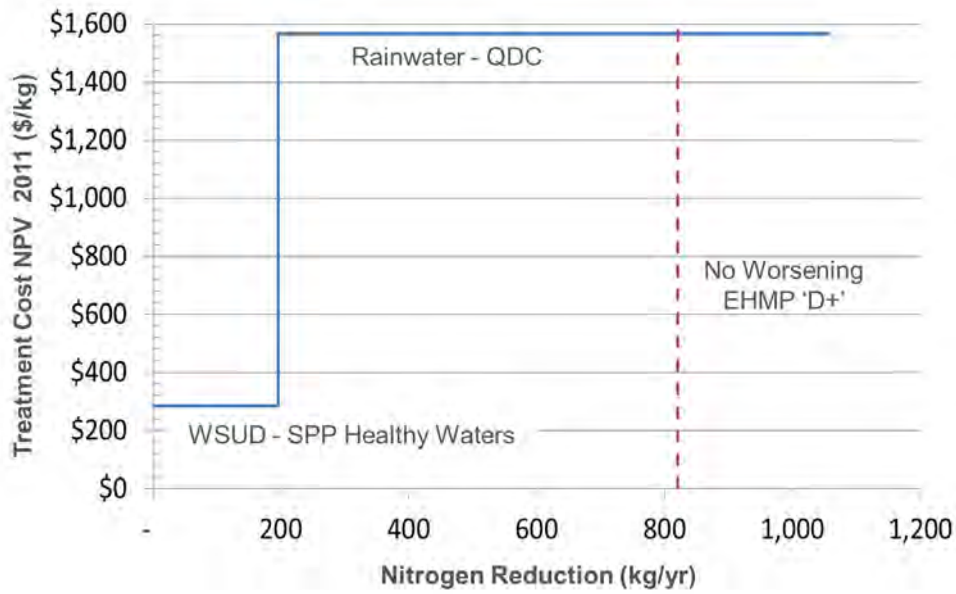



**Figure 7-42 Redcliffe Catchment TN Treatment Cost Curve**

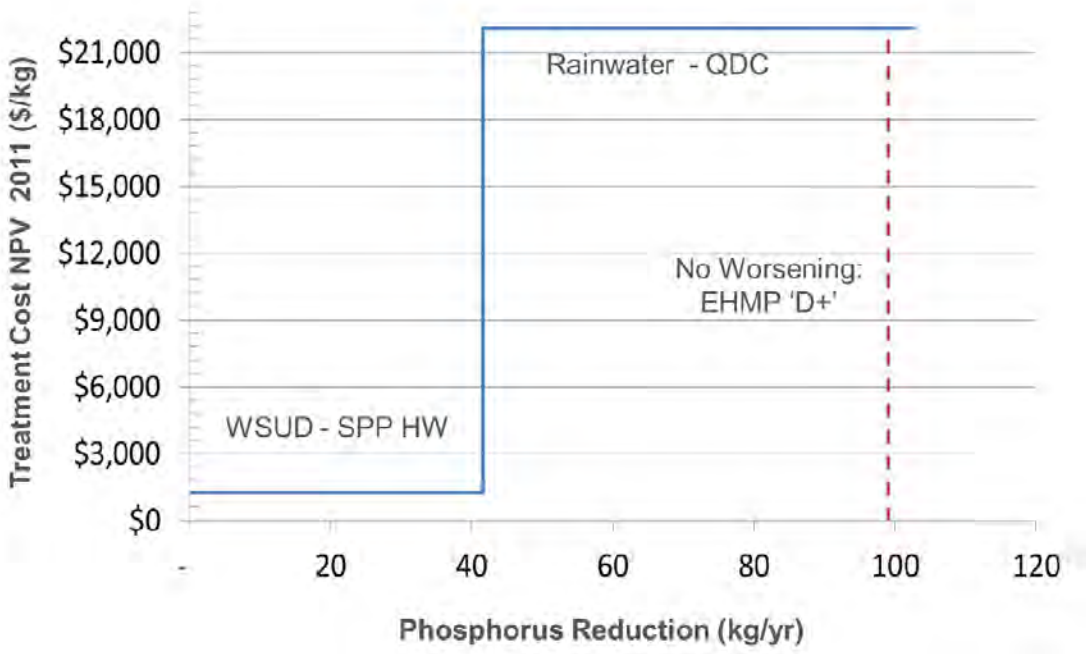



**Figure 7-43 Redcliffe Catchment TP Treatment Cost Curve**

## 7.10 Sideling Creek Catchment

A summary of the individual solutions contained in the adopted management scenario for Sideling Creek Catchment and the overall performance of this management scenario is detailed in Table 7-51. As no future development will be occurring in this catchment, it is noted that the proposed management solutions were limited.

Table 7-52 provides a summary of the capital and operational costs of the solutions, Table 7-53 includes a distribution of these costs per Equivalent Person (EP).

As there is no receiving water quality model for Sideling Creek, no sustainable load targets could be determined for this catchment. As there is no new urban development in this catchment, water quality modelling predicts pollutant loads in the future to remain approximately the same, hence 'no worsening' targets are met.

Implementing the preferred management scenario over the planning period is estimated to contribute towards improving waterway health in freshwater reaches of the Pine River from an EHMP grade of C- to C. It will also assist to improve waterway health in the receiving Pine River estuary.

**Key Catchment Characteristics:**

- Area: 5,267 ha
- Existing Population: 1,400
- Future Population: 2,600
- Future Population Growth: 87%
- Future Urban Land Use: 11%
- Water Supply Catchment: Potable water from Lake Kurwongbah is distributed to adjacent catchments
- Wastewater treated at Burpengary East STP & discharges to Caboolture River
- EHMP Score 2010: C- (Pine River Freshwater)

**Table 7-51 Summary of Preferred Management Scenario for Sideling Creek Catchment**

| Management Scenario – Medium Intensity | | | | | | |
|---|---|---|---|---|---|---|
| **Solution** | **Indicative NPV ($2011)** | **TSS Treatment (kg/yr)** | **TN Treatment (kg/yr)** | **TP Treatment (kg/yr)** | **Potable Water Saving (ML/yr)** | **Land Take (ha)** |
| Waterway riparian revegetation on 3rd & 4th order streams | $344,000 | 12,304 | - | - | - | 2 |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams) | $3,511,000 | 93,245 | - | - | - | 19 |
| Rural BMP for Horticulture - Filter strips | $69,000 | 7,742 | 50 | 9 | - | - |
| Education and capacity building to support implementation of solutions[1] | NA | NA | NA | NA | NA | - |
| **Total for Management Scenario:** | **$3,924,000** | **113,292** | **50** | **9** | **0** | **21** |

[1] Detailed assessment of the cost and performance of this solution has not been undertaken (Not Assessed NA)

**Table 7-52 Summary of Capital and Operating Expenditures for Sideling Creek Catchment**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | MBRC | Unitywater | Developer | MBRC | Unitywater | Household |
| Waterway riparian revegetation on 3rd & 4th order streams | $343,549 | - | - | - | - | - |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams)[1] | $3,455,381 | - | - | $4,440 | - | - |
| Rural BMP for Horticulture - Filter strips[1] | $17,210 | - | - | $4,119 | - | - |
| ***Sub-Total*** | $3,816,141 | **-** | **-** | $8,559 | **-** | **-** |
| **Total CAPEX / OPEX** | **$3,816,141** | | | **$8,559** | | |

[1] Implementation of this solution and the associated costs are expected to be shared between Council and private landowners. Further investigation of the funding and implementation mechanisms will be undertaken during implementation planning.

**Table 7-53 Summary of Capital and Operating Expenditures per EP for Sideling Creek Catchment**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | CAPEX/EP | Contributing EP | Contributing Description | OPEX/EP | Contributing EP | Contributing Description |
| Waterway riparian revegetation on 3rd & 4th order streams | $2 | 168,862 | Catchment Total | - | 168,862 | Catchment Total |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams) | $20 | 168,862 | Catchment Total | $0.03 | 168,862 | Catchment Total |
| Rural BMP for Horticulture - Filter strips | $0.10 | 168,862 | Catchment Total | $0.02 | 168,862 | Catchment Total |
| **Total (Maximum/EP)** | **$23** | | | **$0.05** | | |

Rural best management practices (using filter strips for horticulture) was the only solution targeted at nutrient removal, with a levelised NPV cost of approximately $70/kg and $375/kg of TN and TP treatment respectively. Solutions contained in the adopted management scenario for removing TSS have been plotted in the treatment cost curve presented in Figure 7-44. This figures show the cumulative predicted annual treatment performance of the management scenario, in order of least cost to implement the solutions.

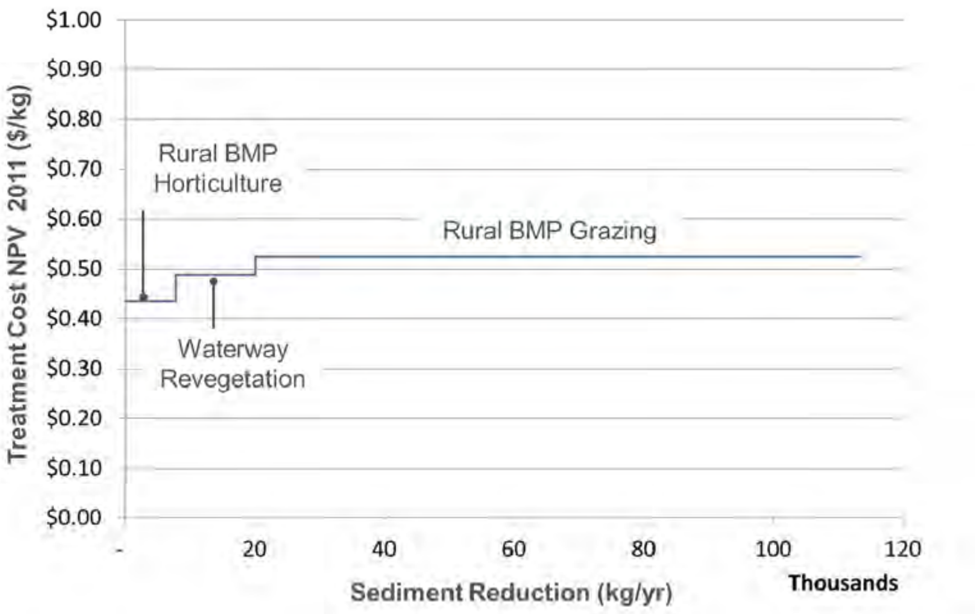



**Figure 7-44 Sideling Creek Catchment TSS Treatment Cost Curve**

## 7.11 Stanley River Catchment

A summary of the individual solutions contained in the preferred management scenario for Pumicestone Passage Catchment and the overall performance of this management scenario is detailed in Table 7-55. Table 7-56 provides a summary of the capital and operational costs of the solutions, while Table 7-57 includes a distribution of these costs per Equivalent Person (EP).

**Key Catchment Characteristics:**

- Area: 31,830 ha
- Existing Population: 4,100
- Future Population: 8,600
- Future Population Growth: 110%
- Future Urban Land Use: 3%
- Water supply catchment: Potable water sourced from Woodford Weir. Stanley River flows to Somerset Dam.
- Wastewater treated at Woodford STP
- EHMP Score (2010): B- (Stanley River)

A summary of the performance of the preferred management scenario with regards to meeting 'no worsening' load reduction targets is shown in Table 7-54. As there is no receiving water quality model for the Stanley River, no sustainable load targets could be determined for this catchment. The summary indicates that 'no worsening' annual load reduction targets are met for TSS, TN and TP.

Implementing the preferred management scenario in this catchment over the planning period is predicted to improve waterway health in the Stanley River from an EHMP grade of B- to B.

**Table 7-54 Summary of Waterway Health Performance of Management Scenario in Stanley River Catchment**

| Parameter | Scenario Load Reduction (t/yr) | No Worsening Reduction Target (t/yr) | Meets 'no worsening' Target? |
|---|---|---|---|
| TSS | 723 [1] | 4 | ✓ |
| TN | 1.3 | 0.5 | ✓ |
| TP | 0.2 | 0.07 | ✓ |

[1]This does not include loads from improved E&SC

**Table 7-55 Summary of Preferred Management Scenario for Stanley River Catchment**

| Management Scenario 2 – Medium Intensity | | | | | | |
|---|---|---|---|---|---|---|
| **Solution** | **Indicative NPV ($2011)** | **TSS Treatment (kg/yr)** | **TN Treatment (kg/yr)** | **TP Treatment (kg/yr)** | **Potable Water Saving (ML/yr)** | **Land Take (ha)** |
| Future Development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $2,762,000 | 4,133 | 33 | 7 | - | 0.92 |
| Future development meets QDC alternative water supply target | $5,296,000 | 1,860 | 169 | 12 | 93 | - |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams) | $34,714,000 | 509,803 | - | - | - | 191 |
| Rural BMP for Horticulture - Filter strips | $1,440,000 | 43,390 | 370 | 38 | | - |
| Waterway riparian revegetation on 3rd & 4th order streams | $8,630,000 | 163,701 | - | - | - | 58 |
| Increased Implementation/Enforcement of E&SC | $43,000 | 6,124 | - | - | - | - |
| Land disposal of STP effluent (Woodford) | $2,040,000 | 290 | 726 | 145 | - | - |
| Prevention of illegal stormwater inflow connections to sewer[1] | NA | NA | NA | NA | NA | - |
| Upgrade Woodford STP Capacity[1] | NA | NA | NA | NA | NA | - |
| Education and capacity building to support implementation of solutions[1] | NA | NA | NA | NA | NA | - |
| **Total for Management Scenario:** | **$54,925,000** | **729,301** | **1,299** | **203** | **93** | **250** |

[1] Detailed assessment of the cost and performance of this solution has not been undertaken (Not Assessed NA)

**Table 7-56 Summary of Capital and Operating Expenditures for Stanley River Catchment**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | MBRC | Unitywater | Developer | MBRC | Unitywater | Household |
| Future Development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | | | $2,550,943 | $18,438 | | |
| Future development meets QDC alternative water supply target | | | $4,921,595 | | | $32,637 |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams)[1] | $34,166,756 | | | $43,901 | | |
| Rural BMP for Horticulture - Filter strips[1] | $361,419 | | | $86,500 | | |
| Waterway riparian revegetation on 3rd & 4th order streams | $8,629,909 | | | | | |
| Increased Implementation/Enforcement of E&SC | $3,342 | | | $4,860 | | |
| Land disposal of STP effluent (Woodford) | | $1,700,000 | | | $64,623 | |
| ***Sub-Total*** | $43,161,427 | $1,700,000 | $7,472,538 | $153,699 | $64,623 | $32,637 |
| **Total CAPEX / OPEX** | **$52,333,965** | | | **$250,958** | | |

[1] Implementation of this solution and the associated costs are expected to be shared between Council and private landowners. Further investigation of the funding and implementation mechanisms will be undertaken during implementation planning.

**Table 7-57 Summary of Capital and Operating Expenditures per EP for Stanley River Catchment**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | CAPEX/EP | Contributing EP | Contributing Description | OPEX/EP | Contributing EP | Contributing Description |
| Future Development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $468 | 5,450 | Catchment New | $1.65 | 11,205 | Catchment Total |
| Future development meets QDC alternative water supply target | $1,077.14 | 4,569 | Serviced only | $7.14 | 4,569 | Serviced only |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams) | $3,049 | 11,205 | Catchment Total | $3.92 | 11,205 | Catchment Total |
| Rural BMP for Horticulture - Filter strips | $32.26 | 11,205 | Catchment Total | $7.72 | 11,205 | Catchment Total |
| Waterway riparian revegetation on 3rd & 4th order streams | $770 | 11,205 | Catchment Total | | 11,205 | Catchment Total |
| Increased Implementation/Enforcement of E&SC | $0.30 | 11,205 | Catchment Total | $0.43 | 11,205 | Catchment Total |
| Land disposal of STP effluent (Woodford) | $312 | 5,450 | Serviced only (new) | $12 | 5,450 | Serviced only (new) |
| **Total (Maximum/EP)** | **$5,709** | | | **$33** | | |

The levelised cost of treating pollutants for solutions contained in the preferred management scenario have been plotted in Figure 7-45 to Figure 7-47 for TSS, TN and TP respectively. These figures show the cumulative predicted annual treatment performance of the management scenario, in order of least cost to implement the solutions. For comparison, annual load reduction targets for the catchment to achieve a 'no worsening' from existing conditions have been included. It is noted that the EHMP report card (2010) result for the Stanley River catchment is shown to put into context the indicative results that a 'no worsening' scenario may achieve.

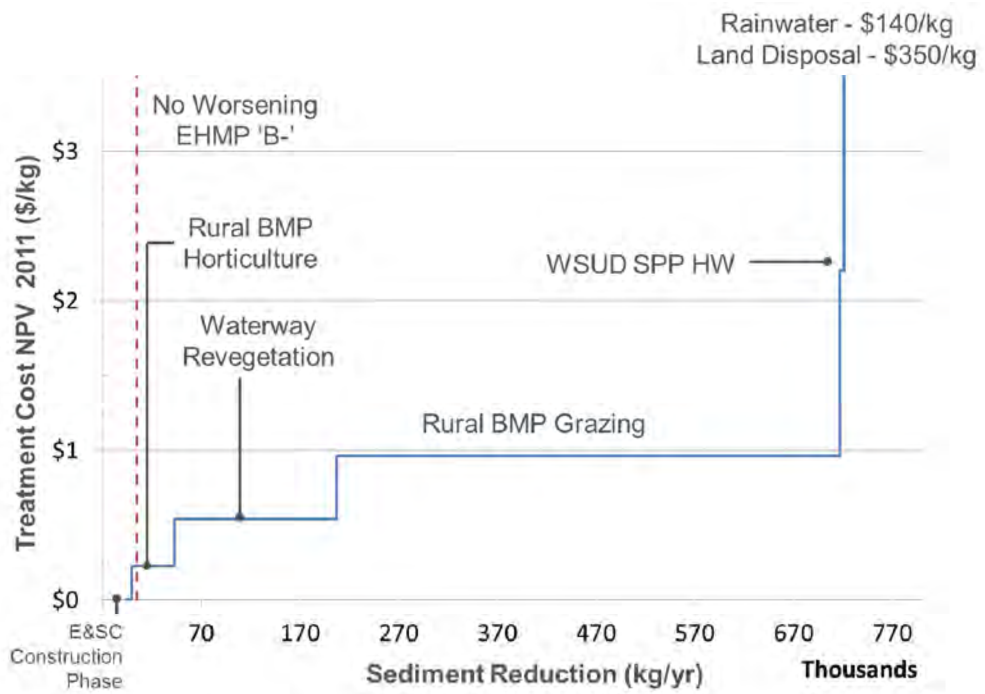



**Figure 7-45 Stanley River Catchment TSS Treatment Cost Curve**

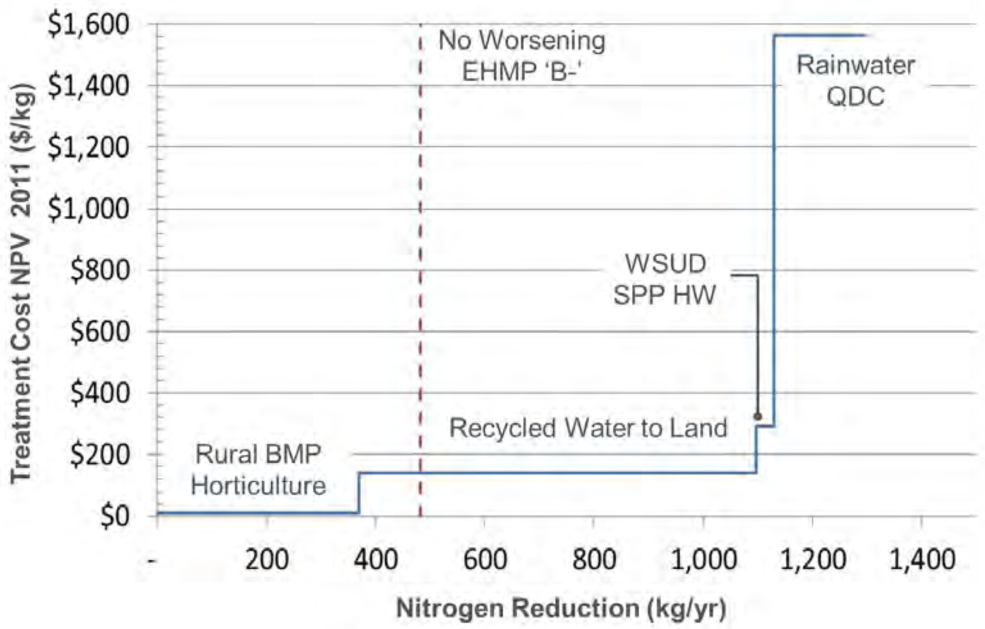



**Figure 7-46 Stanley River Catchment TN Treatment Cost Curve**

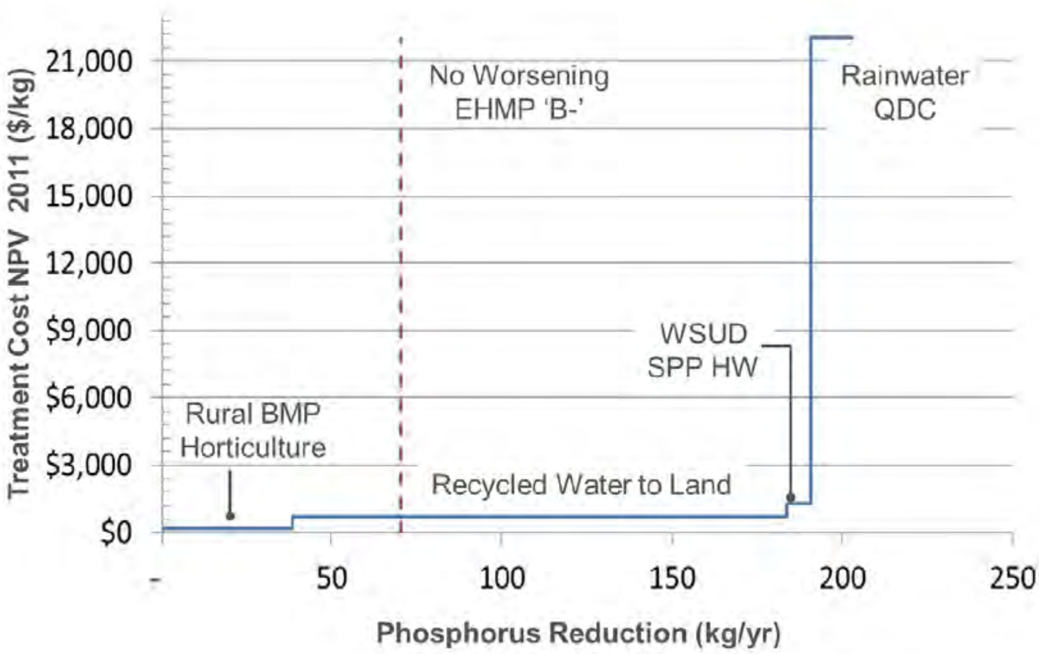



**Figure 7-47 Stanley River Catchment TP Treatment Cost Curve**

## 7.12 Upper Pine River Catchment

A summary of the individual solutions contained in the preferred management scenario for Upper Pine River Catchment and the overall performance of this management scenario is detailed in Table 7-58. Table 7-59 provides a summary of the capital and operational costs of the solutions, while Table 7-60 includes a distribution of these costs per Equivalent Person (EP).

**Key Catchment Characteristics:**

- Area: 34,890 ha
- Existing Population: 2,000
- Future Population: 3,200
- Future Population Growth: 60%
- Future Urban Land Use: 3%
- Potable water from North Pine Dam is distributed to other catchments and Brisbane
- Potable water in Dayboro sourced from groundwater borefield
- Wastewater treated at Dayboro STP treated wastewater irrigated to land
- EHMP Score 2010: C- (Freshwater)

As there is little future urban development in this catchment, the increase in modelled pollutant loads is minimal, and therefore load reduction targets to achieve 'no worsening' are zero for TN and TP, and only 1 t/yr for TSS, meaning the scenario easily meets these targets. However, as there is no receiving water quality model for the Upper Pine River (including North Pine Dam), no sustainable load targets could be determined for this catchment. The importance of implementing management measures in this catchment is to protect the drinking water quality of North Pine Dam, a significant regional water storage.

Implementing the preferred management scenario in this catchment over the planning period is predicted to contribute towards improving waterway health in freshwater reaches of the Pine River from an EHMP grade of C- to C+. It will also assist to improve waterway health in the receiving Pine River estuary.

**Table 7-58 Summary of Preferred Management Scenario for Upper Pine River Catchment**

| Management Scenario 3 – High Intensity | | | | | | |
|---|---|---|---|---|---|---|
| **Solution** | **Indicative NPV ($2011)** | **TSS Treatment (kg/yr)** | **TN Treatment (kg/yr)** | **TP Treatment (kg/yr)** | **Potable Water Saving (ML/yr)** | **Land Take (ha)** |
| Future development meets QDC alternative water supply target | $1,402,000 | 492 | 45 | 3 | 25 | - |
| Waterway riparian revegetation on 3rd & 4th order streams | $8,342,000 | 206,693 | - | - | - | 56 |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams) | $19,081,000 | 1,266,826 | - | - | - | 105 |
| Rural BMP for Horticulture - Filter strips | $3,452,000 | 364,414 | 2,873 | 266 | - | - |
| Increased Implementation/Enforcement of E&SC | $11,500 | 230 | - | - | - | - |
| Greenfield WSUD achieves 'no worsening' | $220,000 | 241 | 2 | 0.5 | - | 0.07 |
| Prevention of illegal stormwater inflow connections to sewer[1] | NA | NA | NA | NA | NA | - |
| Upgrade WTP Capacity[1,2] | NA | NA | NA | NA | NA | - |
| Upgrade STP Capacity[3] | NA | NA | NA | NA | NA | - |
| Education and capacity building to support implementation of solutions[1] | NA | NA | NA | NA | NA | - |
| **Total for Management Scenario:** | **$32,508,500** | **1,838,896** | **2,920** | **270** | **25** | **161** |

[1] Detailed assessment of the cost and performance of this solution has not been undertaken (Not Assessed NA)
[2] Dayboro borefield capacity issue. Pipeline from Petrie to Dayboro under consideration by the state agencies responsible for Bulk Water.
[3] Dayboro STP licence capacity and potentially design capacity

**Table 7-59 Summary of Capital and Operating Expenditures for Upper Pine River Catchment**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | MBRC | Unitywater | Developer | MBRC | Unitywater | Household |
| Future development meets QDC alternative water supply target | - | - | $1,302,901 | | - | $8,640 |
| Waterway riparian revegetation on 3rd & 4th order streams | $8,342,302 | - | - | | - | - |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams)[1] | $18,780,519 | - | - | $24,131 | - | - |
| Rural BMP for Horticulture - Filter strips[1] | $866,489 | - | - | $207,380 | | - |
| Increased Implementation/Enforcement of E&SC | $885 | - | - | $1,287 | - | - |
| Greenfield WSUD achieves 'no worsening' | - | - | $202,825 | $1,466 | - | - |
| ***Sub-Total*** | $27,990,194 | - | $1,505,726 | $234,264 | - | $8,640 |
| **Total CAPEX / OPEX** | **$29,495,920** | | | **$242,904** | | |

[1] Implementation of this solution and the associated costs are expected to be shared between Council and private landowners. Further investigation of the funding and implementation mechanisms will be undertaken during implementation planning.

**Table 7-60 Summary of Capital and Operating Expenditures per EP for Upper Pine River Catchment**

| Solution | CAPEX (2011-2031) | | | Annual OPEX | | |
|---|---|---|---|---|---|---|
| | CAPEX/EP | Contributing EP | Contributing Description | OPEX/EP | Contributing EP | Contributing Description |
| Future development meets QDC alternative water supply target | $1,077.14 | 1210 | Serviced only | $7.14 | 1210 | Serviced only |
| Waterway riparian revegetation on 3rd & 4th order streams | $49 | 170,274 | Catchment Total | 0 | 170,274 | Catchment Total |
| Rural BMP for Grazing (Revegetation 1st & 2nd order streams) | $110 | 170,274 | Catchment Total | $0.14 | 170,274 | Catchment Total |
| Rural BMP for Horticulture - Filter strips | $5.09 | 170,274 | Catchment Total | $1.22 | 170,274 | Catchment Total |
| Increased Implementation/Enforcement of E&SC | $0.01 | 170,274 | Catchment Total | $0.01 | 170,274 | Catchment Total |
| Greenfield WSUD achieves 'no worsening' | $101 | 2,001 | Catchment New | $0.01 | 170,274 | Catchment Total |
| **Total (Maximum/EP)** | **$1,343** | | | **$8.52** | | |

The levelised cost of treating pollutants for solutions contained in the preferred management scenario have been plotted in Figure 7-48 to Figure 7-50 for TSS, TN and TP respectively. These figures show the cumulative predicted annual treatment performance of the management scenario, in order of least cost to implement the solutions.

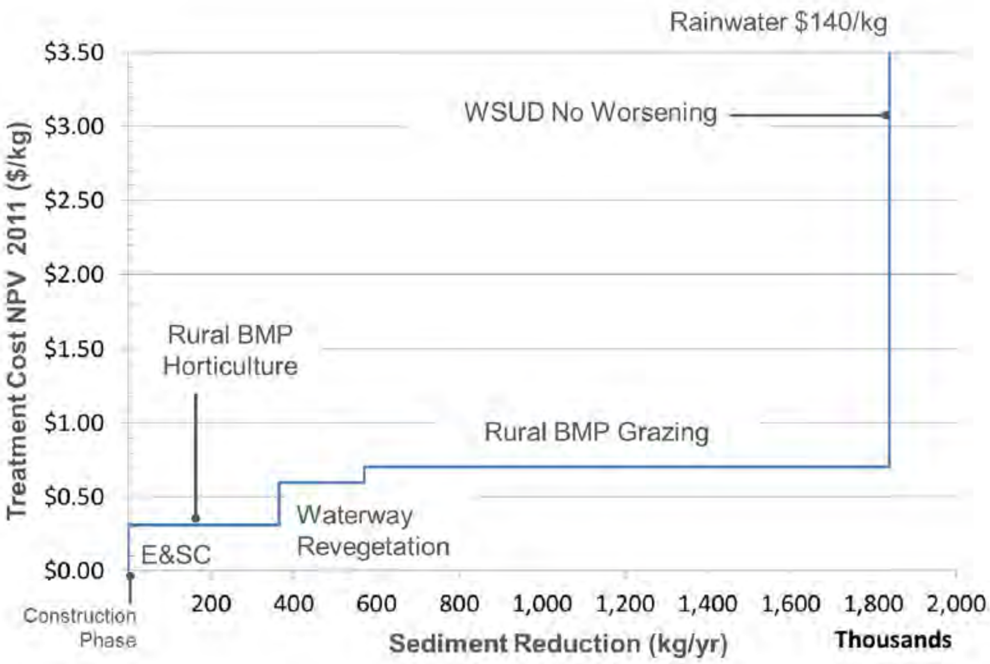



**Figure 7-48 Upper Pine River Catchment TSS Treatment Cost Curve**

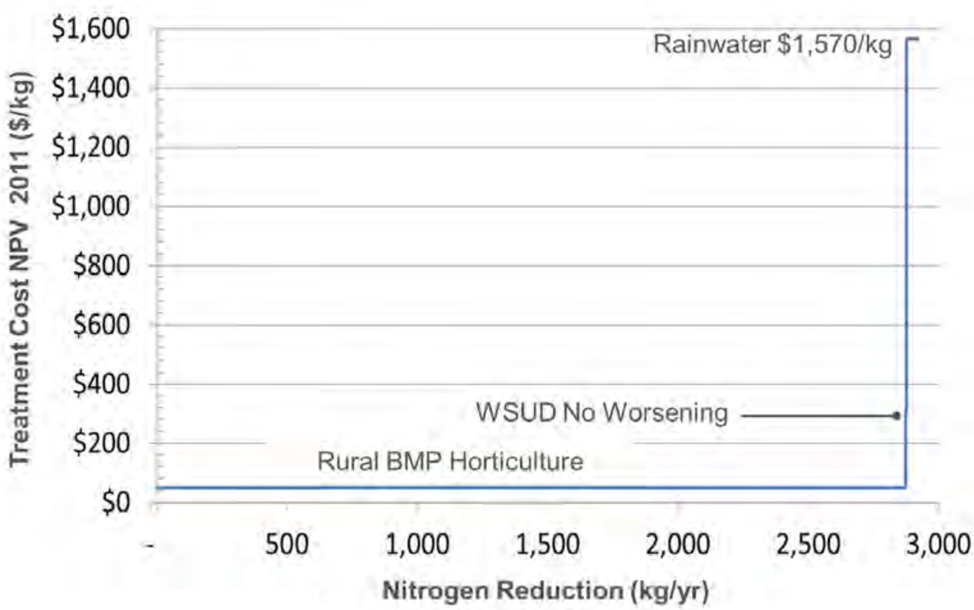



**Figure 7-49 Upper Pine River Catchment TN Treatment Cost Curve**

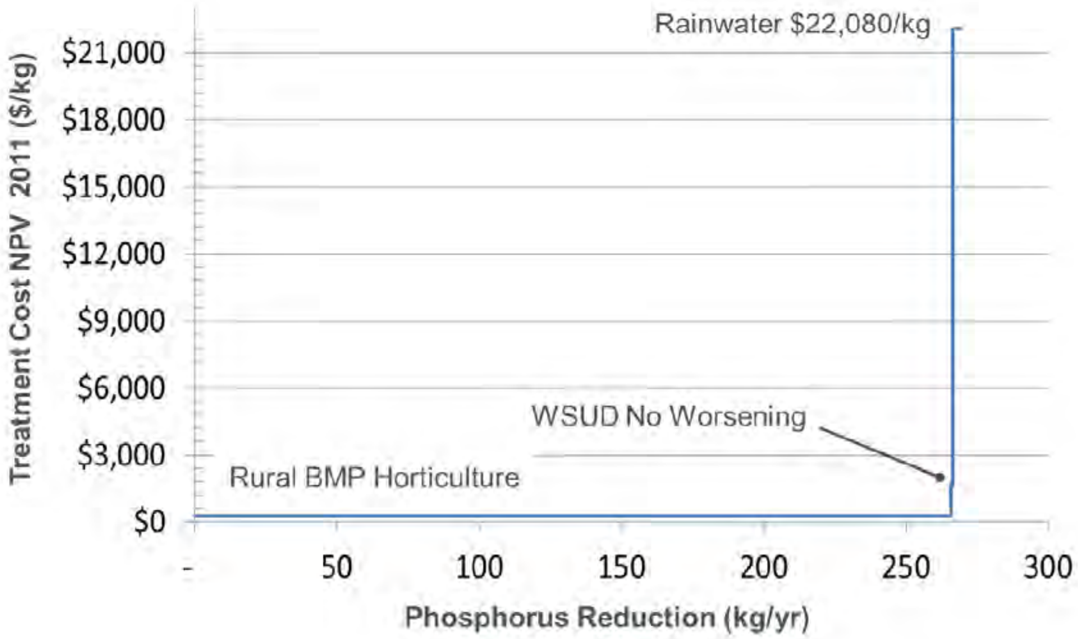



**Figure 7-50 Upper Pine River Catchment TP Treatment Cost Curve**

# 8 IMPLEMENTATION / DELIVERY PLANNING

To assist with the development of an Implementation Plan, Table 8-1 provides a summary of the total cost over the planning period, primary responsibility and actions for implementing the solutions contained in the recommended management scenario of each catchment. Preferred scenarios from the MCA that have been replaced with recommended alternatives for the TWCM Plan are also presented, and are shaded in red for ease of reference.

**Table 8-1 Potential Implementation Pathways of Preferred Management Scenarios**

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Caboolture Scenario 3 | Future Development meets QDC Alternative Water Supply Target | $24,677,000 | MBRC, Developers | This is a legislative requirement, however to ensure compliance, MBRC should include provisions in its local planning scheme and ensure development approvals are only granted where it can be demonstrated that they comply with this requirement. Rainwater tanks should be internally plumbed to supply water to the toilet and laundry.<br><br>Capital costs will be borne by the developer. Ongoing maintenance and operational costs to be borne by the household owner. |
| | Waterway Riparian Reveg (3rd & 4th order streams) | $14,980,000 | MBRC | This will be implemented via Council's Planning Scheme and Priority Infrastructure Plan. Opportunities exists to undertake this in partnership with community groups and local residents (schools, etc). |
| | Rural BMP for Grazing - Reveg 1st & 2nd order streams | $46,204,000 | MBRC, private landowners | The implementation of this solution will need to be investigated further with local landowners. Council will need to work closely with local landowners to implement this solution. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ Catchments. Other community groups and local residents (e.g. schools) may be approached to assist with revegetation efforts. |
| | Rural BMP for Horticulture - Filter strips | $187,000 | MBRC, private landowners | The implementation of this solution will need to be investigated further with local landowners. It will require implementation though educating property owners of BMPs. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ catchments. |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Caboolture Scenario 3 (continued) | Increased Implementation/Enforcement of E&SC | $406,000 | MBRC | MBRC will be responsible for ensuring this is implemented through internal policies. It will involve dedicating more time to Council staff for on-site compliance inspections of E&SC practices on development sites. |
| | WSUD Retrofit to Existing Urban Areas | $45,705,000 | MBRC | Detailed site investigations and design should be undertaken for identified wetland and bioretention basin opportunities. For each site, detailed survey, geotechnical and drainage information will be required to progress with detailed design. Council will be responsible for implementing this solution through its PIP.<br><br>Opportunities to implement streetscape WSUD during urban renewal projects (e.g. road upgrades) should be investigated further. |
| | Greenfield WSUD achieves 'No Worsening' | $73,624,000 | MBRC, developers | MBRC to include provisions in planning scheme or condition development approvals to achieve ‘no worsening’ from existing conditions for development to be allowed to proceed.<br><br>Development Assessment team to grant development approval only where ‘no worsening’ targets are demonstrated by developer. Training of internal Council staff may be required.<br><br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will be the responsibility of Council. |
| | Recycled Water for Dual Retic & POS | $238,774,000 | Unitywater | The adoption of this scheme is dependent on third party feasibility investigations. Should the agricultural reuse scheme not prove viable, further detailed feasibility studies should be undertaken for the following urban recycled water schemes<br><br>- North East Business Park<br>- Narangba East LDAP<br>- Burpengary East LAP<br>- Morayfield Burpengary<br><br>It is noted that during conceptual design, the Narangba Industrial estate was not deemed cost viable. Furthermore, costing of conceptual design of the above schemes by Project Support was significantly more expensive than originally anticipated during the planning phase and during the MCA. The costs presented in this table have been updated to reflect Project Support costings.<br><br>This solution may be included in both Unitywater’s Network Services Plans (Netserv) and Council’s Local Planning Scheme for further |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Caboolture Scenario 3 (continued) | | | | investigation. |
| | Stormwater Harvesting for Non-Potable Use | $6,220,000[1] | MBRC | This solution should be included in Council's Local Planning Scheme for further investigation by the developer prior to development approval being granted. It is noted that the extent of this solution has been reduced in scale from original intentions during detailed planning, due to development approvals being granted on some sites.<br>Construction and initial maintenance cost will be borne by the developer, however on going maintenance costs will likely be the responsibility of Unitywater (for treatment and supply of water). |
| | Prevention of illegal stormwater inflow connections to sewer[3] | Not Costed | Unitywater | Investigate a change in design standards to one way valve (at overflow points) to prevent inflows. Implement community education campaigns to assist in preventing illegal connections. Additional staff may be needed for compliance inspections and follow up notices of illegal connections. These actions should be investigated in conjunction with Unitywater's Sewer Overflow Abatement Strategy. |
| | Education and capacity building to support implementation of solutions[3] | Not Costed | MBRC, Unitywater | This will be needed both within Council as well as in the general community to aid in successful implementation of solutions. For example:<br>- WSUD Demonstration sites for community/developers /consultants<br>- Signage educating community about WSUD elements<br>- Information packages educating community on WSUD, illegal stormwater connections to sewer, and recycled water with purchase of property with purchase of property<br>- Capacity building for Council DA staff on WSUD requirements<br>- Capacity building for Council staff on E&SC compliance and inspections<br>- Community educational programs for rural best management practices |
| | Upgrade STP Capacity[3] | Not Costed | Unitywater | Upgrade to design capacity of Caboolture South STP required by 2023 |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Caboolture Scenario 3 (continued) | Total | $450,777,000 | | |
| Caboolture Scenario 2 | Future Development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $62,474,000 | MBRC, Developers | MBRC to ensure provisions included in planning scheme.<br>Development Assessment team to allow development only where compliance is demonstrated. Training may be required.<br>Construction and initial maintenance cost will be borne by the developer, however on going maintenance costs will be the responsibility of Council. |
| | Future Development meets Queensland Development Code Alternative Water Supply Target through installation of rainwater tanks | $49,470,000 | MBRC, Developers | This is a legislative requirement, however to ensure compliance, MBRC should include provisions in its local planning scheme and ensure development approvals are only granted where it can be demonstrated that they comply with this requirement. Rainwater tanks should be internally plumbed to supply water to the toilet and laundry.<br>Capital costs will be borne by the developer. Ongoing maintenance and operational costs to be borne by the household owner. |
| | Waterway Riparian Revegetation (3rd & 4th order streams) | $14,980,000 | MBRC | This will be implemented via Council's Planning Scheme and Priority Infrastructure Plan. Opportunities exists to undertake this in partnership with community groups and local residents (schools, etc). |
| | Rural BMP for Grazing – Revegetation 1st & 2nd order streams | $46,204,000 | MBRC, private landowners | The implementation of this solution will need to be investigated further with local landowners. Council will need to work closely with local landowners to implement this solution. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ Catchments. Other community groups and local residents (e.g. schools) may be approached to assist with revegetation efforts. |
| | Rural BMP for Horticulture - Filter strips | $187,000 | MBRC, private landowners | The implementation of this solution will need to be investigated further with local landowners. It will require implementation though educating property owners of BMPs. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ catchments. |
| | Increased Implementation/Enforcement of E&SC | $406,000 | MBRC | MBRC will be responsible for ensuring this is implemented through internal policies. It will involve dedicating more time to Council staff for on-site compliance inspections of E&SC practices on development sites. |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Caboolture Scenario 2 (continued) | Recycled Water Supplied to Agricultural Users (Wamuran Scheme) | $50,248,000 | Unitywater, third party proponent of agricultural reuse scheme | The adoption of this scheme is dependent on third party feasibility investigations. If feasible, the scheme will likely be undertaken at no cost to Unitywater/ratepayers. Should the agricultural reuse scheme not prove viable, further detailed feasibility studies may be undertaken for the following urban recycled water schemes (refer Scenario 3)<br>- North East Business Park<br>- Narangba East LDAP<br>- Burpengary East LAP<br>- Morayfield Burpengary |
| | Prevention of illegal stormwater inflow connections to sewer[3] | Not Costed | Unitywater | Investigate a change in design standards to one way valve (at overflow points) to prevent inflows. Implement community education campaigns to assist in preventing illegal connections. Additional staff may be needed for compliance inspections and follow up notices of illegal connections. These actions should be investigated in conjunction with Unitywater's Sewer Overflow Abatement Strategy. |
| | Education and capacity building to support implementation of solutions[3] | Not Costed | MBRC, Unitywater | This will be needed both within Council as well as in the general community to aid in successful implementation of solutions. For example:<br>- WSUD Demonstration sites for community/developers /consultants<br>- Signage educating community about WSUD elements<br>- Information packages educating community on WSUD, illegal stormwater connections to sewer, and recycled water with purchase of property with purchase of property<br>- Capacity building for Council DA staff on WSUD requirements<br>- Capacity building for Council staff on E&SC compliance and inspections<br>- Community educational programs for rural best management practices |
| | Upgrade STP Capacity[3] | Not Costed | Unitywater | Upgrade to design capacity of Caboolture South STP required by 2023 |
| | Total | $223,969,000 | | |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| CIGA Scenario 2 | Future Development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $153,764,000 | MBRC, Developers | MBRC to ensure provisions included in planning scheme.<br>Development Assessment team to allow development only where compliance is demonstrated. Training may be required.<br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will be the responsibility of Council. |
| | Waterway Riparian Revegetation (3rd & 4th order streams) | $3,600,000 | MBRC | This will be implemented via Council's Planning Scheme and Priority Infrastructure Plan. Opportunities exists to undertake this in partnership with community groups and local residents (schools, etc). |
| | Increased Implementation/Enforcement of E&SC | $500,000 | MBRC | MBRC will be responsible for ensuring this is implemented through internal policies. It will involve dedicating more time to Council staff for on-site compliance inspections of E&SC practices on development sites. |
| | Recycled Water for Dual Retic & POS, with remainder irrigated to land. | $184,753,000[2] | Unitywater | Further detailed investigations are required to investigate the costs of this solution, how risks of cross connections may be managed, and identify land options/locations for disposal. If the Wamuran agricultural reuse scheme does not proceed, agricultural reuse may be considered as an alternative to dual reticulation in the CIGA. It is noted that the capital cost estimate by Project Support varies substantially from the estimate undertaken during planning, affecting the feasibility of this option. The costs presented in this table have been updated to reflect Project Support cost estimates.<br>It is noted that DERM requires zero discharge or demonstration of sustainable loads to allow a new STP to be constructed to service the CIGA.<br>This solution will need to be included in both Council's Local Planning Scheme and Unitywater's Network Services Plans (Netserv) for further investigation. |
| | Prevention of illegal stormwater inflow connections to sewer[3] | Not Costed | Unitywater | Investigate a change in design standards to one way valve (at overflow points) to prevent inflows. Implement community education campaigns to assist in preventing illegal connections. Additional staff may be needed for compliance inspections and follow up notices of illegal connections. These actions should be investigated in conjunction with Unitywater's Sewer Overflow Abatement Strategy. |
| | Education and capacity building to support implementation of solutions[3] | Not Costed | Council, Unitywater | This will be needed both within Council as well as in the general community to aid in successful implementation of solutions. For example: |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| CIGA Scenario 2 (continued) | | | | - WSUD Demonstration sites for community/developers /consultants<br>- Signage educating community about WSUD elements<br>- Information packages educating community on WSUD, illegal stormwater connections to sewer, and recycled water with purchase of property with purchase of property<br>- Capacity building for Council DA staff on WSUD requirements<br>- Capacity building for Council staff on E&SC compliance and inspections |
| | New STP[3] | Not Costed | Unitywater | A new STP will need be required to treat sewage from the development. |
| | Total | $342,617,000 | | |
| CIGA Scenario 1 | Future Development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $153,764,000 | MBRC, Developers | MBRC to ensure provisions included in planning scheme.<br>Development Assessment team to allow development only where compliance is demonstrated. Training may be required.<br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will be the responsibility of Council. |
| | Future Development meets QDC Alternative Water Supply Target | $28,342,000 | MBRC, Developers | This is a legislative requirement, however to ensure compliance, MBRC should include provisions in its local planning scheme and ensure development approvals are only granted where it can be demonstrated that they comply with this requirement. Rainwater tanks should be internally plumbed to supply water to the toilet and laundry.<br>Capital costs will be borne by the developer. Ongoing maintenance and operational costs to be borne by the household owner. |
| | Recycled Water for POS irrigation | $28,629,000 | Unitywater | It is noted that as this was identified as an alternative option, no conceptual design or detailed costing by Project Support has been undertaken. Costing has assumed Class A+ water, however significant savings could be made by building a Class A plant. This solution should be further analysed in a Recycled Water options study for CIGA.<br>This solution may be included in both Unitywater's Network Services Plans (Netserv) and Council's Local Planning Scheme for further investigation. |
| | Total | $210,735,000 | | |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Burpengary Scenario 3 | Future Development meets Queensland Development Code Alternative Water Supply Target through installation of rainwater tanks | $17,492,000 | MBRC, Developers | This is a legislative requirement, however to ensure compliance, MBRC should include provisions in its local planning scheme and ensure development approvals are only granted where it can be demonstrated that they comply with this requirement. Rainwater tanks should be internally plumbed to supply water to the toilet and laundry.<br><br>Capital costs will be borne by the developer. Ongoing maintenance and operational costs to be borne by the household owner. |
| | Waterway Riparian Revegetation (3rd & 4th order streams) | $8,029,000 | MBRC | This will be implemented via Council's Planning Scheme and Priority Infrastructure Plan. Opportunities exists to undertake this in partnership with community groups and local residents (schools, etc). |
| | Rural BMP for Grazing - Revegetation 1st & 2nd order streams | $1,060,000 | MBRC, Private Landowners | The implementation of this solution will need to be investigated further with local landowners. Council will need to work closely with local landowners to implement this solution. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ Catchments. Other community groups and local residents (e.g. schools) may be approached to assist with revegetation efforts. |
| | Increased Implementation/Enforcement of E&SC | $206,000 | MBRC | MBRC will be responsible for ensuring this is implemented through internal policies. It will involve dedicating more time to Council staff for on-site compliance inspections of E&SC practices on development sites. |
| | Greenfield WSUD achieves 'No Worsening' | $20,156,000 | MBRC, Developers | MBRC to include provisions in planning scheme or condition development approvals to achieve 'no worsening' from existing conditions for development to be allowed to proceed.<br><br>Development Assessment team to grant development approval only where 'no worsening' targets are demonstrated by developer. Training of internal Council staff may be required.<br><br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will be the responsibility of Council. |
| | Stormwater Harvesting for Non-Potable Use | $7,699,158 [1] | MBRC | This solution should be included in Council's Local Planning Scheme for further investigation by the developer prior to development approval being granted. It is noted that the extent of this solution has been reduced in scale from original intentions during detailed planning, due to development approvals being granted on some sites.<br><br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will likely be the responsibility of Unitywater (for treatment and supply of water). |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Burpengary Scenario 3 (continued) | WSUD Retrofit to Existing Urban Areas | $22,151,000 | MBRC | Detailed site investigations and design should be undertaken for identified wetland and bioretention basin opportunities. For each site, detailed survey, geotechnical and drainage information will be required to progress with detailed design. Council will be responsible for implementing this solution through its PIP.<br>Opportunities to implement streetscape WSUD during urban renewal projects (e.g. road upgrades) should be investigated further. |
| | Education and capacity building to support implementation of solutions[3] | Not Costed | MBRC | This will be needed both within Council as well as in the general community to aid in successful implementation of solutions. For example:<br>- WSUD Demonstration sites for community/developers /consultants<br>- Signage educating community about WSUD elements<br>- Information packages educating community on WSUD with purchase of property<br>- Capacity building for Council DA staff on WSUD requirements<br>- Capacity building for Council staff on E&SC compliance and inspections<br>- Community educational programs for rural best management practices |
| | Total | 76,793,158 | | |
| Upper Pine Scenario 3 | Future development meets Queensland Development Code Alternative Water Supply Target through installation of rainwater tanks | $1,402,000 | MBRC, Developers | This is a legislative requirement, however to ensure compliance, MBRC should include provisions in its local planning scheme and ensure development approvals are only granted where it can be demonstrated that they comply with this requirement. Rainwater tanks should be internally plumbed to supply water to the toilet and laundry.<br>Capital costs will be borne by the developer. Ongoing maintenance and operational costs to be borne by the household owner. |
| | Waterway Riparian Revegetation (3rd & 4th order streams) | $8,342,000 | MBRC | This will be implemented via Council's Planning Scheme and Priority Infrastructure Plan. Opportunities exists to undertake this in partnership with community groups and local residents (schools, etc). |
| | Rural BMP for Grazing - Revegetation 1st & 2nd order streams | $19,081,000 | MBRC, Private landowners | The implementation of this solution will need to be investigated further with local landowners. Council will need to work closely with local landowners to implement this solution. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Upper Pine Scenario 3 (continued) | | | | partnership with SEQ Water and SEQ Catchments. Other community groups and local residents (e.g. schools) may be approached to assist with revegetation efforts. |
| | Rural BMP for Horticulture - Filter strips | $3,452,000 | MBRC, Private landowners | The implementation of this solution will need to be investigated further with local landowners. It will require implementation though educating property owners of BMPs. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ catchments. |
| | Increased Implementation/Enforcement of E&SC | $11,500 | MBRC | MBRC will be responsible for ensuring this is implemented through internal policies. It will involve dedicating more time to Council staff for on-site compliance inspections of E&SC practices on development sites. |
| | Greenfield WSUD achieves 'No Worsening' | $220,000 | MBRC, Developers | MBRC to include provisions in planning scheme or condition development approvals to achieve 'no worsening' from existing conditions for development to be allowed to proceed.<br><br>Development Assessment team to grant development approval only where 'no worsening' targets are demonstrated by developer. Training of internal Council staff may be required.<br><br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will be the responsibility of Council. |
| | Prevention of illegal stormwater inflow connections to sewer[3] | Not Costed | Unitywater | Investigate a change in design standards to one way valve (at overflow points) to prevent inflows. Implement community education campaigns to assist in preventing illegal connections. Additional staff may be needed for compliance inspections and follow up notices of illegal connections. These actions should be investigated in conjunction with Unitywater's Sewer Overflow Abatement Strategy. |
| | Upgrade WTP Capacity[3] | Not Costed | Unitywater | Dayboro borefield capacity issue. Pipeline from Petrie to Dayboro under consideration by Unitywater |
| | Upgrade STP Capacity[3] | Not Costed | Unitywater | Dayboro STP licence capacity upgrade may be required before 2031 and potentially design capacity. |
| | Education and capacity building to support implementation of solutions[3] | Not Costed | MBRC, Unitywater | This will be needed both within Council as well as in the general community to aid in successful implementation of solutions. For example:<br>- WSUD Demonstration sites for community/developers /consultants<br>- Signage educating community about WSUD elements<br>- Information packages educating community on WSUD and illegal |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Upper Pine Scenario 3 (continued) | | | | stormwater connections to sewer with purchase of property with purchase of property<br>- Capacity building for Council DA staff on WSUD requirements<br>- Capacity building for Council staff on E&SC compliance and inspections<br>- Community educational programs for rural best management practices |
| | Total | 32,508,500 | | |
| Lower Pine Scenario 3 | Future Development meets Queensland Development Code Alternative Water Supply Target through installation of rainwater tanks | $18,258,000 | MBRC, Developers | This is a legislative requirement, however to ensure compliance, MBRC should include provisions in its local planning scheme and ensure development approvals are only granted where it can be demonstrated that they comply with this requirement. Rainwater tanks should be internally plumbed to supply water to the toilet and laundry.<br>Capital costs will be borne by the developer. Ongoing maintenance and operational costs to be borne by the household owner. |
| | Waterway Riparian Revegetation (3rd & 4th order streams) | $9,817,000 | MBRC | This will be implemented via Council's Planning Scheme and Priority Infrastructure Plan. Opportunities exists to undertake this in partnership with community groups and local residents (schools, etc). |
| | Increased Implementation/Enforcement of E&SC | $402,000 | MBRC | MBRC will be responsible for ensuring this is implemented through internal policies. It will involve dedicating more time to Council staff for on-site compliance inspections of E&SC practices on development sites. |
| | Rural BMP for Grazing - Revegetation 1st & 2nd order streams | $1,519,000 | MBRC, Private Landowners | The implementation of this solution will need to be investigated further with local landowners. Council will need to work closely with local landowners to implement this solution. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ Catchments. Other community groups and local residents (e.g. schools) may be approached to assist with revegetation efforts. |
| | Rural BMP for Horticulture - Filter strips | $1,297,000 | MBRC, Private Landowners | The implementation of this solution will need to be investigated further with local landowners. It will require implementation though educating property owners of BMPs. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ catchments. |
| | Greenfield WSUD achieves 'No Worsening' | $27,683,000 | MBRC, Developers | MBRC to include provisions in planning scheme or condition development approvals to achieve 'no worsening' from existing conditions for development to be allowed to proceed. |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Lower Pine Scenario 3 (continued) | | | | Development Assessment team to grant development approval only where 'no worsening' targets are demonstrated by developer. Training of internal Council staff may be required.<br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will be the responsibility of Council. |
| | WSUD Retrofit to Existing Urban Areas | $38,332,000 | MBRC | Detailed site investigations and design should be undertaken for identified wetland and bioretention basin opportunities. For each site, detailed survey, geotechnical and drainage information will be required to progress with detailed design. Council will be responsible for implementing this solution through its PIP.<br>Opportunities to implement streetscape WSUD during urban renewal projects (e.g. road upgrades) should be investigated further. |
| | Stormwater Harvesting for Non-Potable Use | $7,886,428 [1] | MBRC | This solution should be included in Council's Local Planning Scheme for further investigation by the developer prior to development approval being granted. It is noted that the extent of this solution has been reduced in scale from original intentions during detailed planning, due to development approvals being granted on some sites.<br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will likely be the responsibility of Unitywater (for treatment and supply of water). |
| | Indirect Potable Reuse of Purified Recycled Water (PRW) | $471,359,000 [2] | Unitywater | Further detailed feasibility studies should be undertaken for the PRW scheme. This includes investigation and review of the current operating policy that restricts use of such schemes to when dam capacity is <40%.<br>It is noted that capital costing of conceptual design by Project Support was similar to that originally anticipated during the planning phase. The costs presented in this table have been updated to reflect Project Support cost estimates.<br>This solution may be included in both Unitywater's Network Services Plans (Netserv) and Council's Local Planning Scheme for further investigation. |
| | Prevention of illegal stormwater inflow connections to sewer[3] | Not Costed | Unitywater | Investigate a change in design standards to one way valve (at overflow points) to prevent inflows. Implement community education campaigns to assist in preventing illegal connections. Additional staff may be needed for compliance inspections and follow up notices of illegal connections. These actions should be investigated in conjunction with Unitywater's Sewer Overflow Abatement Strategy. |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Lower Pine Scenario 3 (continued) | Education and capacity building to support implementation of solutions[3] | Not Costed | MBRC, Unitywater | This will be needed both within Council as well as in the general community to aid in successful implementation of solutions. For example:<br>- WSUD Demonstration sites for community/developers /consultants<br>- Signage educating community about WSUD elements<br>- Information packages educating community on WSUD, PRW and illegal stormwater connections to sewer with purchase of property<br>- Capacity building for Council DA staff on WSUD requirements<br>- Capacity building for Council staff on E&SC compliance and inspections<br>- Community educational programs for rural best management practices<br>Importantly, community consultation and a targeted campaign to market and educate the community about Purified Recycled Water will be required to ensure successful implementation of this solution. |
| | Upgrade WTP Infrastructure[3] | Not Costed | Unitywater | Capacity issues identified from Clear Mountain to Samford to be further investigated and resolved. |
| | Upgrade STP Design Capacity (Murrumba & Brendale)[3] | Not Costed | Unitywater | Upgrade to design capacity of Murrumba Downs required by 2021 if 7,000 EP diverted from Burpengary East. Upgrade to Brendale design capacity required with expansion outside headworks, including CSR land, Strathpine TOD and Albany Creek Redevelopment. |
| | Total | $557,366,000 | | |
| Lower Pine Scenario 2 Alternative Option | Future Development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $27,683,000 | MBRC, Developer | MBRC to ensure provisions included in planning scheme.<br>Development Assessment team to allow development only where compliance is demonstrated. Training may be required.<br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will be the responsibility of Council. |
| | Future Development meets Queensland Development Code Alternative Water Supply Target through installation of rainwater tanks | $23,209,000 | MBRC, Developer | This is a legislative requirement, however to ensure compliance, MBRC should include provisions in its local planning scheme and ensure development approvals are only granted where it can be demonstrated that they comply with this requirement. Rainwater tanks should be internally plumbed to supply water to the toilet and laundry. |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Lower Pine Scenario 2 Alternative Option (continued) | Waterway Riparian Revegetation (3rd & 4th order streams) | $9,817,000 | MBRC | This will be implemented via Council's Planning Scheme and Priority Infrastructure Plan. Opportunities exists to undertake this in partnership with community groups and local residents (schools, etc). |
| | Increased Implementation/Enforcement of E&SC | $402,000 | MBRC | MBRC will be responsible for ensuring this is implemented through internal policies. It will involve dedicating more time to Council staff for on-site compliance inspections of E&SC practices on development sites. |
| | Rural BMP for Grazing - Revegetation 1st & 2nd order streams | $1,519,000 | MBRC, Private Landowners | The implementation of this solution will need to be investigated further with local landowners. Council will need to work closely with local landowners to implement this solution. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ Catchments. Other community groups and local residents (e.g. schools) may be approached to assist with revegetation efforts. |
| | Rural BMP for Horticulture - Filter strips | $1,297,000 | MBRC, Private Landowners | The implementation of this solution will need to be investigated further with local landowners. It will require implementation though educating property owners of BMPs. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ catchments. |
| | Recycled Water Supplied to Urban Users | $70,689,000 | Unitywater | It is noted that as this was identified as an alternative option, no conceptual design or detailed costing by Project Support has been undertaken. Provision of recycled water to the northern growth corridor for irrigation of Public Open Space is a licence requirement. Further detailed feasibility studies should be undertaken for the Brendale Recycling Scheme (large users and POS).<br><br>This solution may be included in both Unitywater's Network Services Plans (Netserv) and Council's Local Planning Scheme for further investigation. |
| | Prevention of illegal stormwater inflow connections to sewer[3] | Not Costed | Unitywater | Investigate a change in design standards to one way valve (at overflow points) to prevent inflows. Implement community education campaigns to assist in preventing illegal connections. Additional staff may be needed for compliance inspections and follow up notices of illegal connections. These actions should be investigated in conjunction with Unitywater's Sewer Overflow Abatement Strategy. |
| | Education and capacity building to support implementation of solutions[3] | Not Costed | MBRC, Unitywater | This will be needed both within Council as well as in the general community to aid in successful implementation of solutions. For example:<br>- WSUD Demonstration sites for community/developers /consultants |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Lower Pine Scenario 2 Alternative Option (continued) | | | | - Signage educating community about WSUD elements<br>- Information packages educating community on WSUD, PRW and illegal stormwater connections to sewer with purchase of property<br>- Capacity building for Council DA staff on WSUD requirements<br>- Capacity building for Council staff on E&SC compliance and inspections<br>- Community educational programs for rural best management practices |
| | Upgrade WTP Infrastructure[3] | Not Costed | Unitywater | Capacity issues identified from Clear Mountain to Samford to be further investigated and resolved. |
| | Upgrade STP Design Capacity (Murrumba & Brendale)[3] | Not Costed | Unitywater | Upgrade to design capacity of Murrumba Downs required by 2021 if 7,000 EP diverted from Burpengary East. Upgrade to Brendale design capacity required with expansion outside headworks, including CSR land, Strathpine TOD and Albany Creek Redevelopment. |
| | Total | $134,616,000 | | |
| Sideling Scenario 2 | Waterway Riparian Revegetation (3rd & 4th order streams) | $344,000 | MBRC | This will be implemented via Council's Planning Scheme and Priority Infrastructure Plan. Opportunities exists to undertake this in partnership with community groups and local residents (schools, etc). |
| | Rural BMP for Grazing - Revegetation 1st & 2nd order streams | $3,511,000 | MBRC, Private Landowners | The implementation of this solution will need to be investigated further with local landowners. Council will need to work closely with local landowners to implement this solution. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ Catchments. Other community groups and local residents (e.g. schools) may be approached to assist with revegetation efforts. |
| | Rural BMP for Horticulture - Filter strips | $69,000 | MBRC, Private Landowners | The implementation of this solution will need to be investigated further with local landowners. It will require implementation though educating property owners of BMPs. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ catchments. |
| | Education and capacity building to support implementation of solutions[3] | Not Costed | MBRC | Community educational programs for rural best management practices. |
| | Total | $3,924,000 | | |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Hays Scenario 3 | Future Development meets Queensland Development Code Alternative Water Supply Target through installation of rainwater tanks | $24,516,000 | MBRC, Developers | This is a legislative requirement, however to ensure compliance, MBRC should include provisions in its local planning scheme and ensure development approvals are only granted where it can be demonstrated that they comply with this requirement. Rainwater tanks should be internally plumbed to supply water to the toilet and laundry.<br><br>Capital costs will be borne by the developer. Ongoing maintenance and operational costs to be borne by the household owner. |
| | Waterway Riparian Revegetation (3rd & 4th order streams) | $1,797,000 | MBRC | This will be implemented via Council's Planning Scheme and Priority Infrastructure Plan. Opportunities exists to undertake this in partnership with community groups and local residents (schools, etc). |
| | Increased Implementation/Enforcement of E&SC | $457,000 | MBRC | MBRC will be responsible for ensuring this is implemented through internal policies. It will involve dedicating more time to Council staff for on-site compliance inspections of E&SC practices on development sites. |
| | Recycled Water Supplied to Urban Users (Redcliffe STP) | $39,273,000 [2] | Unitywater | Further detailed feasibility studies should be undertaken for the following schemes:<br>- Redcliffe Reuse Scheme<br>- Ray Frawley Fields<br><br>It is noted that costing of conceptual scheme design was more expensive than originally anticipated during the planning phase, and may affect the feasibility of this project. The costs presented in this table have been updated to reflect Project Support cost estimates.<br><br>Another alternative to recycled water that should be further investigated by Unitywater is the upgrade of treatment processes at Redcliffe STP to improve effluent quality.<br><br>This solution may be included in both Unitywater's Network Services Plans (Netserv) and Council's Local Planning Scheme for further investigation. |
| | Greenfield WSUD achieves 'No Worsening' | $82,822,000 | MBRC, Developers | MBRC to include provisions in planning scheme or condition development approvals to achieve 'no worsening' from existing conditions for development to be allowed to proceed.<br><br>Development Assessment team to grant development approval only where 'no worsening' targets are demonstrated by developer. Training of internal Council staff may be required.<br><br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will be the responsibility of Council. |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Hays Scenario 3 (continued) | Stormwater Harvesting for Non-Potable Use | $10,536,000 [1] | MBRC | This solution should be included in Council's Local Planning Scheme for further investigation by the developer prior to development approval being granted. It is noted that the extent of this solution has been reduced in scale from original intentions during detailed planning, due to development approvals being granted on some sites.<br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will likely be the responsibility of Unitywater (for treatment and supply of water). |
| | WSUD Retrofit to Existing Urban Areas | $8,841,000 | MBRC | Detailed site investigations and design should be undertaken for identified bioretention basin opportunities. For each site, detailed survey, geotechnical and drainage information will be required to progress with detailed design. Council will be responsible for implementing this solution through its PIP.<br>Opportunities to implement streetscape WSUD during urban renewal projects (e.g. road upgrades) should be investigated further. |
| | Prevention of illegal stormwater inflow connections to sewer[3] | Not Costed | Unitywater | Investigate a change in design standards to one way valve (at overflow points) to prevent inflows. Implement community education campaigns to assist in preventing illegal connections. Additional staff may be needed for compliance inspections and follow up notices of illegal connections. These actions should be investigated in conjunction with Unitywater's Sewer Overflow Abatement Strategy. |
| | Education and capacity building to support implementation of solutions[3] | Not Costed | MBRC, Unitywater | This will be needed both within Council as well as in the general community to aid in successful implementation of solutions. For example:<br>- WSUD Demonstration sites for community/developers /consultants<br>- Signage educating community about WSUD elements<br>- Information packages educating community on WSUD and illegal stormwater connections to sewer with purchase of property<br>- Capacity building for Council DA staff on WSUD requirements<br>- Capacity building for Council staff on E&SC compliance and inspections |
| | Upgrade STP Design Capacity[3] | Not Costed | | Review of current plant loading at Redcliffe STP required, as immediate design capacity upgrade may be required. |
| | Total | $168,242,000 | | |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Redcliffe Scenario 1 | Future Development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $6,788,000 | MBRC, Developers | MBRC to ensure provisions included in planning scheme.<br>Development Assessment team to allow development only where compliance is demonstrated. Training may be required.<br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will be the responsibility of Council. |
| | Future Development meets Queensland Development Code Alternative Water Supply Target through installation of rainwater tanks | $26,914,000 | MBRC, Developers | This is a legislative requirement, however to ensure compliance, MBRC should include provisions in its local planning scheme and ensure development approvals are only granted where it can be demonstrated that they comply with this requirement. Rainwater tanks should be internally plumbed to supply water to the toilet and laundry.<br>Capital costs will be borne by the developer. Ongoing maintenance and operational costs to be borne by the household owner. |
| | Total | $33,702,000 | | |
| Brisbane Coastal Scenario 2 | Future Development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $811,000 | MBRC, Developers | MBRC to ensure provisions included in planning scheme.<br>Development Assessment team to allow development only where compliance is demonstrated. Training may be required.<br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will be the responsibility of Council. |
| | Future Development meets QDC Alternative Water Supply Target | $1,690,000 | MBRC, Developers | This is a legislative requirement, however to ensure compliance, MBRC should include provisions in its local planning scheme and ensure development approvals are only granted where it can be demonstrated that they comply with this requirement. Rainwater tanks should be internally plumbed to supply water to the toilet and laundry.<br>Capital costs will be borne by the developer. Ongoing maintenance and operational costs to be borne by the household owner. |
| | Increased Implementation/Enforcement of E&SC | $13,900 | MBRC | MBRC will be responsible for ensuring this is implemented through internal policies. It will involve dedicating more time to Council staff for on-site compliance inspections of E&SC practices on development sites. |
| | Education and capacity building to support implementation of solutions[3] | Not Costed | MBRC | This will be needed both within Council as well as in the general community to aid in successful implementation of solutions. For example:<br>- WSUD Demonstration sites for community/developers /consultants<br>- Signage educating community about WSUD elements |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Brisbane Coastal Scenario 2 (continued) | | | | - Information packages educating community on WSUD with purchase of property<br>- Capacity building for Council DA staff on WSUD requirements<br>- Capacity building for Council staff on E&SC compliance and inspections |
| | Total | 2,514,900 | | |
| Stanley Scenario 2 | Future Development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $2,762,000 | MBRC, Developers | MBRC to ensure provisions included in planning scheme.<br>Development Assessment team to allow development only where compliance is demonstrated. Training may be required.<br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will be the responsibility of Council. |
| | Future Development meets Queensland Development Code Alternative Water Supply Target through installation of rainwater tanks | $5,296,000 | MBRC, Developers | This is a legislative requirement, however to ensure compliance, MBRC should include provisions in its local planning scheme and ensure development approvals are only granted where it can be demonstrated that they comply with this requirement. Rainwater tanks should be internally plumbed to supply water to the toilet and laundry.<br>Capital costs will be borne by the developer. Ongoing maintenance and operational costs to be borne by the household owner. |
| | Rural BMP for Grazing - Revegetation 1st & 2nd order streams | $34,714,000 | MBRC, Private Landowners | The implementation of this solution will need to be investigated further with local landowners. Council will need to work closely with local landowners to implement this solution. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ Catchments. Other community groups and local residents (e.g. schools) may be approached to assist with revegetation efforts. |
| | Rural BMP for Horticulture - Filter strips | $1,440,000 | MBRC, Private Landowners | The implementation of this solution will need to be investigated further with local landowners. It will require implementation though educating property owners of BMPs. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ catchments. |
| | Waterway Riparian Revegetation (3rd & 4th order streams) | $8,630,000 | MBRC | This will be implemented via Council's Planning Scheme and Priority Infrastructure Plan. Opportunities exists to undertake this in partnership with community groups and local residents (schools, etc). |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Stanley Scenario 2 (continued) | Increased Implementation/Enforcement of E&SC | $43,000 | MBRC | MBRC will be responsible for ensuring this is implemented through internal policies. It will involve dedicating more time to Council staff for on-site compliance inspections of E&SC practices on development sites. |
| | Recycled water to land / agricultural users | $2,040,000 | Unitywater | Feasibility studies by Unitywater indicated this is the least cost solution for wastewater management. It should be included in Unitywater's Network Service Plan for implementation. The scheme needs to be operational by 2020 to comply with licence discharge requirements. |
| | Prevention of illegal stormwater inflow connections to sewer[3] | Not Costed | Unitywater | Investigate a change in design standards to one way valve (at overflow points) to prevent inflows. Implement community education campaigns to assist in preventing illegal connections. Additional staff may be needed for compliance inspections and follow up notices of illegal connections. These actions should be investigated in conjunction with Unitywater's Sewer Overflow Abatement Strategy. |
| | Upgrade Woodford STP Capacity[3] | Not Costed | Unitywater | Immediate design capacity upgrade required |
| | Education and capacity building to support implementation of solutions[3] | Not Costed | MBRC, Unitywater | This will be needed both within Council as well as in the general community to aid in successful implementation of solutions. For example:<br>- WSUD Demonstration sites for community/developers /consultants<br>- Signage educating community about WSUD elements<br>- Information packages educating community on WSUD and illegal stormwater connections to sewer with purchase of property<br>- Capacity building for Council DA staff on WSUD requirements<br>- Capacity building for Council staff on E&SC compliance and inspections<br>- Community educational programs for rural best management practices |
| | Total | 54,925,000 | | |
| Pumicestone Scenario 2 | Future Development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $33,118,000 | MBRC, Developers | MBRC to ensure provisions included in planning scheme.<br>Development Assessment team to allow development only where compliance is demonstrated. Training may be required.<br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will be the responsibility of Council. |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Pumicestone Scenario 2 (continued) | Future Development meets Queensland Development Code Alternative Water Supply Target through installation of rainwater tanks | $890,000 | MBRC, Developers | This is a legislative requirement, however to ensure compliance, MBRC should include provisions in its local planning scheme and ensure development approvals are only granted where it can be demonstrated that they comply with this requirement. Rainwater tanks should be internally plumbed to supply water to the toilet and laundry.<br>Capital costs will be borne by the developer. Ongoing maintenance and operational costs to be borne by the household owner. |
| | Rural BMP for Grazing - Revegetation 1st & 2nd order streams | $15,141,000 | MBRC, Private Landowners | The implementation of this solution will need to be investigated further with local landowners. Council will need to work closely with local landowners to implement this solution. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ Catchments. Other community groups and local residents (e.g. schools) may be approached to assist with revegetation efforts. |
| | Rural BMP for Horticulture - Filter strips | $521,000 | MBRC, Private Landowners | The implementation of this solution will need to be investigated further with local landowners. It will require implementation though educating property owners of BMPs. Incentive schemes may be used to promote adoption. Opportunities should be investigated to undertake this in partnership with SEQ Water and SEQ catchments. |
| | Waterway Riparian Revegetation (3rd & 4th order streams) | $4,806,000 | MBRC | This will be implemented via Council's Planning Scheme and Priority Infrastructure Plan. Opportunities exists to undertake this in partnership with community groups and local residents (schools, etc). |
| | Increased Implementation/Enforcement of E&SC | $7,000 | MBRC | MBRC will be responsible for ensuring this is implemented through internal policies. It will involve dedicating more time to Council staff for on-site compliance inspections of E&SC practices on development sites. |
| | Education and capacity building to support implementation of solutions[3] | Not Costed | MBRC | This will be needed both within Council as well as in the general community to aid in successful implementation of solutions. For example:<br>- WSUD Demonstration sites for community/developers /consultants<br>- Signage educating community about WSUD elements<br>- Information packages educating community on WSUD with purchase of property<br>- Capacity building for Council DA staff on WSUD requirements<br>- Capacity building for Council staff on E&SC compliance and inspections |

| Catchment & Scenario | Solution | Indicative Cost ($2011 NPV) | Primary Responsibility | Actions and Notes on Implementation Pathway |
|---|---|---|---|---|
| Pumicestone Scenario 2 (continued) | | | | - Community educational programs for rural best management practices |
| | Total | $54,483,000 | | |
| Bribie Scenario 2 | Future Development meets SPP Healthy Waters 80/60/45% load reduction for TSS/TP/TN | $3,622,000 | MBRC, Developers | MBRC to ensure provisions included in planning scheme.<br>Development Assessment team to allow development only where compliance is demonstrated. Training may be required.<br>Construction and initial maintenance cost will be borne by the developer, however ongoing maintenance costs will be the responsibility of Council. |
| | Future Development meets Queensland Development Code Alternative Water Supply Target through installation of rainwater tanks | $5,444,000 | MBRC, Developers | This is a legislative requirement, however to ensure compliance, MBRC should include provisions in its local planning scheme and ensure development approvals are only granted where it can be demonstrated that they comply with this requirement. Rainwater tanks should be internally plumbed to supply water to the toilet and laundry.<br>Capital costs will be borne by the developer. Ongoing maintenance and operational costs to be borne by the household owner. |
| | Increased Implementation/Enforcement of E&SC | $45,000 | MBRC | MBRC will be responsible for ensuring this is implemented through internal policies. It will involve dedicating more time to Council staff for on-site compliance inspections of E&SC practices on development sites. |
| | Education and capacity building to support implementation of solutions[3] | Not Costed | MBRC | This will be needed both within Council as well as in the general community to aid in successful implementation of solutions. For example:<br>- WSUD Demonstration sites for community/developers /consultants<br>- Signage educating community about WSUD elements<br>- Information packages educating community on WSUD with purchase of property<br>- Capacity building for Council DA staff on WSUD requirements<br>- Capacity building for Council staff on E&SC compliance and inspections |
| | Total | $ 9,111,000 | | |

[1] Cost estimates based on revisions to feasible stormwater harvesting schemes (refer to Appendix F and Table F2 for details)

[2] Includes capital cost estimate by Project Support (refer Appendix G) based on conceptual design layout for recycled water schemes by Bligh Tanner (refer to Appendix F)

[3] Assessment of the cost and performance of this solution has not been undertaken

# 9 REFERENCES


ABARE (1998-99). Resource Management Survey Data Package 1998-99, online at: http://abareconomics.com/ame/lrm/lrmalt.asp.

AECOM et al (2010). *Morayfield-Burpengary Local Planning Area Investigation.* Prepared for Moreton Bay Regional Council.

Beal, C.D., Stewart, R.A., Huang, T. (2010). *South East Queensland Residential End Use Study:Baseline results – Winter 2010*. Urban Water Security Research Alliance Technical Report No. 31.

Bligh Tanner and Design Flow (2009). *Stormwater Infrastructure Options to Achieve Multiple Water Cycle Outcomes.* Queensland Water Commission, Brisbane.

BMT WBM (2010). *Total Water Cycle Management Strategy for Moreton Bay Regional Council*.

BMT WBM (2011). *Sub-Regional Total Water Cycle Management Plan for the Caboolture Identified Growth Area (CIGA)*. Prepared for Queensland Water Commission.

Brisbane City Council (2000). *Stormwater Monitoring Program 1999/2000.* Water and Environment, City Design, Brisbane City Council, Brisbane, November 2000.

Brisbane City Council (BCC) (2011). *Brisbane City Council Streetscape Planning & Design Package*

Buckley Vann et al (2009). *Old Bay Structure Plan Project, Phase 2 Report.* Prepared for Moreton Bay Regional Council and Portfolio Projects.

Cardno (2010). *Caboolture Identified Growth Area Infrastructure & Staging Report.* Prepared for Brookfield Multiplex, Stockland Development, Heritage Properties and Lenvest Holdings.

Chowdhury, R., Gardner, T., Laredo, L., McIntosh, B., Maheepala, S. and Beecham, S. *Biophysical Rules for Stormwater Harvesting in South East Queensland.* (2011). Paper presented at the Stormwater Industry Association of Queensland Conference, Gold Coast 25-27 May 2011.

Croke, J., Wallbrin, P., Fogarty, P., Hairsine, P., Mockler, S., McCormack, B. and Brophy, J. (1999) *Managing Sediment Sources and Movement in Forests: The Forest Industry and Water Quality, Industry Report 99/11*, Cooperative Research Centre for Catchment Hydrology

Department of Climate Change and Energy Efficiency (DCCEE) (2011). *National Greenhouse Accounts Factors.* Australian Government.

Department of Environment and Natural Resources (DERM), 2009. *Environmental Protection (Water) Policy 2009*. Queensland Government.

Department of Infrastructure and Planning (DIP), 2009. *South East Queensland Regional Plan 2009-2031* (SEQ Regional Plan). Queensland Government.

Department of Natural Resources and Water (DNRW) (Queensland Government) (2008). *Water Quality Guidelines for Recycled Water Schemes.* DNRW, Brisbane.

Environmental Protection Agency (EPA) (2005). *Queensland Recycled Water Guidelines*. EPA, Brisbane.

Fane, S. et al (2002). *The Use of Levelised Cost in Comparing Supply and Demand Side Options.* Water Supply Vol 3 No 3 pp185-192, IWA Publising.

Fane, S. and White, S. (2003). *Levelised Cost, a General Formula for Calculations of Unit Cost in Integrated Resource Planning.*

GHD (2007). *Northeast Business Park Environmental Impact Assessment, Water Supply and Sewerage Systems.*

GHD (2002). *Redcliffe City Council Effluent Reuse Project Feasibility Study.* Prepared for Redcliffe City Council.

Hall, M. et al (2009). *Energy and Greenhouse Gas Emissions for the SEQ Water Strategy*. Urban Water Security Research Alliance Technical Report No. 14

Helm, L., Mollogy, R., Lennon, L. and Dillon, P. (2009) *South East Queensland Opportunity Assessment for Aquifer Storage and Recovery.* Facilitating Recycling of Stormwater and Reclaimed Water via Aquifers in Australia – Milestone Report 3.3.2. CSIRO Water for a Healthy Country Flagship.

Lu, H., Moran, C.J., DeRose, R. and Cannon, G. (2003). *Spatially Distributed Investment Prioritization for Sediment Control in the Murray Darling Basin.* Technical Report 31/03, CSIRO and Water.

MBRC. (2011) Unit Rates. Spreadsheet of infrastructure unit rates for Priority Infrastructure Planning.

MWH (2009). *Moreton Bay Regional Council Integrated Urban Water Cycle Management Strategy, Final Report.* Prepared for Moreton Bay Regional Council.

Natural Resource Management Ministerial Council, Environment Protection and Heritage Council Australian Health Ministers' Conference (2006). *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase1).* Natural Resource Management Ministerial Council Environment Protection and Heritage Council Australian Health Ministers' Conference, Canberra

National Water Commission (NWC) 2007. *The Cost-Effectiveness of Rainwater Tanks in Urban Australia.* Australian Government.

Rawlinsons Publishing (2011). *Rawlinsons Australian Construction Handbook (Edition 29).*

Queensland Water Commission. (2010). Bulk Water Prices. Accessed at: http://www.qwc.qld.gov.au/reform/pdf/bulk-water-prices-061210.pdf accessed 28 July 2011.

Taylor, A and Wong, T. (2002). *Non-Structural Stormwater Quality Best Management Practices - A Literature Review Of Their Value And Life-Cycle Costs*. CRCCH Technical Report 02/13. Cooperative Research Centre for Catchment Hydrology, Melbourne.

Unitywater (2010) *Woodford Sewage Treatment Plant Upgrade Business Case.*

Water by Design (WBD) (2010a). *Total Water Cycle Management Guideline for South East Queensland. SEQ Healthy Waterways Partnership. Brisbane, Queensland (Version 1, December 2010)*. Department of Environment and Resource Management, Brisbane, Queensland.

Water by Design (WBD) (2010b). *MUSIC Modelling Guidelines.* SEQ Healthy Waterways Partnership. Brisbane, Queensland. ISBN 978-0-9806278-4-8.

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|---|---|
| BMT WBM Brisbane | Level 8, 200 Creek Street Brisbane 4000<br>PO Box 203 Spring Hill QLD 4004<br>Tel +61 7 3831 6744 Fax +61 7 3832 3627<br>Email bmtwbm@bmtwbm.com.au<br>Web www.bmtwbm.com.au |
| BMT WBM Denver | 14 Inverness Drive East, #B132<br>Englewood Denver Colorado 80112 USA<br>Tel +1 303 792 9814 Fax +1 303 792 9742<br>Email denver@bmtwbm.com<br>Web www.bmtwbm.com.au |
| BMT WBM Mackay | Suite 1, 138 Wood Street Mackay 4740<br>PO Box 4447 Mackay QLD 4740<br>Tel +61 7 4953 5144 Fax +61 7 4953 5132<br>Email mackay@bmtwbm.com.au<br>Web www.bmtwbm.com.au |
| BMT WBM Melbourne | Level 5, 99 King Street Melbourne 3000<br>PO Box 604 Collins Street West VIC 8007<br>Tel +61 3 8620 6100 Fax +61 3 8620 6105<br>Email melbourne@bmtwbm.com.au<br>Web www.bmtwbm.com.au |
| BMT WBM Newcastle | 126 Belford Street Broadmeadow 2292<br>PO Box 266 Broadmeadow NSW 2292<br>Tel +61 2 4940 8882 Fax +61 2 4940 8887<br>Email newcastle@bmtwbm.com.au<br>Web www.bmtwbm.com.au |
| BMT WBM Perth | Suite 3, 1161 Hay Street West Perth 6005<br>Tel +61 8 9328 2029 Fax +61 8 9484 7588<br>Email perth@bmtwbm.com.au<br>Web www.bmtwbm.com.au |
| BMT WBM Sydney | Level 1, 256-258 Norton Street Leichhardt 2040<br>PO Box 194 Leichhardt NSW 2040<br>Tel +61 2 9713 4836 Fax +61 2 9713 4890<br>Email sydney@bmtwbm.com.au<br>Web www.bmtwbm.com.au |
| BMT WBM Vancouver | 401 611 Alexander Street Vancouver<br>British Columbia V6A 1E1 Canada<br>Tel +1 604 683 5777 Fax +1 604 608 3232<br>Email vancouver@bmtwbm.com<br>Web www.bmtwbm.com.au |

Moreton Bay Regional Council